The Effectiveness of Interactive Metronome® as a Tool to Improve Cognition and Motor Performance in Healthy Older Adults in Eastern North Carolina

by

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The purpose of this study was to measure the effectiveness of the Interactive Metronome (IM) in improving cognitive and motor performance in healthy older adults. As the aging adult population continues to rise, it is important to explore tools which can support this population to live as independently as possible, for as long as possible. Literature indicates there is a natural decline in cognition with aging, and that cognitive decline may be related to decline in functional performance. 13 healthy older adults completed 18 sessions of IM protocol and researchers gathered data from IM assessments, d2 Test of Attention, and Nine Hole Peg Test across four points of measure. Results indicated a significant increase in percentage of change from the baseline measure to the final point of measure on each of the four assessments. Researchers concluded the participants' improved scores on cognitive and fine motor measures may indicate IM could be beneficial in preventatively treating this population. Future research should explore if increased performance on assessment scores might contribute to increased functional performance.

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Chapter I

Introduction

The rate of growth for adults over the age of 65 is irrefutable. The population for adults aged 65 and over has increased from 35.9 million in 2003 to 44.7 million in 2013; it is projected to more than double to 98 million in 2060 (Administration on Aging, 2014). As the population grows, the need for research on healthy aging adults living in their community becomes greater. Research should address how to improve functioning of adults with impairments, but it should also focus on prevention of functional decline due to aging.

The *Occupational Therapy Practice Framework (OTPF): Domain & Process 3rd Edition* (OTPF) highlights the need for, "preservation of occupational identity for those who are at risk for developing an illness, injury, disease, disorder, condition, impairment, disability, activity limitation or participation restriction" (American Occupational Therapy Association [AOTA], 2014, p. S1). Additionally, the *International Classification of Functioning, Health and Disability* (ICF) offers a model for describing functioning and disability; two of the major components addressed in the model are *activities* and *participation*. *Activities* and *participation* are described in terms of the amount of participation and the restrictions of the individual based on functioning (World Health Organization [WHO], 2002). Similarly to the OTPF, the ICF outlines the importance of viewing an individual's participation as a primary determinant of health, and highlights the need for prevention to be a component of intervention (WHO, 2002). In order to successfully address the needs of healthy aging adults, it is important to support participation in activities that promote well-being and enhance self-efficacy so they may live longer within their communities. Occupational therapists can bolster the health of populations in need through

utilizing preventative methods, rather than focusing primarily on rehabilitative methods (AOTA, 2014; Hildenbrand & Lamb, 2013; Metz & Robnett, 2011).

Reduced cognitive function is a typical result of aging (Antsey & Lowe, 2004; Deary, 2009), and some researchers are finding participation in cognitively stimulating activities may equip aging adults with tools to better compensate for the typical cognitive decline (Hertzog, Kramer, Wilson, & Lindenberger, 2009; Metz & Robnett, 2011; Opdebeek, Martyr & Clare, 2015; Willis et al., 2006). Many new intervention methods and therapeutic technologies are emerging that may be beneficial in supporting older adults' continued participation in "*activities of daily living"* (ADLs) and *"instrumental activities of daily living"* (IADLs). The OTPF defines ADLs as, "activities oriented toward taking care of one's own body", some examples include: bathing, eating, toileting, and dressing; IADLs are defined as "activities to support daily life within the home and community that often require more complex interactions than those used in ADLs, including activities such as: driving, financial management, care of others, and home management (AOTA, 2014, p. S19).

Burton, Strauss, Hultsch and Hunter (2006) cite numerous studies which support the theory that "executive functions have been found to be significant predictors of IADLs for both individual's with cognitive impairment or dementia, and cognitively intact, high-functioning individuals" (p. 434). In order for older adults to function independently in their day-to-day lives, it is imperative cognitive abilities stay intact, and current research is exploring preventative methods to reduce cognitive decline in healthy older adults (HOAs). Studies suggest decreased cognitive abilities are associated with reduced participation in ADLs and IADLs (Allaire, Gamaldo, Ayote, Sims, & Whitfield, 2009; Burton et al., 2006; Johansson, Marcusson, & Wressele, 2012); but it is unclear if cognitive training tasks will significantly enhance functional

performance in ADLs and IADLs (Ball, et al., 2002; Hertzog et al., 2009; Mueller, Raymond, & Yochim, 2013).

