USING DANCE TO IMPROVE EXECUTIVE FUNCITONING IN OLDER ADULTS

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ABSTRACT

Can age-related declines in cognition be reversed? Previous research has used two fundamentally different approaches for addressing this theoretical question, mentally stimulating activities and aerobic exercise. The current study extends this prior research by combining these two approaches through the use of aerobic dance with steps of varying cognitive difficulty. The cognitive performance of three groups of older adults was measured before and after engaging in six weekly dance classes. One group completed an aerobic dance class with simple steps intended to create little cognitive demand. A second group completed an aerobic dance class involving more complex, cognitively challenging choreography. A final group did not receive any dance training between pre- and post-testing. It was hypothesized that the two dance groups would show more gain than the no-dance group with the most gain observed for participants in the cognitively challenging dance class given its combination of mental and physical exercise. Neither of these hypotheses was supported. Both methodological and theoretical explanations for this failure to find training gains are discussed.

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Finally, a special mention about three individuals who have added a new dimension to my world and have helped me realize that what I do as an individual will be perpetuated into the future. My grandchildren Tiffany, Chase, and Sarah Beth remind me daily why it is important to do everything we can to help improve this world for the people around us.

DEDICATION

This thesis is dedicated to my daughter Rae and my son Nick who are two of the greatest Blessings in my life. The love we share means more to me than they will ever know.

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INTRODUCTION

Using Dance to Improve Executive Functioning in Older Adults

From 1950 to 2005 the population age 65 years and older grew at approximately twice the rate of the total population (Health, 2005). Furthermore, the fastest growing segment in this older category was age 75 years and over, which continues to increase at a rate of almost three times the average annual growth. It is projected that by 2030 almost one in five Americans will be 65 years or older (National Institute on Aging, 2005). Statistics for North Carolina reveal that during the 1990's the population of individuals over the age of 65 grew 46% and is expected to more than double from 2000 to 2030. According to U. S. News and World Report (Pethokoukis, 2006), Wilmington is the 8th fastest growing small metropolitan area for people age 65 and older.

Unfortunately, these increases in longevity are often accompanied by a corresponding decrease in cognitive functioning. Considerable research has shown that many forms of cognition appear to be negatively correlated with age (Park, 2000; Wecker, Kramer, Wisniewski, Delis, Kaplan, 2000). Indeed, surveys show that age-related declines in mental functioning are among the top concerns for older adults (Health, 2005). Of particular concern are cognitive processes deemed "executive" in nature as they appear particularly susceptible to age-related declines and are the processes most critical for independent living (Daniels, Toth, & Jacoby, 2006; Salthouse, Atkinson, & Berish, 2003).

Executive processes are described as complex forms of cognition closely tied to frontal lobe functioning (Stuss & Benson, 1986; Tranel, Anderson, & Benton, 1994). Salthouse and colleagues (e.g., Salthouse, Atkinson, & Berish, 2003) classify working memory, attention, planning, and reasoning as primary executive functions and have demonstrated that age-related changes in such executive functions begin when an individual is in his or her twenties and worsen across the lifespan. One of the executive abilities of particular interest in the current study is working memory. In a recent article, Engle (2002) defined working memory as “the ability to control attention to maintain information in an active, quickly retrievable state” (p. 20). Working memory will be measured in the current study using the Backward Digit Span task. This task, and other tasks purported to measure executive functioning, will be described in detail in the methods section.

Methods for Improving Executive Forms of Cognition

While aging has generally become synonymous with the kinds of declines in cognitive functioning discussed above, there is some research showing that a variety of techniques can be used to enhance cognitive performance well into late life (Drew & Waters, 1986; Kramer, Hahn, Cohen, Banich, McAuley, Harrison, Chason, Vakil, Bardell, Boileau, & Colcombe, 1999; Kramer & Willis, 2002; Noice & Noice, 2006; Willis & Nesselroade, 1990). Such training enhancements can be explained by pointing to the human brain’s ability to undergo continual change, a concept originally referred to as *modifiability* but later renamed *plasticity* (Baltes & Labouvie, 1973). It is not clear to what degree such plasticity endures into late life. Are older adults capable of the same training gains as the young? Baltes and colleagues introduced two important concepts relevant to this question. First is the notion of *reserve capacity* where they claim that "…most old people, like young people, possess sizable reserves that can be activated via learning, exercise, or training" (Baltes & Baltes, 1990, p. 9). This suggests that even an older individual’s cognitive ability can be enhanced using appropriate education, activity, and experience. Of particular interest in the current research is whether dance constitutes an appropriate activity for activating such reserves?

Baltes also cautions, however, that plasticity in old age may be relatively limited when compared to a young individual and that, even among older adults, there will be a great deal of inter-individual variability in observed gains (Baltes, 1987; Baltes & Lindenberger, 1988). Said differently, Baltes points to potential boundary conditions on increases in reserve capacity suggesting that older adults may show limited training gains and that those limits may be more apparent for some older individuals than others. Intervention studies like the current one are important for understanding both the range of plasticity and its constraints.

Methods for Increasing Executive Functioning

There have been a number of approaches for attempting to improve executive functioning in older adults. Such interventions have included drugs and supplements, a brain-healthy diet, mental stimulation, and aerobic exercise (Colcombe, Erickson, Scalf, Kim, Prakash, McAuley, Elavsky, Marquez, Hu, & Kramer, 2006; Starr & Whalley, 2005; Pronk, Anderson, Crain, Martinson, O'Connor, Sherwood, & Whitebird, 2004; Salthouse et al., 2003; Toth, Daniels, & Jacoby, 2005; Colcombe & Kramer, 2003). The present study will focus on the latter two approaches. The following sections will highlight the research in each of these areas.

Mental Stimulation. Previous research has explored what happens to the brain when it is stimulated. Extensive animal research demonstrates improvements in memory and performance as a function of a stimulating mental environment. For example, Van Pragg, Kempermann, and Gage (1999) found that rodents living in an enriched environment (e.g., one with a variety of toys, opportunities for social interaction, etc.) had 2.5 times as many new nerve cells in the hippocampus, an area of the brain involved in supporting new memories. These findings suggest that mental activity might serve to stimulate brain cell growth. Additional research showed that these enriched-living rodents were also superior learners in a water maze task (Kempermann, Brandon & Gage, 1998; Kempermann & Gage, 2002).

Research with humans has shown that age-related decline in cognition can be reduced through novel learning. For example, a recent correlational study reported in the New England Journal of Medicine concluded that participation in leisure activities such as crossword puzzles, playing a musical instrument, and playing board games is associated with a reduced risk of dementia (Verghese, Lipton, Katz, Hall, Derby, Kuslansky, Ambrose, et al., 2003). Subsequent intervention studies have also supported the link between mental "exercise" and gains in executive functioning. One such study by Toth, Daniels, and Jacoby (2005) found improvements for older adults in working memory, long-term memory, and psychomotor speed after approximately 8 hours of playing *Art Dealer*, a computer game that uses complex stimuli (classic paintings by famous artists) and requires players to perform increasingly challenging memory feats as part of the game-play. Additional support for the benefit of mental stimulation via videogames is provided by Dustman, Emmerson, Steinhaus, Shearer, and Dustman (1992). In their study, older adults who played video games for one hour three times per week for a total of 11 weeks showed significant improvements in reaction time relative to a non-play group. Together, these findings point to mental stimulation as an important component of any cognitive intervention strategy. Numerous studies of older adults find that training in a specific area such as executive functioning can show positive results (Stuss, Robertson, Craik, Levine, Alexander, Black, Dawson, Binns, Plamer, Downey-Lamb & Winocur, 2007).

Aerobic Exercise. Beyond interventions that target learning, researchers have explored the effects of aerobic fitness on cognitive functioning. Aerobic fitness is the ability to continue physical activity at less than maximum intensity and to withstand the onset of fatigue. Such activity is believed to allow the body to use oxygen more efficiently by conditioning the heart and lungs ("Aerobic exercise," 1998). Examples of aerobic activities are jogging, dancing, swimming, and cycling.

In a comprehensive review of 18 intervention studies that investigated the effect of fitness on the cognition of older adults, Colcombe and Kramer (2003) found that aerobic fitness training benefited performance especially for executive processes. Similarly, in an empirical study of 124 older adults 60 to 75 years old, Kramer and colleagues (Kramer, et al., 1999) compared an aerobic-fitness group who engaged in walking with an anaerobic group who engaged in stretching. They also found that the aerobic group enjoyed significantly more improvement in executive functioning compared to the anaerobic group. Similarly, a 2005 Swedish longitudinal study of over 1400 older individuals from 1972 to 1998 investigated the association of physical activity during midlife and the development of dementia and found that physical activity at least twice per week reduced the risk of later developing dementia (Rovio, Kareholt, Helkala, Viitanen, Winblad, Tuomilehto, Soininen, Nissinen, and Kivipelto, 2005).

These findings beg the following question: *How* does aerobic exercise improve executive functioning? Aerobic exercise has been shown to increase blood flow throughout the body, including the brain. Non-human animal studies (Van Praag et al., 1999) have demonstrated changes in the hippocampus and a strengthening of synaptic connections between neurons as a result of physical exercise; importantly, these are brain areas involved in learning and memory. More recently, studies using functional magnetic resonance imaging (fMRI) have documented exercise-related changes in both white matter and grey matter in the human brain (Colcombe, Erickson, Scalf, Kim, Prakash, McAuley, Elavsky, Marquez, Hu & Kramer, 2006). White matter increases were seen in the corpus callosum, the band of nerve fibers connecting the right and left hemispheres of the brain. Grey matter increases were present in the prefrontal and temporal cortices. These areas are associated with higher-order control and processing.

