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The Effects of a Movement with Music Program on Measures of Balance and Gait Speed in Healthy Older Adults

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A group of 16 healthy older adults participated in a movement with music program to enhance physical flexibility, balance, and gait speed. The program, designed by a Laban Movement Analyst, consisted of 14 movement sequences set to music composed to reflect the dynamics, rhythm, timing, and phrasing of the movements. After 5 weeks, individuals showed statistically significant increases in measures of one-foot stance balance, gait speed, and functional reach. From the 5th to the 14th week, improvements continued in all measures but were not statistically significant.

Introduction

It is well known that the older population is increasing rapidly across the world with projections of 70 million people at age 65 years and older by the year 2030. Those over age 85 comprise the fastest growing segment of the population (Mezzeo et al., 1998). With this increase in older individuals comes the need to identify what determines good physical functioning levels and the potential for their maintenance or decline (Seeman et al., 1995). There are strong indications that regular exercise and physical activity contribute to improved physical function, increased independence, good overall health, and improved life quality (Mazzeo et al., 1998). Furthermore, physical activity reduces the likelihood of physical disability in later years (Leveille, Guralnik, Ferruci, & Langlois, 1999). Even so, individuals over the age of 50, and especially those over age 75, comprise the most sedentary segment of the adult population (United States Department of Health and Human Services, 1996). This age group experiences the largest proportion of chronic disease and disability

and receives the greatest amount of health care (Berg & Casells, 1990; Hoffman, Rice, & Sung, 1996; LaPlante, 1998), which begins as early as the fifth decade of life (Huang et al., 1998). Changes in diet and exercise have been shown to reduce the health care need for this segment of the population (Berg & Casells, 1990; Hoffman et al., 1996; LaPlante, 1989; Lonegran & Krevans, 1992).

The risk for functional decline increases as people age, and the potential for deteriorated physical strength and flexibility can lead to falls, the precursor to the most serious injuries and most common medical problems suffered by older adults (Province et al., 1995). Falls lead to morbidity and even mortality, especially in deaths attributed to unintentional injury in adults over the age of 65, but particularly in those over age 85 years (Sattin, 1992). Those who survive falls experience greater declines in activities of daily living, physical activities, and social interactions (Dunn, Rudberg, Furner, & Cassells, 1992; Kiel, O'Sullivan, Teno, & Mor, 1991). Fall survivors are more likely to be institutionalized (Tinetti, Liu, & Claus, 1993). It has been shown, however, that participation in moderate and even strenuous activity is associated with improved physical performance in older adults, regardless of sociodemographic factors and baseline health (Seeman et al., 1995).

Falls are due in large part to an older adult's physical deficits in strength, reaction time, flexibility (Province et al., 1995) and to disturbances in balance (Cho & Kamen, 1998; Hornbrook et al., 1994; Province et al., 1995; Tinetti et al., 1994; Tinetti, Speechley, & Ginter, 1988) and gait (Cho & Kamen, 1998; Hornbrook et al., 1994; Rubenstein et al., 1998; Tinetti et al., 1988). Falls can be prevented by improving physical abilities, including balance and gait (Cho & Kamen, 1998). It is therefore essential to design interventions that target these areas in the context of physical exercise and movement with music to promote better health and wellness for older adults.

Johnson, Otto, and Clair (2002) conducted a study that demonstrated some positive responses to familiar music as an external stimuli that facilitated adherence to a physical rehabilitation exercise program with persons who are elderly. Study participants were distracted by the music, however, and often sang along with familiar music used in the exercise program. These participants were less likely to engage in physical exercise movements while they sang. While the research outcomes with music were positively received by the participants, the study indicated unfamiliar music,

rather than familiar music, would likely function to enhance adherence to exercise programs designed for older adults.

The purpose of this study was to evaluate the effects of "Motivating Moves: Movement with Music to Promote the Health of Older Adults" on balance and gait. New music was composed to cue each of the movement sequences in the program.

The 14 movement sequences were based on movement principles developed by Rudolf Laban and Irmgard Bartenieff (Bartenieff & Lewis, 1980). Laban was a Hungarian dancer, choreographer, educator, and movement theorist who spent much of his professional life in Germany before immigrating to Great Britain in 1938 (Preston-Dunlop, 1998). He developed a framework to observe, analyze, and notate all types of movement, from everyday gesture and work actions to sport and theatrical performance. His theories are supported by neurophysiological research on the relationship among sensorimotor, affective, and cognitive aspects of movement (Bartenieff, 1974). Bartenieff was a protégé of Laban's in Berlin. After immigrating to New York City in 1936, she became a physical therapist and a founding member of the American Dance Therapy Association.