Various types of cognitive training techniques have been utilized by therapists. The *Center on Aging at American Institutes for Research* defines cognitive training as using "repetitive exercises keyed to specific cognitive abilities. May be computer-assisted or delivered in person individually or in small groups" (Kueider, Bichay, & Rebok, 2014, p. 2). Cognitive training tasks are utilized in therapy to prevent cognitive decline, however, it is unclear if significant change results from these tasks due to the challenge of obtaining scientific information regarding functional task transfer, and because testing is often conducted on older adults who do not currently have impairments (Ball et al., 2002; Hertzog et al., 2009; Mueller et al., 2013; Willis et al., 2006). While researchers have not identified one specific cognitive training format to be superior to others, they have found that cognitive training tasks may improve cognitive function. Additionally, some researchers suggest that the implementation of computerized cognitive training programs supports reduced healthcare costs for the growing aging population by decreasing the need for face-to-face therapy (Kueider et al., 2014; Kueider, Parisi, Gross, & Rebok, 2012).

Current studies suggest more participation in cognitively stimulating activities may lead to lower rates of cognitive decline for older adults (Hertzog et al.; La Rue, 2010; Mueller et al., 2013), but researchers have found it challenging to prove increased training in cognitively stimulating activities promotes functional improvement in day-to-day life (Hertzog et al., 2009; Willis et al., 2006). There is a lack of empirical evidence identifying specific tools which may be utilized to combat cognitive decline (Kueider et al., 2014), and research contributing to this body

of knowledge will support the preventative goals outlined in the OTPF and ICF, specifically for the growing HOA population.

Problem

There is a growing initiative to support older adults aging in the community. Due to the high rate of growth among this population, more research needs to examine interventions that support healthy aging in the community (Bacsu et al., 2014; Orellano, Colo´n, & Arbesman, 2012). Cognitive decline is a typical occurrence in the aging adult, and these cognitive changes can impact HOA's ability to problem-solve and process information efficiently, potentially impacting ADL and IADL participation (Glover & Wright, 2013). Participation in occupations such as ADLs and IADLs is associated with independence (Hertzog et al., 2009), and in order to perform ADLs and IADLs, individuals must employ the use of executive functions, attention, memory, fine and gross motor skills (Burton et al., 2006; Dayanidhi & Valero-Cuevas, 2014; Incel, Sezgin, As, Cimen, & Sahin, 2009). Mild cognitive impairments may disrupt many of these everyday tasks making it challenging for older adults to live independently (Burton et al., 2006; Felix et al, 2014). Research is lacking in the area of intervention methods which can be utilized by therapists to support HOAs, prevent cognitive decline, and maintain functional performance in ADLs and IADLs (Fratiglioni, Pallard-Borg & Winblad, 2004; Green & Bavelier, 2008; La Rue, 2010).

Purpose

The purpose of this study is to examine the relationship between healthy older adults' participation in a training tool, Interactive Metronome® (IM) and participant scores on tests of cognition and motor abilities. The IM was chosen as the training tool because it provides a standardized measurement that will be compared to the assessments included in the study. The

study will compare percentage of change in scores on IM and scores on the math and reading fluency subtests of Woodcock Johnson III, d2 Test of Attention, Four Square Step Test (gross motor measure) and Nine Hole Peg Test (fine motor measure).

Schaffer et al. (2001) explains IM is an evidence-based tool that improves timing, rhythm and synchronization in the brain which can support motor planning and sequencing. Koomar et al. (2000) states because of the potential impact on synchronization, IM may be a beneficial tool to combine with other interventions to support skills such as motor planning and sequencing in various diagnoses. The IM was selected as a research tool for this study because research indicates a positive relationship between IM participation and scores on tests of motor abilities, attention, and other cognitive functions in various populations including attention deficit hyperactivity disorder, cerebral vascular accident, traumatic brain injury, and coordination disorders (Cosper, Lee, Peters, & Bishop; Hill, 2011; Koomar et al., 2000; Nelson, MacDonald, Stall, & Pazdan, 2013; Schaffer et al., 2001; Shank & Harron, 2015). Attention is identified as being one of the most basic functions of the human brain and some theories suggest it is the basis for many other cognitive functions (Gillen, 2013), and motor abilities enable adults to maintain independence as they age (Dayanidhi & Valero-Cuevas, 2014). Therefore, researchers hope to examine the use of IM in the HOA population to support prevention of cognitive and motor decline.