To summarize, two disparate intervention methods have been used to improve cognitive functioning in older adults. One has incorporated mentally stimulating learning while a second has relied on more physical interventions. The unique effects of these two approaches have been fairly well-documented; however, the benefits of *combining* these mental and physical activities have been much less thoroughly explored. That was primary goal of the current research.

Dance as a Novel Method for Cognitive Improvement

The current study was designed to investigate the effects of a combination of aerobic exercise and mental stimulation using aerobic dance. Dance has a number of the mental and physical characteristics discussed earlier that recommend it as a training tool; it involves being aerobically active, interacting with other people, and learning new, sometimes complex ways to move. A recent, exploratory study investigating the psychological effects of dance found that older adults who received ballroom dance lessons reported a significant reduction in depression (Haboush, Floyd, Caron, LaSota, & Alvarez, 2006). In research directed at the possible cognitive benefits of dance for adults over the age of 70, tango dancing was found to significantly improve performance on spatial and numerical memory tasks (McKinley, Bednarczyk, Jacobson, Leroux, Rainville, Rossignol, & Fung, 2005).

From a training standpoint, another positive aspect of dance is that it appears to be an enjoyable activity for this age group. In the study by McKinley and colleagues (2005), 66% of the participants were found to still be engaged in regular dance one year later. Intrinsic enjoyment of a training activity should help to increase adherence to the training regimen and to reduce the rate of attrition. Although prior research examining the direct impact of dance on cognition is limited, the aforementioned studies suggest that dance may provide an efficacious approach to cognitive improvement.

To summarize, work by Baltes and others encourages intervention in helping to ameliorate age-related declines in executive functioning by triggering plasticity and the activation of reserve capacity. Prior research points to two fruitful methods for such an intervention, mental stimulation and physical activity. Both of these critical components can be incorporated into aerobic dance, an activity that holds intrinsic interest for a number of older adults. Together, these findings point to dance, when properly implemented, as a potentially powerful training tool.

METHOD

Participants

Sixty-three older adults were initially recruited for this project from the Wilmington, North Carolina area using the advertisements shown in Appendices B and C. If an individual expressed interest in participating, the experimenter spoke to him or her individually to both thoroughly explain the nature of the eight-week project as well as to carefully screen the individual for preexisting health conditions. Nineteen participants did not complete the study for the following reasons: Three participants withdrew for health reasons, one feared that post-testing would expose cognitive decline, and fifteen individuals failed to complete a sufficient number of dance classes. The remaining forty-four older adults (mean age = 68.98; age range 54 to 79 years, females = 42) completed both the pre-test and the post-test. Thirty-seven of the participants completed the dance intervention during an initial dance class (Phase 1) held at the New Hanover County Department of Aging Senior Center from June through August 2007. The remaining seven participants completed dance training during a second class (Phase 2) held at Southeast Dance Academy from September through October.

The final sample of 44 participants comprised three groups, a no-dance control group and two dance, intervention groups. Group 1, the Control group (n = 16), consisted of individuals recruited from two different sources, a weekly sewing group and a foster grandparent group from the Senior Center (both ostensibly low aerobic, low cognitive activity groups). This control group completed the same pre-test and post-test measures as the dance groups according to the same timetable. Individuals in Group 2, the Easy Dance group (n = 13), and Group 3, the Complex Dance group (n = 15), participated in a weekly, one-hour dance class on Tuesdays or Thursdays. Dance participants were required to complete all pre- and post-tests and to attend a minimum of four out of six dance classes in order for their data to be included in the final analyses (for an explanation of attendance requirements, see Westerberg, Jacobaeus, Hirvikoski, Clevberger, Őstensson, BartFai, & Klingberg, 2007).

Materials

Consent Form. Participants were asked to read, date, and sign a standard University of North Carolina Wilmington (UNCW) consent form approved and stamped by the UNCW Internal Review Board. Participants were offered a copy of the consent form for their records.

Participant Information Questionnaire. This questionnaire was used to obtain general information about participants including demographic information, health and fitness history, and basic information about their memory and attention abilities (see Appendix A).

Logbook. Each participant received a logbook in which to keep an ongoing record of his or her pulse rate, which was taken at the beginning, middle and end of each dance class. These booklets were used to document the time and duration of all exercise outside of this project occurring during the period of this present study.

After completing the consent form, participant information questionnaire, and receiving a personal logbook, participants were given a test booklet containing the following nine paper-and-pencil, cognitive tasks. These nine tests comprise the pre-test and post-test measures for the current study with the exception of the *Shipley Vocabulary Test*, which was completed during pre-test only. Attached to the post-test booklet were two subjective questions using a Likert scale from 1 through 10 asking the participant to (1) rate his or her perception of the *physical* difficulty of the class, and (2) rate his or her perception of the *mental* difficulty of the class.

Verbal Paired Associates (Immediate and Delayed). Participants were read aloud six pairs of unrelated words with a two-second delay between each pair. Following this auditory list, participants were directed to a sheet in their booklet containing the first word from each pair and were given 45 seconds to write as many of the second words from the pairs as they could remember. This paired-associates test was administered twice; once immediately after the initial list was read aloud and a second time after a delay of approximately 40 minutes (after a number of intervening tests). The immediate version was used as a measure of short-term memory and the delayed version as a measure of long-term memory.

Trails A. This task assesses an individual's speed in dealing with numerical sequences. Participants were given a sheet with the number 1 to 25. They instructed to begin by placing their pencil on the number one and were asked to connect the digits in ascending order as fast as they could. They were given 20 seconds to complete this task.

Trails B. This task assesses an individual's ability to switch between two subtasks, tracking numbers and letters in ascending order. Participants turned to the test sheet in their booklet containing the numbers 1 to 13 and the letters A to L presented mixed together in a randomized display. They were instructed to begin by placing their pencil on the number *one* and then alternating between numbers and letters in connect-the-dot fashion (i.e., "1-A-2-B-3-C, etc.) as fast as they could. They were given 20 seconds to complete this task. Unlike Trails A, this task is purported to place demands on executive control.

Backward Digit Span. This task measures working memory, or a participant's ability to maintain and manipulate information, by requiring an individual to write an orally presented digit sequence (e.g., "2, 7, 9, 1, 4") in backward order ("4, 1, 9, 7, 2"). Scoring was achieved using two different techniques. A*bsolute span* was calculated by counting the number of individual digits that the individual reported in the correct order <u>*only for trials that were entirely*</u>

correct. *Relative span* was calculated by counting *all* correct digits irrespective of whether the entire trial was correct. Relative scores are always equal to or higher than absolute scores.

Raven's Advanced Progressive Matrices. This task is believed to measure visual reasoning, abstract thinking, and fluid intelligence. Participants completed an abbreviated version of the original 60-item test. Participants were shown 12 patterns composed of abstract shapes and lines with a single piece missing, and required to select, from among six presented alternatives, which piece best completes the pattern.

Rey Auditory Verbal Learning. Participants heard a list of fifteen, one- or two-syllable words and were asked to write down as many of the words as they could remember. This task is an assessment of verbal learning and memory.

Digit-Symbol Substitution. This is considered to be a standard measure of cognitive speed and mental efficiency. Participants were instructed to turn to a test sheet in their booklet containing two parts. At the top of the sheet is a legend linking each of the digits from one to nine with an arbitrary symbol (the symbols are shown under their respective numbers). Below this legend, participants saw series of test items containing digits with an empty box below it; they were given 120 seconds to fill in as many squares as possible with the corresponding symbol without skipping any squares. Scoring was accomplished by totaling the correct number of symbols produced within the time limit.

Shipley Vocabulary Test. This is a common test of vocabulary where participants are shown a target word (e.g., "big") and asked to choose from among four alternatives (e.g., "cold", "soft", "large", and "open") the word that is most similar to it in meaning. There are a total of 40 words that progress from simple to more challenging (e.g., "querulous").

Design and Procedure

Data collection occurred in two separate phases: Phase 1 took place in the summer of 2007 from June 11th until August 30th; Phase 2 took place in the fall of 2007 from September 6th until October 25th. Participant recruitment took place in the summer and fall of 2007 through announcements in monthly newsletters (see Appendix B) distributed by the Senior Center at the New Hanover County Department. For additional recruitment, fliers (see Appendix C) were placed in the Senior Center, as well as in local businesses and area churches.

Phase 1 of this project began Monday, June 11, 2007 and continued for eight weeks; Phase 2 of this project began Thursday, September 6, 2007 and also continued for eight weeks. Each class met for one hour per week with the specific time-slot being dictated by the Senior Center's class schedule: Tuesday morning classes were from 8:45 until 9:45 and Thursday morning classes were from 10:00 until 11:00. During Phase 2, Tuesday classes were from 2:00 until 3:00 and the Thursday classes were from 2:00 until 3:00 o'clock.