The work of Laban, Bartenieff, and Laban protégé Warren Lamb is known as Laban Movement Analysis. Its four major components are the body and its internal pathways of coordination; the shape that the body and its parts form during motion; the space in which the movement occurs, and the dynamics of movement. Bartenieff elaborated on Laban's theories, developing a series of basic movements called Bartenieff Fundamentals, which are the building blocks of all coordinated movement. These fundamental movements identify where in the body movement initiates and how it sequences through the body. Bartenieff first applied her Fundamentals in therapeutic work with polio patients and children with disabilities (Bartenieff & Lewis, 1980).

The movement program for this study was designed and implemented by a certified Laban Movement Analyst who is also a professor of dance at a large, Midwestern university. Program feasibility was tested in preliminary research that indicated the content and duration were appropriate, and that the participants enjoyed the program (Teel, Carson, Hamburg, & Clair, 1999). The Motivating Moves with Music program was unique because it did not require aerobic activity that stimulates heart rate and respiration.

The 14 movement sequences were not in the form of traditional physical exercises but of movements phrased with varying dynamic qualities. The research questions were as follows:

1. Does the "Motivating Moves" program improve gait speed of healthy older adults?
2. Does the "Motivating Moves" program increase characteristics of balance, comprised of one-foot stance and functional reach, in healthy older adults?

Method

Subjects

Healthy older adults who enrolled in the "Motivating Moves" class at their local senior center were asked to volunteer as participants. Sixteen individuals gave consent for the study. Of these, 14 class members, two males and 12 females, served as participants. They were involved in at least 10 of the 14 learning sessions held once weekly for one hour. These individuals ranged in age from 65 to 78 years.

"Motivating Moves" Music

Music to facilitate the movements was based on the scientific model of Neurological Music Therapy, which demonstrates that music serves as an auditory cue for movement (Kenyon, Irwin, McIntosh, & Thaut, 2000; Kenyon & Thaut, 2000; Peterson & Thaut, 2000; Thaut & Peterson, 2000). In this approach movements entrain, or become synchronized, with rhythm. As a basic element of music, rhythm has perceptual and physiological attributes that can influence the control of movement (Hurt, Rice, McIntosh, & Thaut, 1998). This movement control not only occurs in lower extremities, but in the upper extremities as well (Thaut, Schleiffers, & Davis, 1991). The influence of music goes beyond physical movement cueing to include shifts in attitude and perceptions of pacing, strength, and endurance (Gfeller, 1988). Through rhythm, music enhances movement duration, speed, and range of motion while it reinforces the rhythm, timing, phrasing, and dynamics of the movements.

To assure that participants had no prior association or experience with musical selections that could influence outcomes, the music for this program was composed by the director of jazz stud-

ies at a large, Midwestern university. The music was created to reflect the duration, speed, number of repetitions, and movement dynamics for each movement as demonstrated by the Laban Movement Analyst. In this music ascending pitches cued movements that moved from lower to higher points in space. Conversely, descending pitches, or melody lines, cued movements from higher to lower spatial points. Tempos were matched to the repetition rate of movements and the duration of musical phrases that cued the ranges of motion through space. Dynamics cued the force of movement, that is, loud phrases indicated strong force while soft phrases indicated light effort. Each movement sequence had a two to four measure introduction that gave a clear indication of the type of movement that followed.

A professional recording was made of the instrumental music that was performed on piano, soprano saxophone, string bass, and percussion. The individual musical pieces for each movement in the program were recorded and mastered into an audio tape that was sequenced as follows: (a) a verbal announcement of the specific movement; (b) a musical introduction to provide an auditory cue; (c) music to cue the speed, range, duration, and repetitions of specific movements; (d) a clear musical ending to give an auditory cue for closure to the movement, and (e) a 5-second break before the next movement was announced.

The "Motivating Moves" Program

The instructor for the program developed it to enhance physical flexibility, balance, diaphragmatic breathing, coordination, and spatial awareness. It was designed in 1997 at the request of the University of Kansas Medical Center's Center on Aging. It includes alternative movements for older adults who have varying physical performance abilities. All movements were taught in three alternate positions: (a) standing unassisted, (b) standing holding on to a chair for stability, or (c) seated. All three positions were modeled by the instructor and the class assistants each time a movement sequence was taught and when it was performed within the program. The entire program lasted 20 minutes. Although they were not discouraged from doing so, participants generally did not practice the movements during the week following the learning session, but performed them only in the "Motivating Moves" class.