Research Questions

This study will address the following research questions:

- What is the percentage of change in Task Average of participants' scores on Task 1 and Task 14 of the Long Form Assessment across the four points of measure?

- What is the percentage of change in participants' scores on the d2 Test of Attention, Four Step Square Test, Nine Hole Peg Test, and Woodcock Johnson III across the four points of measure?
- How might these changes indicate improvement in cognitive operations?
- How might these changes indicate improvement in motor performance?

Expectation of Results

Researchers expected to see an improvement on IM scores as well as improved attention, processing speeds, and concentration scores on the assessments across each of the four measurement points. Researchers also anticipate increased performance of fine and gross motor skills.

Significance of the Study

As the baby boomer generation transitions into older adulthood, there are a growing number of individuals living and aging within the community. In order to support older adults as they age, it is necessary to address the potential of cognitive and physical decline. Some tools may be used to support preventative efforts in this decline, and the IM is a tool that is worthy of exploring due to the positive impact it has had on other populations' attentional and motor rehabilitation.

Chapter II

Review of the Literature

Due to the accelerated rate of growth of HOAs, more research needs to be conducted concerning this population. A HOA, for the purposes of this study, can be defined as an adult over the age of 60 who is "normally" aging. "Normal" aging may include a decline in physical, sensory, vestibular, cardiovascular, and cognitive health (Goodman & Bonder, 2014). It is imperative that appropriate interventions are identified so older adults can maintain their independence as long as possible.

Numerous studies suggest a slower rate of cognitive decline among older adults who participate in cognitively stimulating activities (Hertzog et al., 2009; Metz & Robnett, 2011; Mueller et al., 2013), however, there is not enough literature identifying if improved cognitive function is linked with improved participation in everyday functions (Fratiglioni et al., 2004; Green & Bavelier, 2008; La Rue, 2010). Participation in ADLs and IADLs is a primary component of maintaining independence, and some studies have attempted to establish generalization of cognitive tasks to ADL's and IADL's, but functional performance results are unclear (Ball et al., 2002; Kueider et al., 2014; Mueller et al., 2012). The following literature explores studies pertaining to prevention of cognitive decline in older adults, brain plasticity, and the Interactive Metronome®.

Brain Plasticity in Aging Adults

Kolb and Whishaw (1998) explain *brain plasticity* is the concept that "experience can modify brain structure long after brain development is complete" (p. 44). In terms of plasticity, and the effect on the aging brain, Mattson et al. (2002) described it as a response from neurons

and glia to environmental stressors in aging, and that the ability for the neurons to adapt to these changes is associated with successful aging. Greenwood (2007) also discusses plasticity in the aging brain and states that plasticity is "poorly accounted for in the dominant theories of cognitive aging" (p. 657), and describes changes in the brain due to aging as "functional alteration in processing networks in the brain" (p. 657). Older theories on brain plasticity supported the belief that brain plasticity was associated with childhood and young adulthood, but current studies show that older adult minds continue to change and grow from new learning (Greenwood, 2007; Hertzog et al., 2009; Mattson et al., 2002). In order to increase knowledge concerning older adults' capacity for improving cognitive function, it is necessary to explore brain plasticity and skill retention in older adults. Due to the normal decline of cognitive skills in aging adults, it is important to determine if mentally stimulating activities may impact brain plasticity, cognitive reserve, and influence the aging process (Deary et al., 2009; Metz & Robnett, 2011; Petrosini, 2009).