The two dance conditions were randomly assigned to Tuesday and Thursday during Phase 1. During Phase 2, the conditions were reversed (i.e., Complex Dance was scheduled for Thursday during Phase 1 and for Tuesday during Phase 2). Group 2 (Easy Dance) engaged in simple aerobic dance without mentally challenging aspects designed by the choreography of this class (e.g., a low number of simple, repetitive steps). Group 3 (Complex Dance) engaged in more complex aerobic dance incorporating multi-step formations placing demands on the memorization and maintenance of the order of dance steps and patterns of movement in group formation (e.g., circles, parallel lines, reversing the parallel line, etc.). Additionally, participants in this cognitively demanding group were instructed to interact with other participants while integrating the use of props (e.g., hats, canes, and chairs). Participants were asked *not* to discuss the content of the class with individuals outside of the class for the eight-week period to control for cross-over effects.

The first meeting of the dance classes was an orientation class during which participants were given general information regarding the research project, completed the consent form and a participant questionnaire (see Appendix A). Participants then completed the nine cognitive pre-test tasks described above. These paper-and-pencil tasks were compiled in a booklet for each participant in the order in which they were to be completed; participants proceeded through the booklet page-by-page with the experimenter and were given specific instructions prior to beginning each task. The same experimenter conducted all pre-testing and post-testing sessions with the aid of a research assistant.

At the end of the first class, each participant was instructed on how to calculate heart rate by taking his or her pulse. Participants were given their logbook at the beginning of each class and were instructed to record (a) their pulse rate for the current date; (b) all forms of exercise in which they engaged during the six weeks of the study both as part of the dance class as well outside of the class; and (c) a brief description of the nature of the exercise and the duration of that exercise in their logbook.

RESULTS

Two main hypotheses were tested in this study. First, it was hypothesized that aerobic dance would produce gains in executive functioning, or that the dance groups would show cognitive improvements beyond the control group after the six-week dance intervention. The second hypothesis stated that dance involving a combination of aerobic activity with mentally challenging choreography would produce greater gain in mental abilities than dance involving aerobic exercise alone; said differently, the Complex Dance group was expected to exhibit greater gains than the Easy Dance group after the six-week intervention.

Three different sets of analyses for this study are described below. The first section characterizes the three experimental groups and demonstrates that they were similar and relatively representative of their age group. The next section focuses on data from the logbook and assesses the mental and physical difficulty of the dance classes. A final section outlines the training gains observed for the main criterion measures as a function of the dance intervention.

Characterizing Older Adult Samples

A series of analyses were used to demonstrate that the three samples in the current study were appropriately equated for various demographic, health, and fitness factors. No significant differences were observed for mean age (Control = 68.56, Easy Dance = 71.58, and Complex Dance = 66.80; F (2, 40) = 2.05, p = 0.14), education (Control = 13.13, Easy Dance = 14.08, and Complex Dance = 14.87; F (2, 39) = 2.71, p = 0.08), self ratings of general health (Control = 3.88, Easy Dance = 4.31, and Complex Dance = 4.13; F (2, 41) = 1.55, p = 0.22), days per week spent exercising (Control = 3.00, Easy Dance = 4.91, and Complex Dance = 4.50; F (2, 28) = 2.44, p = 0.11), and minutes spent exercising (Control = 32.50, Easy Dance = 52.00, and Complex Dance = 47.13; F (2, 40) = 2.05, p = 0.10). Moreover, performance on the Shipley test of vocabulary was similar across the groups (Control = 29.69, Easy Dance = 31.23, and Complex Dance = 31.40; F (2, 41) = .25, p = 0.78) and was generally good suggesting that these older participants are relatively typical of their age group. It should be noted that several participants in the Control group elected not to answer the questions pertaining to physical exercise so many of these items were difficult to accurately assess. Also important to note is that the majority of this sample was Caucasian (36 out of 44 participants) and thus might not generalize to more diverse populations.

Because dance was the chosen training tool in the current study, it was important that pre-experimental dance experience was relatively equal across the groups. Thus, participants were asked to rate their level of dance expertise using a Likert scale from 1 to 5 with “1” signifying “not an expert” and 5 signifying “expert”. A significant difference was found between the groups, F (2, 38) = 6.01, $p < .05$, with a Tukey HSD revealing that the Control group possessed significantly less dance experience than both the Dance Easy group, $p = .02$, and the Complex Dance group, $p = .001$. It is important to note that the two dance groups did not differ from one another in terms of dance experience prior to the experiment.

Assessing the Mental and Physical Difficulty of the Dance Classes

Physical difficulty of the dance classes was assessed in two ways, participants’ pulse rates and their subjective ratings of difficulty. Participants’ resting heart rates were taken prior to each class and their peak heart rates were taken after the most aerobically challenging portion of each class. Separate t-tests were used to analyze these two heart rate measures as well as change in heart rate (peak HR – resting HR). Analyses showed that the resting heart rate for the Easy Dance group (M = 68.40, SD = 8.05) was *lower* than the resting heart rate for the Complex Dance group (M = 74.01, SD = 8.32), t (26) = 1.81, $p = 0.08$, although the difference was only marginal. There were no observed differences in peak heart rate (M = 89.27 vs. M = 90.58), t (26) = 0.26, p = .80, nor was there a significant change from resting to peak heart rate (Easy Dance: M = 20.87, SD = 10.64 and Complex Dance: M = 16.54, SD = 10.18, t (26) = 1.10, p = 0.28). Analyses of pulse rate suggest that, while the Easy Dance group may have started the class at a slightly better level of fitness than the Complex Dance group, the physical difficulty of the classes themselves was equal for the two groups.

The physical and mental difficulty of the dance classes was further assessed using participants' subjective difficulty ratings. Independent samples t-tests were used to analyze these ratings. Contrary to expectation, the mental challenge associated with the classes was perceived similarly by both the Easy Dance group (M = 5.15, SD = 2.82) and the Complex Dance group (M = 5.07, SD = 2.74), t (26) = 0.08, p < .05. Also inconsistent with the heart rate data assessed above, the Easy Dance group rated the activity in their dance class to be significantly *more* physically challenging (M = 4.62, SD = 2.66) than the Complex Dance group (M = 2.67, SD = 1.80), t (26) = 2.30, p = 0.03. It is interesting to note that participants who rated the class as physically challenging also tended to rate the class as mentally challenging, r = 0.746, p < .001, suggesting that participants may not have been able to rate these two dimensions independently. To summarize, while the heart rate data are encouraging in showing that the classes were physically similar as intended, the subjective ratings were more equivocal and suggest that the relative level of physical and mental demand created by the two classes might not have been appropriate.

Cognitive Changes As A Result of the Dance Intervention

These results for the main criterion measures (*Verbal Paired Associates Immediate, Verbal Paired Associates Delayed, Trails A, Trails B, Backward Digit Span, Raven's Advanced*

Progressive Matrices, Rey Auditory Verbal Learning Test, and *Digit-Symbol Substitution*) were analyzed in two ways. The first set of analyses examined pre and post-test performance across the three groups using a 2 (Testing Session: pre vs. post) x 3 (Dance Condition: Control, Easy Dance, and Complex Dance) mixed ANOVA. A second set of analyses was used to corroborate these findings by examining gain scores (post-test performance minus pre-test performance) across the groups using a one-way ANOVA.

The 2x3 mixed ANOVAs were conducted separately for each of the cognitive measures with Testing Session as the within-subjects factor and Dance Condition as the between-subjects factor. Tukey HSD post hoc tests were conducted to more clearly assess the differences in performance among the three experimental groups. Each test is described separately below.

For *Paired Associates Immediate*, there was a main effect of Dance Condition, F (2, 41) = 6.10, MSE = 3.55, $p < .01$, but no main effect of Testing Session, F (2, 41) = 1.02, MSE = 1.43, $p = 0.32$ nor was there an interaction between the two factors, F (2, 41) = 1.16, $p = 0.32$, (see Figure 1). Tukey HSD revealed that the Complex Dance group performed significantly better than the Control group, $p = 0.003$.

Paired Associates Delayed showed a main effect of Dance Condition, F (2, 41) = 6.29, MSE = 2.37, $p < .01$, but no main effect of Testing Session, F (2, 41) = 1.43, MSE = 1.04, $p = 0.24$, nor was there an interaction between the two factors, F (2, 41) = 2.58, $p = 0.09$, (see Figure 2). Post-hoc tests revealed that the Complex Dance group scored significantly higher than the Control group, $p = .004$.