Each movement in the program was designed to meet a func-

tional purpose (e.g., improving spinal mobility), provide a positive outcome (e.g., improving postural support), and to have a practical application to daily living activities (e.g., improving flexibility for dressing or bending down to pick up an object). The movements were sequenced to allow for a balance of exertion and recuperation throughout the program.

The program began with a spine wake-up, progressed through stretches and contrasts between (a) forceful and gentle movements, (b) sudden and sustained movements, (c) direct focus and flexible awareness movements, and ended with weight shifts accompanied by arm swings. The program followed a developmental progression that began with movement of the whole spine and ended with cross-lateral movement of both arms and legs. Diaphragmatic breathing was emphasized throughout the movement program. The complete program with movement titles, purposes, outcomes, and applications is presented in Figure 1.

Procedure

The instructor taught the program with assistance from seven university students enrolled for credit in an upper division class on the topic of movement for older adults. Though the program was designed for delivery by an individual instructor, the class served as a practicum experience for the students. These students helped with the measures for balance, functional reach, and gait speed at Sessions 1, 6, and 14 and were dispersed throughout the class to serve as models. The assistants learned the movement sequences and the movement principles supporting them before meeting with the older adults.

Measures of Balance, Functional Reach, and Gait Speed

On the first day of the class, the older adults were asked to participate in the initial measures for functional reach, balance, and gait speed. To measure the reach, each individual stood on a mark on the floor. The mark was extended up the wall to make certain all subjects were measured from the same point. Each subject was asked to extend the right arm at shoulder level to reach as far ahead as possible with fingers folded into a fist, so that finger length did not affect the measure. A tape measure was used to measure the arm extension from the starting mark to the tip of the knuckles. An assistant recorded the measurement in inches.

Movement title	Functional purpose	Outcome	Applications
1. Spine Wake-up	Improves mobility of the spine from head to tail bone	Improves arm range of motion and postural support	Improves flexibility for dressing, driving, bending or stooping to pick up objects
2. Heel Impressions	Stretches leg muscles, primarily the calf	Allows good contact of heels on the floor	Increases stability while sitting or standing
3. March	Increases hip flexion/flexibility & balance	Improves hip & leg ranges of motion	Improves flexibility to squat & to balance on one foot for stair climbing
4. Lunge & Stretch	Stretches hip muscles	Allows erect posture	Decreases fatigue while standing
5. Lunge & Push	Increases power from shoulder muscles to hand	Increases force of upper body in forward & sideward motion	Increases functional strength to move large objects, e.g., garbage container
6. Flick/Wring/Punch	Improves dynamics & variations in movements & spatial awareness	Rehearses shifts between strong and less forceful movements	Improves skill to change movements & directions of movements quickly, e.g., opening doors, wringing wet items, opening jars
7. Heel Push	Stimulates sensory perception of the soles of the feet	Increases awareness of foot contact with the floor	Improves pedal action while driving or bicycling & improves stability while standing
8. Reaching into Space	Spatial awareness around the body	Improves movement of the spine and midline crossing	Improves reach for & control of objects high above & behind, facilitates twisting movements, e.g., playing golf, driving, sight seeing
9. Releasing the Hip (Tensor Fasciae Latae Release)	Releases tension around the hip joints	Improves mobility and comfort of the hip	Relieves stiffness associated with long periods of sitting

FIGURE 1.
Sequenced movement program description.

Movement title	Functional purpose	Outcome	Applications
10. Shifting Weight: Side to Side	Improves symmetry of walking gait	Increases mobility & comfort while moving	Improves ease in walking & sliding movements while sitting or standing, e.g., sliding along a church pew or bench
11. Arm Circles in Four Directions	Increases arm & shoulder motion ranges	Improves flexibility & reduces arm movement fatigue	Increases endurance for repetitive arm movements, e.g., golf swing, hair grooming, reaching
12. Press/Slash/Glide	Improves functional strength from shoulder muscles to hand & improves dynamic variations in movements	Increases force of upper body movements & ability to make smooth, gentle movements	Improves efficiency for tasks, e.g., closing doors or lids, stapling, opening jars, swatting insects, smoothing pillows, fabric or other materials
13. Punch/Dab/Float	Improves ability to make dynamic changes in the force, focus & timing of movement	Improves spatial awareness, accuracy in timing & ability to vary the force of a movement	Facilitates strength for thrusting/shoving, e.g., shoveling; actions & control for light touch, e.g., typing e-mail; allows muscle release & recuperation, e.g., lift sheets up/float down
14. Walking Weight Shifts	Increases walking efficiency	Improves balance as weight shifts from one foot to the other	Increases walking speed & confidence of movement

FIGURE 1.
Continued.