One study by Lebowitz, Dams-O'Connor, and Cantor (2012) measured the feasibility of computerized brain plasticity based cognitive training with community-dwelling participants who were diagnosed with a mild-to-severe traumatic brain injury (TBI). Researchers developed a program including computer based "exercise programs for the brain" (Lebowitz et al., 2012, p. 1548) as an approach to cognitive rehabilitation. The games were administered on a laptop and consisted of repeated trials on "game-like tasks such as selecting a target stimulus out of an array of distractors or visually tracking an occluded, moving target stimulus" (p.1548). One important concept behind the use of this system is that the complexity, and speed of the program, increases as the user becomes better at the tasks. While the sample was comprised of individuals with mild-to-moderate TBIs, there may be similar symptoms seen in typical cognitive decline in aging

adults. The shared symptoms might include cognitive impairments in areas such as memory, attention, speed and executive functions which may limit day-to-day task completion, ADL and IADL performance (Bogdanova & Verfaellie, 2012; Lebowitz et al., 2012; Trujillo & Painter-Patton, 2015). Due to the similarities in impairments, and literature related to the cognitive task participation for those with mild TBI's, it is important to consider those findings in this study.

The study by Lebowitz et al. (2010) included 10 participants recovering from a mild-to-moderate TBI with a mean age of 46.3 who were at various stages in recovery. Participants were instructed to use the cognitive training software forty minutes per day, 5 days per week for a total of 6 weeks (Lebowitz et al., 2012). Pretest and posttest assessments included neuropsychological assessments measuring processing speed, working memory, attention and concentration, and a self-report measure of cognitive function. Measures used were: (1) TBI battery of the Automated Neuropsychological Assessment Metrics Version 4 which measures working memory, processing speed and efficiency, attention and concentration, and spatial processing, (2) Cognitive Failures Questionnaire, a self-report measure including questions about memory, perception, and motor function, (3) Frontal Systems Behavior Scale, a self-report measure of behavioral function, and, (4) surveys regarding the overall experience with the program. The researchers concluded the program was feasible for their population based on survey results of user experiences and due to small and large effect sizes on neuropsychological measures and self-report questionnaires (Lebowitz et al., 2012).

Cognitive plasticity is an important factor when investigating the role of cognition in healthy aging adults (Deary et al., 2009; Metz & Robnett, 2011; Petrosini, 2009). In a study on cognitive plasticity in older adults by Bherer et al. (2006), researchers examined improvement in task performance in younger (n=12) and older (n=12) adults. Researchers examined the age-

related differences in variability of tasks in the context of "dual task training". Specifically, they explored if improvements in attentional control are as high in older adults as they are in younger adults, and if similar improvement implies plasticity across the life span. Participants performed tests including: general mental abilities (Kaufman Brief Intelligence Test), psychomotor speed (box completion and digit copying), perceptual and mental speed (digit symbol, sequential complexity), short term and working memory (forward, backward, and computation spans), and attention and executive functions (Stroop, Trail making A-B). During the first session, participants were introduced to multiple single-tasks and mixed-tasks without any feedback, as quickly as possible. In subsequent sessions, participants were provided with feedback that enabled them to be more successful in mixed-task completion (multi-tasking strategies, prioritization, auditory and visual cues). At the completion of the training sessions results indicated significant improvements in task performance for both younger and older adults. Bherer et al. (2006) noted equivalent improvements between age groups in terms of response speed and variability, but the older adult group showed greater improvement in accuracy of task completion than the young adult group. Researchers concluded this demonstrates that increased performance conditions can increase task performance, and that age-related differences did not affect training outcomes (Bherer et al., 2006).

Another study comparing task improvement across age groups, by Jarus and Ratzon (2000), explored the effect of mental practice on the acquisition and retention of a motor skill. Researchers divided participants into three age groups: children (n=30, mean age=10), adults (n=30, mean age 28), and older adults (n=29, mean age=67). Older adult participants were currently living in a home for older adults, researchers did not report if this was a skilled nursing facility of an independent retirement community. Researchers taught a bilateral coordination task

they considered appropriate for all age groups as a novel and challenging task. According to researchers, the task involved continuous tracking of the object and was relatively lengthy in duration. After five acquisition trials, participants performed the task and were then separated into two intervention groups: a "physical practice group" and a combined "mental and physical practice group". After a 30 minute interval, both groups repeated the task to test for retention of acquired skill. Researchers' incorrectly hypothesized results would indicate a significant difference among the mental-physical practice group and the physical practice group for all three age ranges. However, results showed children and older adult participants in the mental practice group were significantly faster than those in the physical practice group, but there was no difference in mental practice group and physical practice group for adults. Additionally, researchers learned that in the retention phase, the only group who benefited from the combined physical and mental practice was the older adults.