For *Trails A*, there was a main effect of Testing Session, F (2, 41) = 9.02, MSE = 9.60, $p < .01$, with scores increasing from pre-test to post-test for all three groups, $p = 0.88$. There was

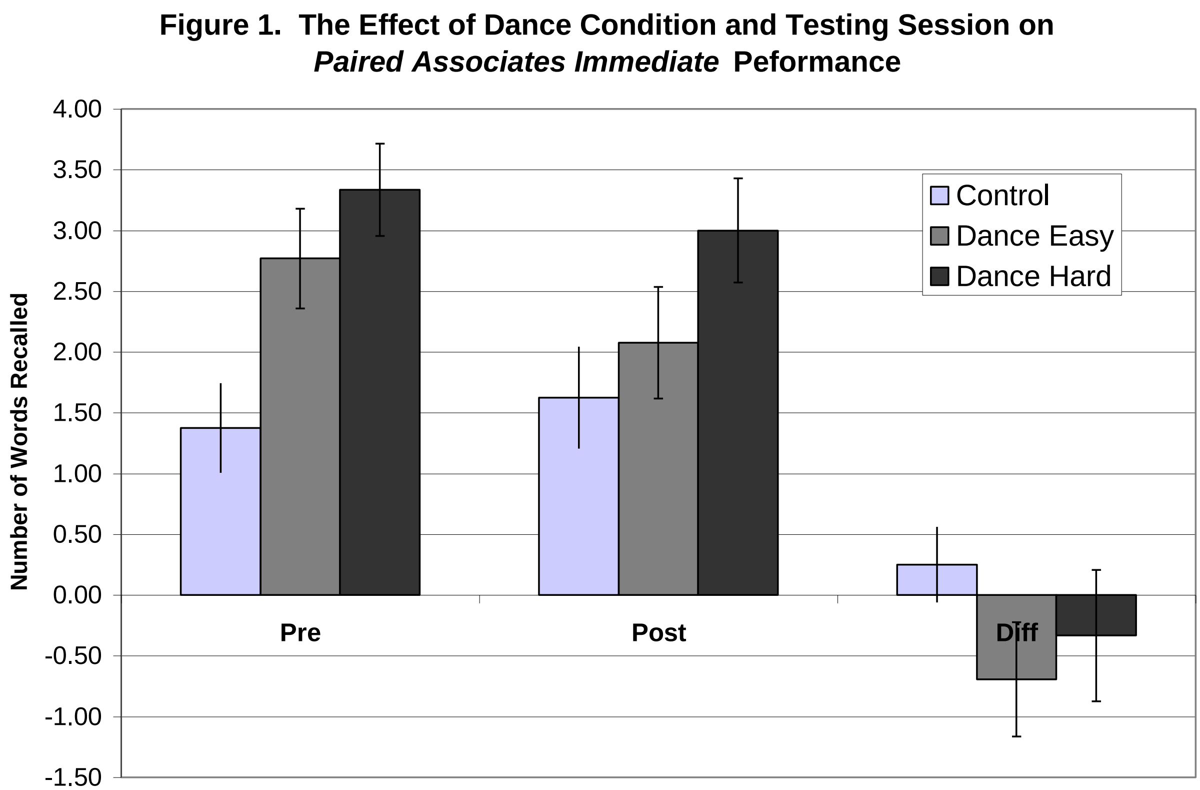

Figure 1. Mean cognitive differences in *Paired Associates Immediate* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

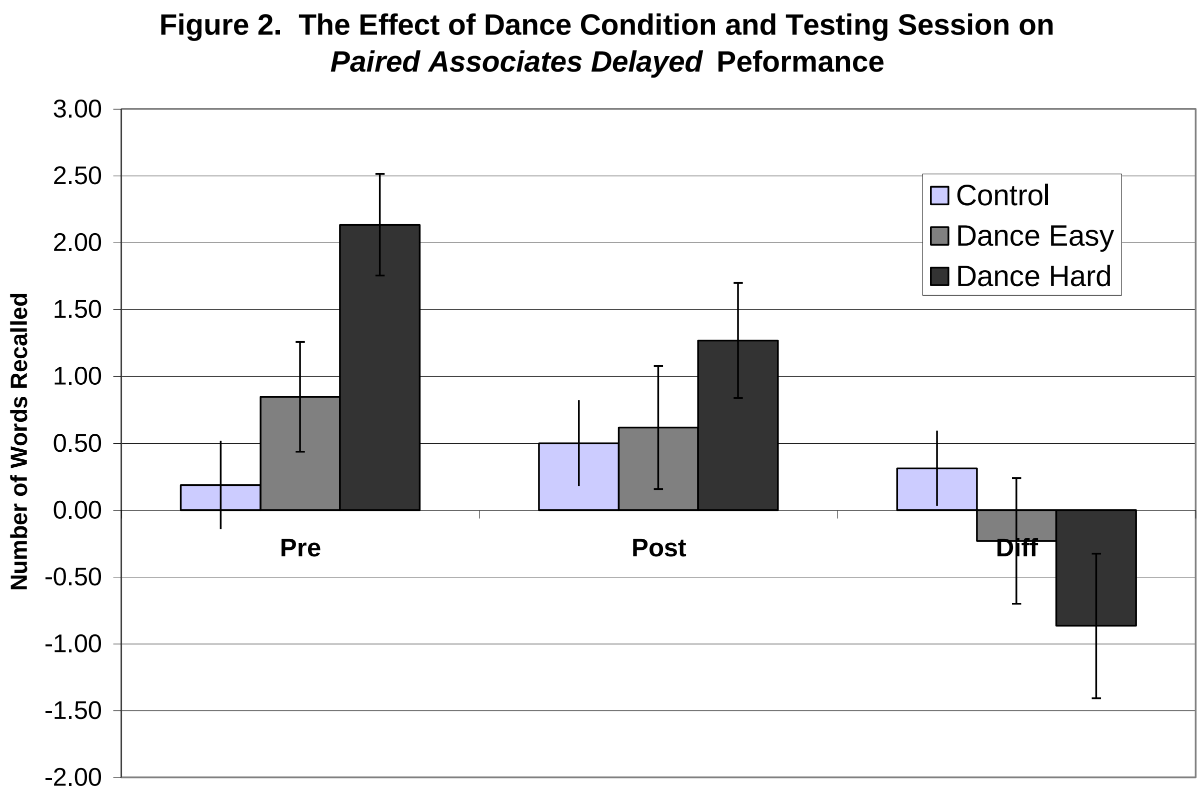

Figure 2. Mean cognitive differences in *Paired Associates Delayed* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

no main effect of Dance Condition, F (2, 41) = 1.86, MSE = 54.16, $p = 0.17$, and no interaction, F (2, 41) = 0.13, (see Figure 3).

Trails B revealed no main effect for Testing Session F (2, 41) = 2.46, MSE = 5.32, $p = 0.12$; no main effect for Dance Condition F (2, 41) = 1.73, MSE = 24.14, $p = 0.19$ and no interaction, F (2, 41) = 1.53, $p = 0.23$, (see Figure 4).

For *Backward Digit Span*, the analysis of *absolute* span scores revealed a main effect of Dance Condition, F (2, 41) = 3.56, MSE = 328.19, $p < .05$, but no main effect of Testing Session, F (2, 41) = 0.69, MSE = 33.82, $p = 0.41$ and no interaction between the two factors, F (2, 41) = 1.67, $p = 0.20$, (see Figure 5). The Tukey HSD procedure revealed that the Complex Dance group significantly outperformed the Control group, $p = 0.04$.

The analysis of *relative* span scores for *Backward Digit Span* showed a main effect of Dance Condition, F (2, 41) = 3.96, MSE = 241.74, $p < .05$, and a main effect of Testing Session, F (2, 41) = 9.15, MSE = 17.23, $p < .005$, but no interaction between Dance Condition and Testing Session, F (2, 41) = 2.17, $p = 0.13$, (see Figure 6). Post-hoc tests revealed a significant difference between the Control group and the Complex Dance group, $p = 0.02$.

For *Raven's Advanced Progressive Matrices*, there was a significant main effect of Testing Session, F (2, 41) = 20.50, MSE = 1.48, $p < .001$ with post-tests showing *lower* scores. No main effect was seen for Dance Condition, F (2, 41) = 0.65, MSE = 9.11, $p = 0.56$ and no interaction between the two factors, F (2, 41) = 0.82, $p = 0.45$, (see Figure 7).

The analyses for the *Rey Auditory Verbal Learning Test* revealed no main effect of Testing Session, F (2, 41) = 1.49, MSE = 2.69, $p = 0.23$, no main effect of Dance Condition, F (2, 41) = 1.49, MSE = 8.11, $p = 0.24$, and no interaction, F (2, 41) = 0.01, $p = 0.99$, (see Figure 8).

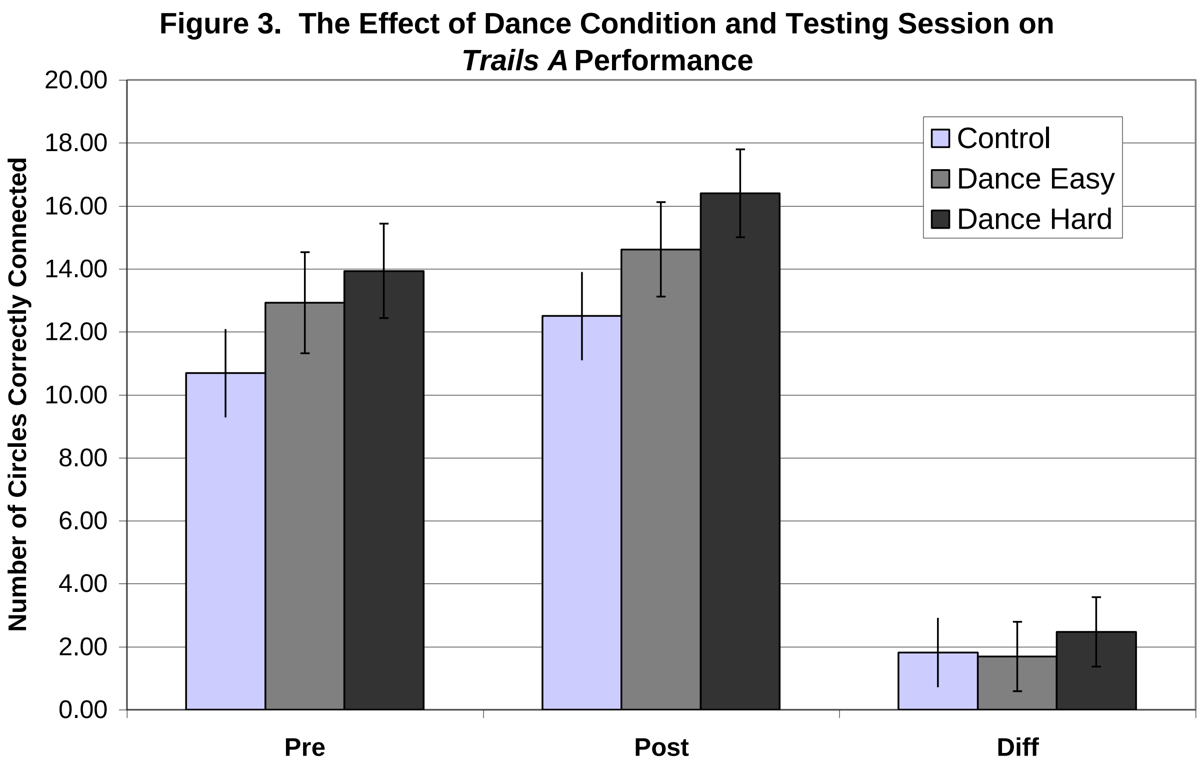

Figure 3. Mean cognitive differences in *Trails A* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