To measure balance, all participants were asked to stand on one foot for as long as was comfortable. They were encouraged to choose the foot on which to stand. Next, an assistant stood in close proximity on either side as each individual executed the task. Two trials were performed in which the participant lifted one foot and stood unassisted. In the second trial, the assistant activated a stopwatch at the point at which the unweighted foot was lifted from the floor and deactivated the stopwatch when the foot again touched down. The assistant then recorded the number of seconds. A ceiling of 30 seconds was set, and anyone who achieved that duration

for one-foot stance was asked to stop. A duration of 30 seconds was then recorded for that subject.

For gait speed, each participant was asked to walk as quickly as possible for 10 meters that were marked in a straight path in the large classroom. Tape on the floor represented the start and end points. Each participant was asked to stand with toes on the start line. When cued to "go," an assistant activated a stopwatch and deactivated it as the participant stepped across the end point. The assistant recorded the time in seconds.

Measures for balance, functional reach, and gait speed were used in the same way at the conclusion of Session 5 and at the conclusion of the last session, Session 14. The measures were taken by the same assistants with each individual participant to assure consistency. When the measures were completed on the last day, each participant was handed a sheet that provided measurement data for his or her balance, functional reach, and walking speed performances.

The class sessions were held once weekly for one hour in a large multipurpose room. At the beginning of every session, each participant selected a chair and positioned it to allow a clear view of the instructor, who worked from an elevated platform at the front of the room. The participants sat in chairs as the instructor began each session with a review of the purpose of the movements to be taught that day. Then the instructor presented models of the movement alternatives and encouraged participants to choose the alternative that best fit their physical abilities. At the initial session the instructor taught the first six movements in the program and assured the group that more material would be introduced each week until the entire program was learned. The movements were performed with the music for several repetitions to allow the instructor to observe each participant's engagement and to provide individual positive feedback along with cues for change if needed. The instructor answered questions as the program proceeded and provided models of each movement. Individual participants were assisted with hands-on cues. This style of presentation was maintained throughout the 14 weeks of the class.

In each class following the first week, the instructor greeted individuals as they entered the room and gave each participant an information sheet to take home that outlined the movement activities for the day. After the first week, the participants learned two

new movements, or movement phrases, each week and reviewed all movement phrases they had learned so far. The entire learned sequence was repeated as many times as possible within the framework of the one-hour class. By the fifth class, the participants had learned the entire program.

In the 15th and final class, the participants performed the "Motivating Moves" program from start to finish. At the conclusion of the class, they were asked to write comments evaluating their experiences. The instructor and her assistants expressed their appreciation to each of the class participants for their involvement in the class after the comment sheets were returned.

Results

Data on all three measures of balance, functional reach, and gait speed were compared across time. A repeated measures ANOVA was calculated to determine the statistical significance for comparisons between (a) the pretreatment measure and the midtreatment measure, (b) the pretreatment measure and the posttreatment measure, and (c) the midtreatment measure and the posttreatment measure for each of three dependent variables: balance, functional reach, and gait speed.

The repeated measures ANOVA calculation for balance at 2 degrees of freedom yielded $F = 8.147$, which was statistically significant at .008. A two-tailed *t*-test was used as a follow-up to determine where the statistically significant differences occurred. The difference between pre and midtreatment measures for balance (Balance 1 and Balance 2) was statistically significant with $t = -2.796$ at $df = 12$ and $p = .016$. When the pre and posttreatment measures were compared for balance (Balance 1 and Balance 3), results were statistically significant with $t = -4.577$ at $df = 12$ and $p = .001$. The midtreatment comparison with the posttreatment measure (Balance 2 and Balance 3) resulted in a statistically nonsignificant $t = -1.887$ with $df = 12$ and $p = .086$. Table 1 displays the mean scores that show marked improvement from the first to the fifth session, and from the first to the last session. There is less change from the fifth to the last session.