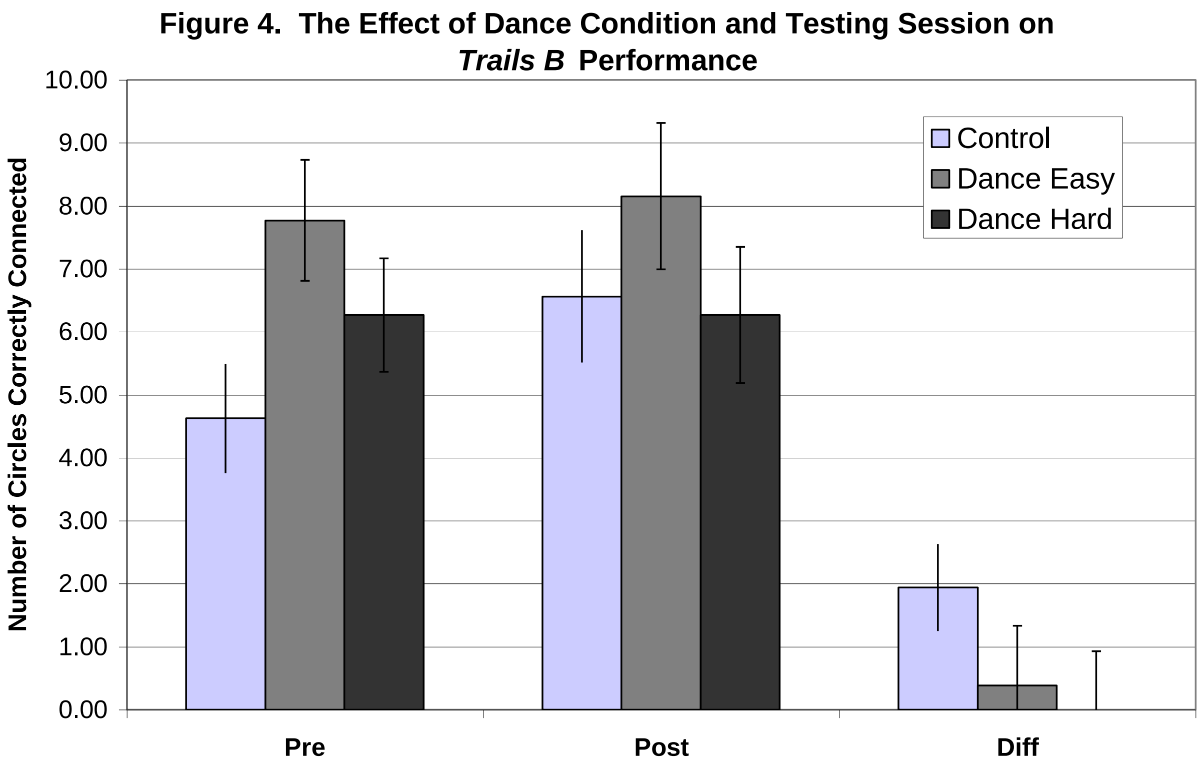

Figure 4. Mean cognitive differences in *Trails B* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

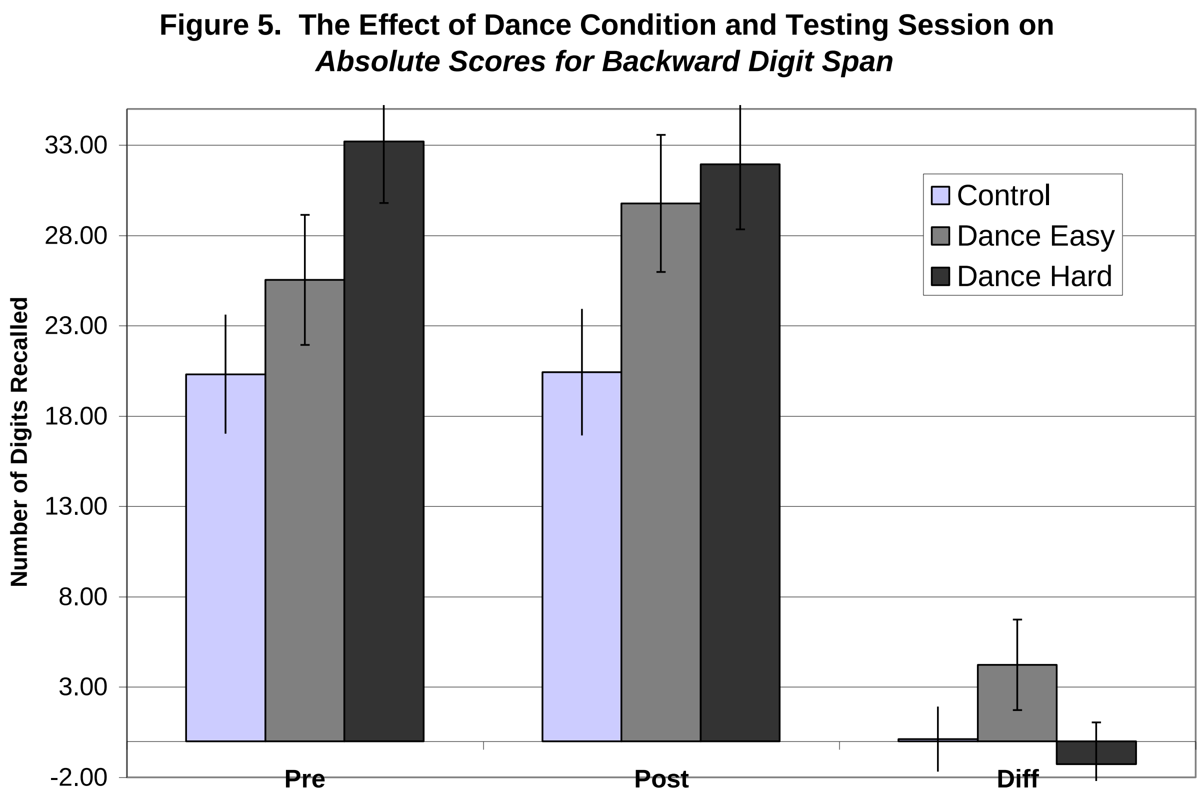

Figure 5. Mean cognitive differences in *Backward Digit Span absolute scores* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

Figure 6. The Effect of Dance Condition and Testing Session on Relative *Scores for Backward Digit Span*

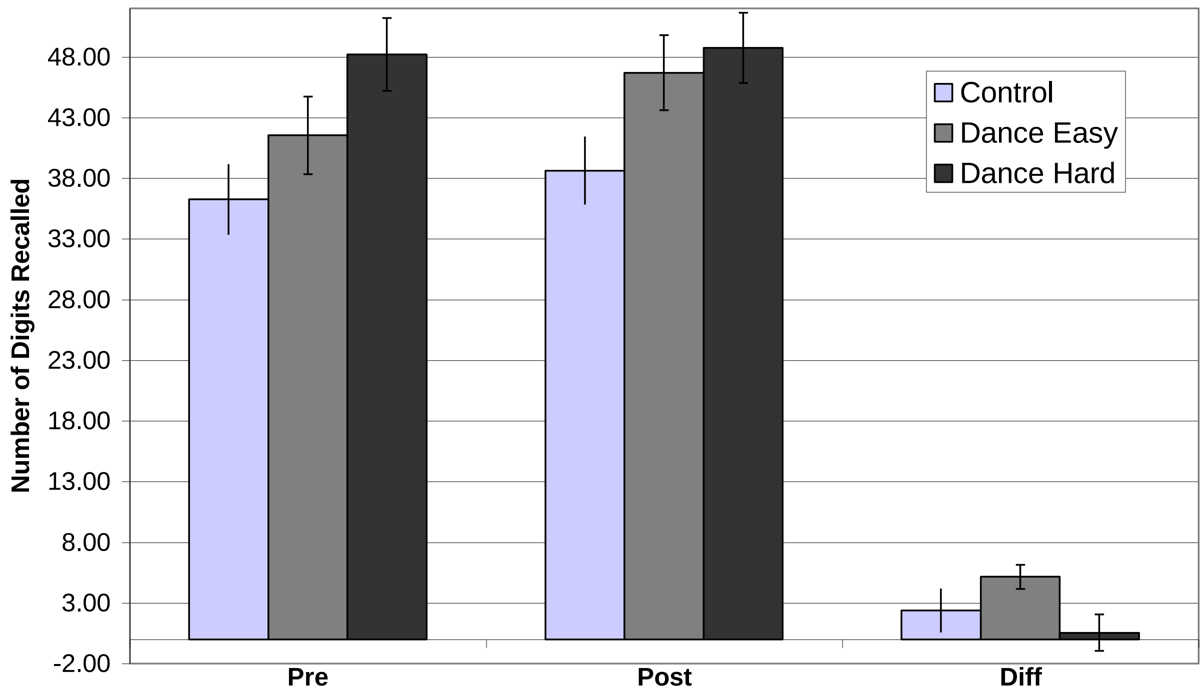

Figure 6. Mean cognitive differences in *Backward Digit Span relative scores* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

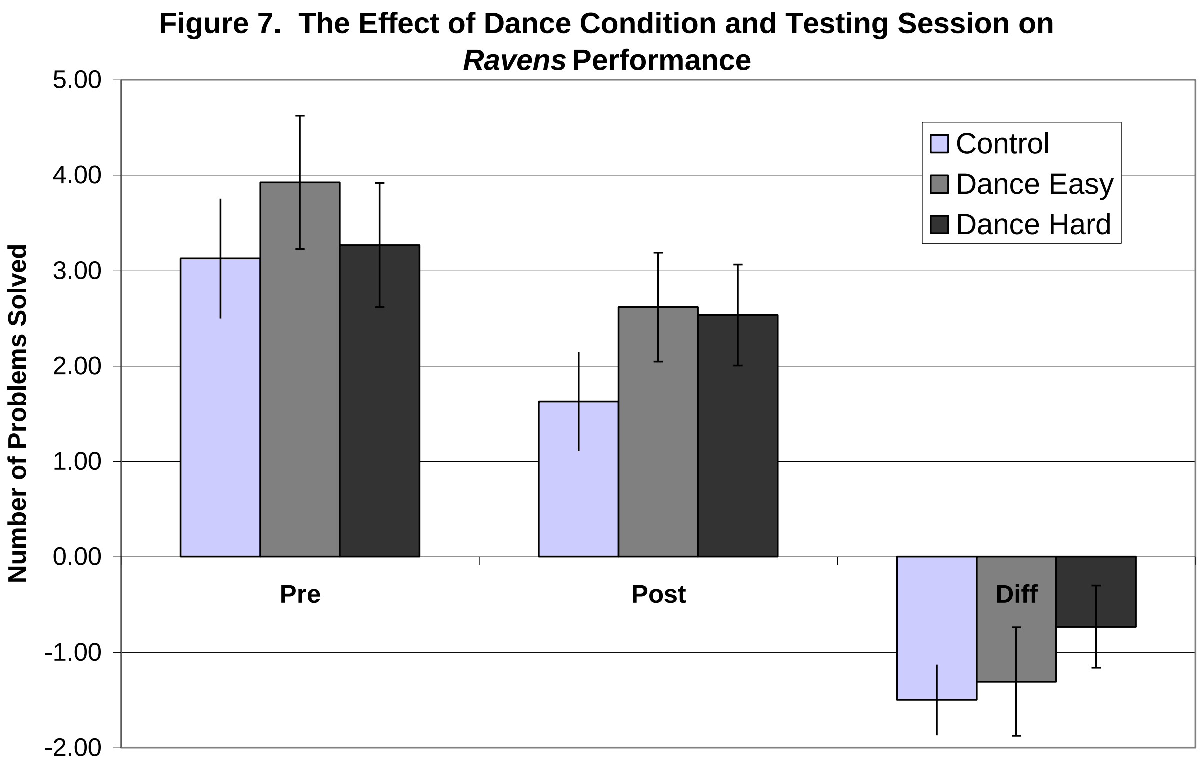

Figure 7. Mean cognitive differences in *Ravens Advanced Progressive Matrices* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

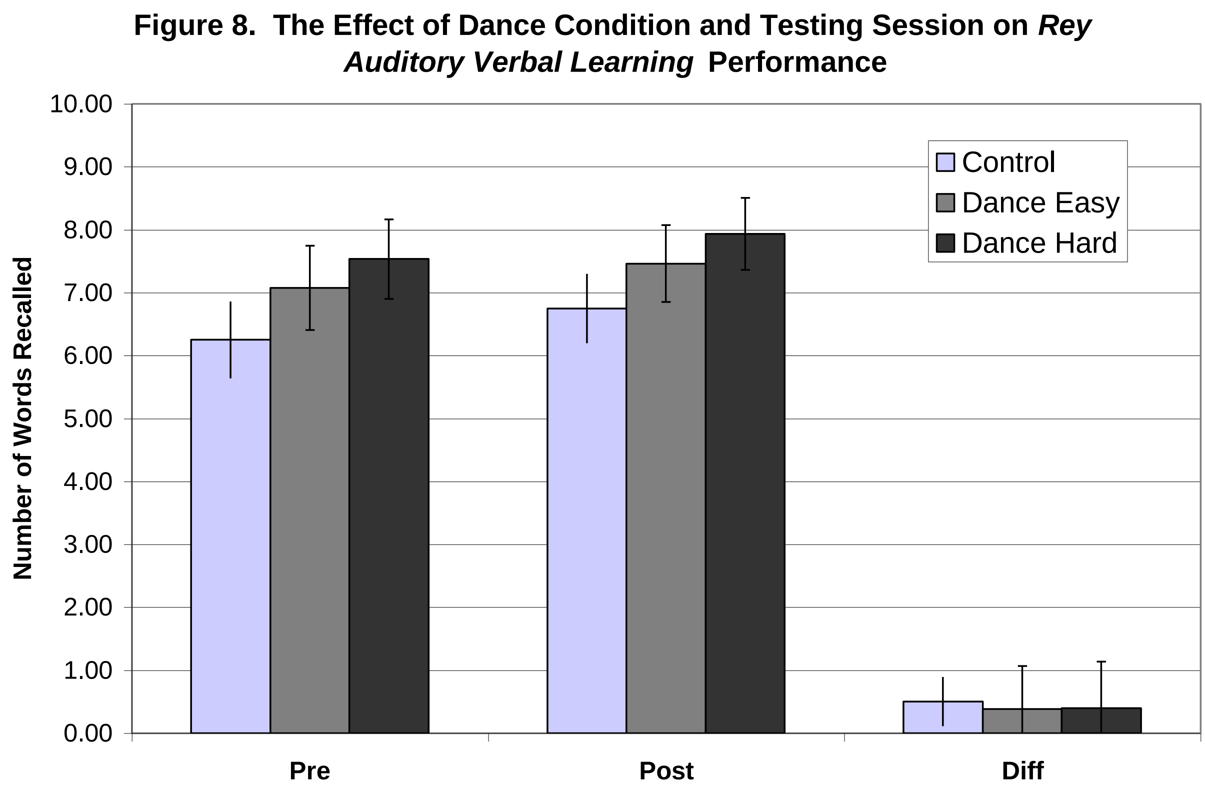

Figure 8. Mean cognitive differences in *Rey Auditory Verbal Learning* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

Lastly, the *Digit Symbol Substitution* task showed a main effect of Dance Condition, $\underline{F}$ (2, 41) = 3.63, MSE = 293.81, $\underline{p} < .05$ and a main effect of Testing Session, $\underline{F}$ (2, 41) = 12.70, MSE = 12.59, $\underline{p} < .001$, due to higher scores at post-testing. No interaction was seen between Dance Condition and Testing Session, $\underline{F}$ (2, 41) = 0.33, $\underline{p}$ = 0.72, (see Figure 9). The Tukey HSD procedure revealed the Complex Dance group showed better overall performance than the Control group, $\underline{p}$ = 0.04.

To corroborate the findings from the 2x3 ANOVAs above, additional one-way ANOVAs were conducted on the gain scores (post-test minus pre-test) for each of the three conditions (Control, Easy Dance, and Complex Dance). The only comparison that approached significance was for *Paired Associates Delayed* for the Control group (M = 0.31) and the Complex Dance (M = -0.87) group, $\underline{F}$ (2, 41) = 2.58, $\underline{p}$ = .09. The remaining comparisons of the gain scores were non-significant.