The repeated measures ANOVA calculated for functional reach yielded $F = 8.147$ with $df = 2$ and $p = .08$. This result did not meet the $p = .05$ criterion for statistical significance and no follow-up two-tailed *t*-tests were done. While Table 1 indicates some changes in

TABLE 1

Mean Scores and Standard Deviations for Pre, Mid, and Posttreatment Measures

Variable & measurement point	*M*	*SD*
Balance 1	9.36	7.54
Balance 2	17.18	10.47
Balance 3	21.56	8.90
Reach 1	36.58	3.11
Reach 2	38.46	2.79
Reach 3	38.65	3.86
Gait speed 1	7.50	1.36
Gait speed 2	6.35	1.06
Gait speed 3	6.11	1.21

functional reach over the course of the study, the changes were not statistically significant.

For gait speed, the repeated measures ANOVA yielded $F = 9.905$ with $df = 2$ and $p = .004$, which was highly statistically significant. Two-tailed *t*-tests were computed as follow-up to determine the differences between the measurement points. The calculation for the pre and midtreatment measures for gait speed (Gait Speed 1 and Gait Speed 2) yielded a statistically significant difference with $t = 4.904$ at $df = 12$ and $p = .000$. The mean scores in Table 1 show that the gait speed scores improved markedly from the first to the fifth session. High statistical significance also was found between the pre/posttreatment differences in gait speed (Gait Speed 1 and Gait Speed 3) with $t = 4.225$ at $df = 12$ and $p = .001$. The mean scores in Table 1 show that the gait speed scores improved from the first to the fifth session and from the first to the last session. The final comparison between the mid and posttreatment measures for gait speed revealed no statistically significant changes with $t = .891$ at $df = 2$ and $p = .392$. The mean scores in Table 1 show a small increase in gait speed between the mid and posttreatment measures, and this change was not statistically significant.

In addition to the objective measures, participants' subjective comments about the course were examined. No negative comments were received. An examination of the participants' anonymous evaluation comments revealed positive changes in daily physical activities. These included sitting, standing, bending, and walking. Participants said that they were more conscious of their bodies and how they moved, which made them more aware of in-

creased flexibility due to class involvement. Three individuals commented they had suffered less arthritic pain and discomfort due to their ongoing participation in the program. Several commented that they felt more limber, or flexible, and had more stamina. Others said they had better sensation of body movements, were more aware of their posture, experienced decreased shoulder and back pain, and felt more assured in their balance while standing and walking.

Discussion

The data show that the largest improvements occurred between the initial (Week 1) and the midterm session (Week 5) of the program. By Week 5, the length of time participants could balance in a one-foot stance increased markedly. Participants also increased the length of their functional reach, while they decreased the length of time to walk 10 meters. The data clearly show that participants made their largest gains in the first five weeks of the program. After the fifth session, they tended to level out, and did not improve significantly in their measures of balance, functional reach, and gait speed.

Conclusions and Recommendations

The "Motivating Moves" program was effective in improving measures of balance, functional reach, and gait speed in a small group of healthy older adults. These parameters are identified in the literature as correlates of lowered fall risk in this population. It is possible that "Motivating Moves" will enhance balance, functional reach, and gait speed in other older adults; however, the sample in this study is small, and generalizations to others in the population cannot be made without further study.

The most marked gains were made in the first five weeks of the class. It is important to determine in future studies if these gains could be even larger if participants were encouraged to consistently practice the program during the week outside the class. In addition, it is important to determine if a program of 6 to 8 weeks is just as effective as a longer 14-week program. If so, the program could be implemented readily to more people in less time.

Finally, it could be important to conduct follow-up measures of those individuals who completed the class to determine whether the gains are maintained or whether they deteriorate after the pro-

gram is completed. Comparisons also could be made between those who continue to use the program after they have completed the course and those who discontinue program use after the class has ended. Further follow-up could compare the number of falls for those who participated with those who did not participate in the program.

It is recognized that this study is limited by the measures used. These measures were selected because they avoided interference with the class schedule on the days they were taken, and they avoided participants' reluctance to engage in extensive testing. It would be beneficial in future studies to incorporate additional measures of balance and gait characteristics. Interference with class schedules and confounding variables such as fatigue could be avoided if the measures were taken outside the class structure.

It was concluded that the "Motivating Moves" program is a viable intervention for healthy older adults who have the potential for compromised physical abilities. The program has the potential to contribute to improved physical function, increased independence, and improved life quality, all of which are important components of wellness. This program could be implemented as a music therapy intervention for older adults who desire optimal health and well-being.

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