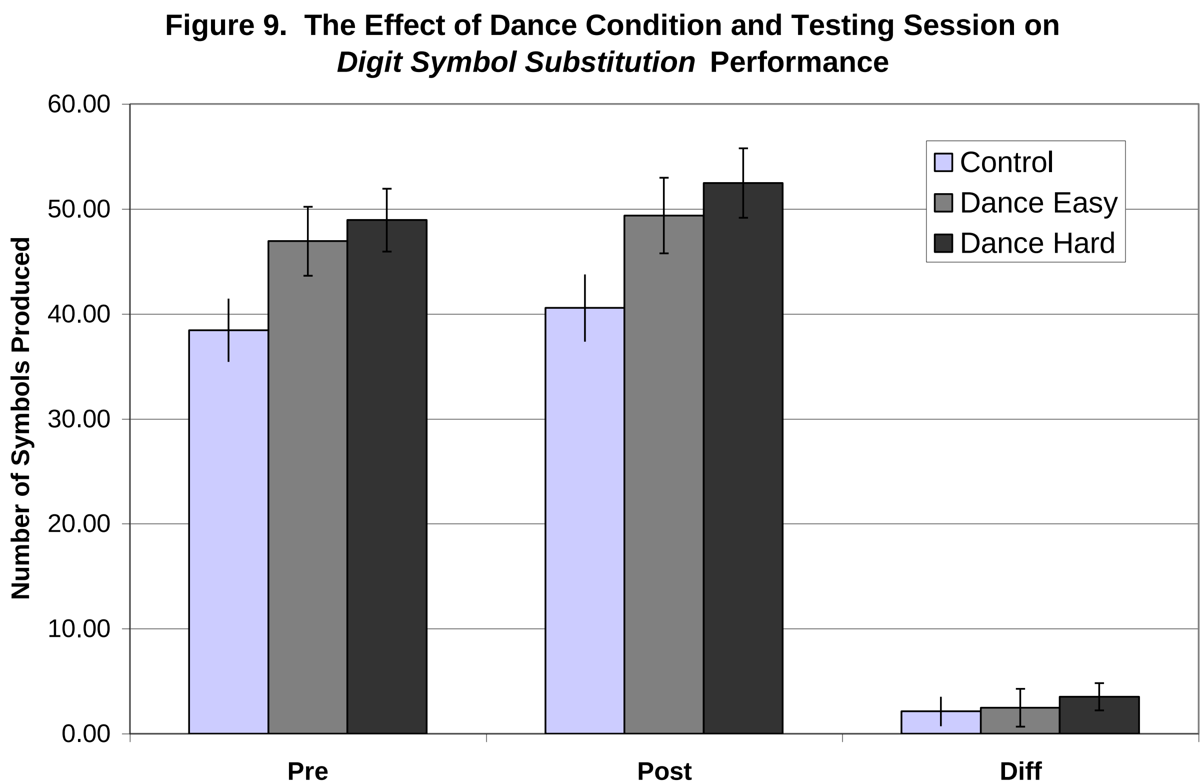

Figure 9. Mean cognitive differences in *Digit Symbol Substitution* for pre-test, post-test, and difference scores for three conditions (Control group, Easy Dance group, and Complex Dance group).

DISCUSSION

To review, it was expected that both dance groups would show greater cognitive gains than the Control group as a result of the dance training and that the most significant benefit would be observed for the Complex Dance group. However, baseline differences at the pre-testing stage of this project complicated interpretation of the data. Although no pre-experimental differences were expected given how well-equated the samples were for a variety of demographic and health factors, significant baseline differences still obtained for six of the nine pre-test measures. In all cases, the Control group demonstrated the lowest pre-test scores, followed by the Easy Dance group, and finally the Complex Dance group with the highest scores. This is obviously problematic from a training perspective, because it limited the amount of improvement that could be observed for the group expected to show the most gain.

Baseline differences aside, very little improvement was observed as a function of the dance intervention. For most of the tasks, gains – the difference between pre-testing and post-testing – were small or nonexistent for all three groups despite the fact that none of the pre-test scores for any of the groups was at ceiling. Thus, neither of the main hypotheses was supported. The next sections discuss possible methodological and theoretical explanations for the lack of training success in the current study.

This project highlighted a number of methodological hurdles that will have to be overcome in order to effectively use dance to train cognition. One issue involves the problem of attrition in a dance-oriented training program. Recall that data from 19 individuals were excluded from all analyses because they simply stopped attending the dance classes. This, of course, raises concerns about selection artifacts. Perhaps these individuals were non-dancers who arguably would have benefited most from the training, but who found the physical and or mental aspects of the class too challenging to continue. There is also the possibility that attrition had a selective impact on the Easy Dance class. Perhaps higher functioning dancers found the Easy Dance class too simplistic and withdrew, leaving participants who found even relatively simple, repetitive steps mentally challenging. These selection artifacts would certainly act to distort any training benefits. Against this possibility of strange samples resulting from attrition, however, is the performance of participants on the Shipley Vocabulary Test for the three groups (Control group M = 29.69, SD = 8.40; Easy Dance M = 31.23, SD = 8.20; Complex Dance M = 31.40, SD = 5.40) which was generally typical of older adult performance. As well, there was no difference in the groups' perceptions of how mentally challenging the dance class was (Easy Dance M = 5.15, SD = 2.82; Complex Dance M = 5.07, SD = 2.74).

This study also begs the question: What is the optimal amount of training? Designs for previous intervention studies have typically involved more frequent contact. For example, Westerberg and colleagues (2007) utilized one hour per day, five days per week, for five weeks and participants in Kramer's (1999) study exercised three times per week for 45 to 60 minutes per session for six months. Unfortunately, the current small study relied on volunteer participants who would obligate themselves only to a one-hour dance class once per week for six weeks. Comparatively, this is a small amount of training, however adequate research has not yet been done to provide clear guidelines for how much training is most efficacious. Future dance studies will need to conduct more frequent classes to more comprehensively examine this issue.

Perhaps the most important methodological question to consider is whether dance is even an appropriate training tool. Dance is a unique, engaging way to combine previously studied mental and physical techniques that have been shown to improve cognition. Indeed, there are a number of strengths to using dance as a training tool. First, it is a pastime already enjoyed by older adults. Weaving together physical and mental activities may be the solution to the boredom and monotony many older adults experience when engaging in a repetitive exercise such as riding a stationary bike or solving crossword puzzles. Second, difficulty levels can be easily adapted to suit the ability level of different individuals and one can begin at a slow pace and increase complexity and speed as abilities improve. Third, dance is a widely accessible and cost effective activity; many senior centers and dance studios offer adult dance classes. Finally, studies show that senior citizens benefit from the social component of this group activity (Verghese et al., 2005). These all point to dance as a viable tool for improving the quality of life for our aging population.

However, the specific implementation of the dance intervention in the current study was not successful in creating cognitive gains despite clear prior evidence that the mental and physical components can independently bolster executive functioning in old age (Churchill, Galvez, Colcombe, Swain, Kramer, Greenough, 2002; Colcombe & Kramer, 2003; Kramer et al., 1999; Dustman et al., 1992; Verghese et al., 2003; Toth et al., 2005). Providing the perfect blend of mental and physical challenge in the form of dance proved difficult in this study. Recall that the Easy Dance group (M = 4.62) perceived their class as significantly *more* physically challenging than the Complex Dance group (M = 2.67), and both groups rated their classes as moderately mentally challenging (Ms = 5.15 and 5.07 out of 10, respectively). Thus, the lack of gains could have also been due to a failure to structure the dance classes with the appropriate combination of mental and physical components.

Turning to a more theoretical explanation for the lack of observed gains, these results might represent the kind of limit on plasticity suggested by Baltes. Perhaps participants in this study were already using all of their reserve capacity pre-experimentally leaving little room for training-related improvements. Again, however, there is no obvious evidence for this claim given the poor baseline performance exhibited by the groups. Alternatively, these non-significant findings might reflect fundamental age-correlated limits on the scope of reserve capacity in general (Craik, 1983; Salthouse, 1985). That is, perhaps they are reflective of genuine boundaries on later life plasticity (Baltes & Lindenberger, 1988). However, in the context of the many successful training interventions discussed earlier, considerably more research will need to be done exploring different contingencies in dance-oriented cognitive training before such negative conclusions are justified.

CONCLUSIONS

To conclude, the population of the United States is getting older and the needs of these older individuals are becoming increasingly paramount. Among the most common needs cited by older Americans is the maintenance of mental health into late life in order to help sustain quality, independent living. The current research took dance, an activity already enjoyed by this older cohort, and examined its efficacy as a tool for improving performance in those cognitive abilities that traditionally are most devastated by the aging process. The results, while equivocal, contribute both to our scientific understanding of cognitive aging and cognitive rehabilitation, as well as provide some initial steps toward a new method for maintaining cognitive health across the lifespan.

REFERENCES

Aerobic exercise definitions (1998). *Executive Health's Good Health Report*, 34 (6), 7.

Baltes, P. B., (1987). Theoretical propositions of life-span developmental psychology: On the dynamics between growth and decline. *Developmental Psychology, 23,* 611-626.

Baltes, P. B., & Baltes, M. M., (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. *Successful Aging*, New York: Cambridge University Press, pp 1-34.

Baltes, P. B., & Labouvie, G. V. (1973). Adult development of intellectual performance: Description, explanation, modification. In C. Eisdorfer & P. Lawton(Eds.), *The psychology of adult development and aging.* Washington DC: American Psychological Association.

Baltes, P. B., & Lindenberger, U. (1988). On the range of cognitive plasticity in old age as a function of experience: 15 years of intervention research. *Behavior Therapy, 19,* 283-300.

Churchill, J. D., Galvez, R., Colcombe, S., Swain, R. A., Kramer, A. F., Greenough, W. T. (2002). Exercise, experience and the aging brain. *Neurobiology of Aging*, 941-955.

Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., Elavsky, S., Marquez, D. X., Hu L., & Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. *Journal of Gerontology*, 61A (11), 1166-1170.

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

Daniels, K. A., Toth, J. P., & Jacoby, L. L. (2006). The Aging of Executive Functions. In E. Bialystok & F.I.M Craik (Eds.), *Lifespan Cognition: Mechanisms of Change (pp. 96-111).* New York: Oxford University Press.

Drew, D., & Waters, J. (1986) Video games: Utilization of a novel strategy to improve perceptual motor skills and cognitive functioning in the non-institutionalized elderly. *Cognitive Rehabilitation*, 4, 26-31.

Dustman, R. E., Emmerson, R. Y., Steinhaus, L. A., Shearer, D. E., & Dustman, T. J. (1992). The effects of videogame playing on neuropsychological performance of elderly individuals. *Journal of Gerontology*, 47, 168-171.

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science,* 11, 19-23.

Haboush, A., Floyd, M., Caron, J., LaSota, M., & Alvarez, K. (2006). Ballroom dance lessons for geriatric depression: An exploratory study. *Arts in Psychotherapy,* 33, 89-97.

Health, United States (2005). Centers for Disease Control, National Health Center for Health Statistics. Retrieved December 20, 2006 from http://www.cdc.gov/nchs/data/hus/hus06.

Kempermann, G., Brandon, E. P., & Gage, F. H. (1998). Environmental stimulation of 129/SvJ mice results in increased cell proliferation and neurogenesis in the adult dentate gyrus. *Current Biology*, 8, 939-942.

Kempermann, G., & Gage, F. H. (2002). Genetic determinants of adult hippocampal neurogenesis correlate with acquisition, but not probe trial performance, in the water maze task. *European Journal of Neuroscience,* 16, 129-136.

Kramer, A, F., Hahn, S., Cohen, N. J., Banich, M. T., McAuley, E., Harrison, C. R., Chason, J., Vakil, E., Bardell, L., Boileau, R. A., & Colcombe, A. (1999). Ageing, fitness and neurocognitive function. *Nature,* 400, 418-419.

Kramer, A. F., & Willis, S. L. (2002). Enhancing the cognitive vitality of older adults. *Current Directions in Psychological Science*, 11, 173-177.

McKinley, P., Bednarczyk, V., Jacobson, A., Leroux, A., Rainville, C., Rossignol, M. L., & Fung, J. (2005). Argentine tango dancing improves balance and complex task performance in at-risk elderly: A feasibility study. *Gait and Posture,* 21 (1), 117.

National Institute on Aging (2005). Retrieved December 20, 2006 from http://www.nia.nih.gov.

Noice, H., & Noice, T. (2006). What studies of actors and acting can tell us about memory and cognitive functioning. *Current Directions in Psychological Science,* 15, 14-18.

Park, D.C. (2000). The basic mechanisms accounting for age-related decline in cognitive function. In D.C. Park & N. Schwarz (Eds.), *Cognitive Aging: A Primer* (pp. 3-21). Philadelphia, PA: Psychology Press.

Pethokoukis, J. (2006, October 2). A nation in full. *U. S. News and World Report*, 48-56.

Pronk, N. P., Anderson, L. H., Crain, A. L., Martinson, B. C., O'Connor, P. J., Sherwood, N. E., Whitebird, R. R. (2004). Meeting recommendations for multiple healthy lifestyle factors. *American Journal of Preventive Medicine*, 27, 25-33.

Salthouse, T. A., Atkinson, T. M., Berish, D. E. (2003). Executive functioning as a potential mediator of age-related cognitive decline in normal adults. *Journal of Experimental Psychology: General*, 132 (4), 566-594.

Starr, J. M., & Whalley, L. J. (2004). Differential cognitive outcomes in the hypertensive ole people in Edinburgh study. *Journal of the Neurological Sciences*, 229, 103-107.

Stuss, D.T., & Benson, D.F. (1986). *The frontal lobes*. New York: Raven Press.

Stuss, D. T., Robertson, I. H., Craik, F. I. M., Levine, B., Alexander, M. P., Black, S., Dawson, D., Binns, M. A., Palmer, H., Downey-Lamb, M., & Winocur, G., (2007). Cognitive rehabilitation in the elderly: A randomized trial to evaluate a new protocol. *Journal of the International Neuropsychological Society, 13,* 120-131.

Toth, J. P., Daniels, K. A., & Jacoby, L. L. (2005). *Art Dealer*: A computer game for enhancing cognition in older adults. Manuscript.

Tranel, D., Anderson. S.W., & Benton, A. (1994). Development of the concept of 'executive function' and its relationship to the frontal lobes. In F. Boller & J. Grafman (Eds.), *Handbook of neuropsychology, Vol. 9* (pp. 125-148). Amsterdam: Elsevier.

Van Praag, H., Kempermann, G., & Gage, F. H. (1999). Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. *Nature Neuroscience,* 2 , 266-270.

Verghese, J., Lipton, R. B., Katz, M. J., Hall, C. B., Derby, C. A., Kuslansky, G., Ambrose, A. F., Sliwinski, M., Buschke, H. (2003). Leisure activities and the risk of dementia in the elderly. *New England Journal of Medicine, 348, 2508-2516.*

Wecker, N. S., Kramer, J. H., Wisniewski, A., Delis, D. C., Kaplan, E. (2000). Age effects on executive ability. *Neuropsychology*, 14, 409-414.

Westerberg, H., Jacobaeus, H., Hirvikoski, T., Clevberger, P., Őstensson, M. L., BartFai, A., & Klingberg, T. (2007). Computerized working memory training after stroke – a pilot study. *Brain Injury*, 21, 21-29.

Willis, S. L., & Nesselroade, C. S. (1990). Long-term effects of fluid ability training in old-old age. *Developmental Psychology, 26, 905-910.*

APPENDIX A

Participant Information

Confidential

Section A: General Demographic Information

Gender:* [ ] *Male* [ ] *Female ***Birthdate:* __/__/__**

Education: _______ (with high school as 12 years)

Ethnicity:

[ ] African-American	[ ] Hispanic
[ ] Asian	[ ] Native-American
[ ] Caucasian	[ ] Other: ________________________

Handedness: Which is your dominant hand? [ ] Right [ ] Left

Language: Is English your native language (i.e., your first and primary language? [ ] Yes [ ] No

If not, how long have you been speaking English? _____ yrs

Prior Participation: ***Have you participated in psychology studies at UNCW before? [ ] Yes [ ] No***

If yes, approximately how many: ________________

Section B: Wellness and Fitness Information

Memory & Attention: Are you currently experiencing any problems with your memory or your ability to pay attention that have been diagnosed by a doctor? **[ ]** Yes **[ ]** No

If yes, explain: ____

Vision: Do you have any problems with your vision that cannot be treated with corrective lenses? **[ ]** Yes **[ ]** No

If yes, explain:____

Medical Conditions: Are you currently seeing a doctor for any medical problem? **[ ]** Yes **[ ]** No

If yes, why and duration: ___________________________________

General Health: How would you rate your health at the present time?

1	2	3	4	5
poor	fair	OK	good	excellent

Medications: Are you currently taking any medications that could make you drowsy and possibly unable to participate well in an experiment that required your attention? **[ ]** Yes **[ ]** No

If yes, explain:____

Injuries: Have you ever had a head injury that resulted in a loss of consciousness for more than 5 min? **[ ]** Yes **[ ]** No

If yes, explain: ____

Dexterity: Some of our experiments require participants to give responses by writing them with a pencil and paper or by using a computer keyboard. Do you have any problems (such as arthritis) that may make this difficult?

[ ] Yes **[ ]** No

If yes, explain: ___________________________________

Fitness: Do you engage in regular physical exercise? **[ ]** Yes **[ ]** No

[If yes, answer a - c]

(a) Please list all the physical activities you engage in regularly.
(b) How many days per week do you exercise? _____
(c) Approx. how long (in minutes) do you exercise each time? _____

Dance experience:

Have you ever participated in a dance class [ ] Yes [ ] No

If yes, how long?___________What type of dance?______________

Rate your level of dance expertise:

1	**2**	**3**	**4**	**5**
Not an expert	Fair dancer	Moderately good	Very good dancer	Expert

APPENDIX B

Hello everyone, my name is Deb Kemp. I plan to teach an 8-week musical theatre style dance class at the New Hanover County Senior Center this summer beginning June 12th and June 14th. Individuals will have a choice of either Tuesday morning classes (8:45 to 9:45) or Thursday morning classes (10:00 to 11:00). I'm a 25-year member of Dance Masters of America and have owned and operated the Performing Arts Dance Studio in Pender County for over thirty years.

This dance class will be part of a research project for my thesis as a graduate student at the University of North Carolina Wilmington. At age 50 (plus!) I'm what the university refers to as a *non-traditional* student. My mentors, Dr. Karen Daniels and Dr. Jeff Toth operate the Aging and Cognition Lab at UNCW. We are interested in understanding how mental and physical abilities change with age. My thesis will investigate the relationship between physical and mental ability in older adults.

I hope you will join this special movement and dance class this summer. It's free so sign up!

Deb Kemp 910-686-7175, dak0889@uncw.edu

APPENDIX C

Have FUN while becoming

PHYSICALLY FIT!!!

ENJOY exercising in a SPECIAL movement class designed just for

YOU!

An exciting Musical Theatre style dance class

for ladies and gentlemen

Previous dance experience not required

ENROLL for either

Tuesday or Thursday mornings

8-week session begins

June 12 and June 14

Classes at the Senior Center

Located at the corner of College Road & Shipyard Blvd., beside Hoggard High School

Cost: FREE

(Instructor requests an 8-week commitment)

For information or enrollment please contact:

Deb Kemp

910-686-7175 or dak0889@uncw.edu