The above studies suggest that task performance can be enhanced through task-training techniques and that brain plasticity in healthy older adults can contribute to improved processing and attention skills. (Hertzog, 2009; La Rue, 2010; Opdebeeck et al., 2015). However, researchers have highlighted the need to further understand how cognitive decline impacts functional performance.

Cognitive Decline and Functional Performance in Older Adults

Research suggesting brain plasticity is present in older adults implies that aspects of cognition may continue to improve in the aging brain. Researchers suggest that decline in cognition would impact functional task performance (Burton et al., 2006; Edwards, Wadley, Vance, Wood, Roenker, & Ball, 2005; Wahl, Schmitt, Danner, & Coppin, 2010). Some

researchers have addressed how cognitive decline may impact functional performance in day-to-day activities, and how cognitive training may help.

In a study on speed of processing in aging adults by Edwards et al. (2005) researchers examined how "speed of processing training" would impact functional performance in adults who exhibited deficits in this area. Researchers discussed the overlap of cognitive functions, and how performance in one area will impact overall cognitive abilities. The researchers explain, "closely related to speed training is training for dual task performance…dual task performance requires rapid information processing and divided attention skills, as well as attention switching and meta-cognitive abilities such as self-monitoring and cognitive resource management" (p. 263). Researchers conducted a randomized study with a control group. The sample included 126 adults aged 62-94 who exhibited processing speed deficits. All participants underwent ten 1-hour training sessions; the majority of the participants (75%) were in a group training format for the remainder of the sessions whereas participants in the intervention group (25%) were in individual sessions for the remainder of the sessions.

Participants were assessed using various measures of speed of processing, including: Usual Field of View (UFOV), Road Sign Test, Timed IADL test, Letter and Pattern Comparison, Digit Symbol Substitution, and Digit Symbol Copy; measures of executive function included: Stroop and the Trail Making Test. Researchers concluded there was significant improvement ($P < .001$) in both groups' performance in the Timed IADL test, as well as the UFOV ($P < .001$). Researchers were pleased the format of training did not impact training gain; however, they were surprised there was not functional task transfer in measures other than the UFVO, and the Timed IADL test. Ultimately, researchers concluded that, "results of such varied approaches show that

older adults seem able to benefit from virtually any effort to improve their basic cognitive abilities" (Edwards et al., 2005, p. 270).

Another study examining speed of processing changes in older adults was conducted by Wahl, Schmitt, Danner, and Coppin (2010). Researchers collected data on 230 aging adults with a mean age of 62.4, over a period of 12 years. The sample was considered to be "without loss of functional ability" at baseline (p. 697). Measures included a functional ability measurement (self-report questionnaire), a cognitive functioning measure (Digit Symbol Substitution Test), and a personality measure. Researchers hypothesized there to be a correlation between cognitive decline, speed of processing, and change in personality traits. Results indicated a significant relationship between a decline in speed of processing, and functional abilities (P = .02); a relationship with declining function and personality changes was also indicated. Wahl et al. (2010) also suggested that the "results add to an understanding of risk trajectories emerging already in early old age in terms of a beginning loss of functional independence and then continue and expand as we get older" (p. 705). The researchers identify cognitive decline as an important risk factor, and support early cognitive training programs as a preventative measure (Wahl et al., 2010, p. 705).

A study by Tucker (2011) discussed the relationship between "neurocognitive functions" and "everyday functions" in aging adults. Tucker (2011) examined a sample of 698 community dwelling adults, aged 65-94, over a period of five years. The adults lived independently at baseline, and were assessed using various tasks of daily living and cognitive functions throughout this longitudinal study.

The participants were assessed on 3 measures of daily living: the Everyday Problems Test, Observed Tasks of Everyday Living, and the Timed Instrumental Activities of Daily Living

assessment; self-reported measures of everyday functioning were also administered to participants. Additionally, Tucker (2011) assessed participant changes in executive reasoning, episodic memory, and perceptual speed by administering various tasks related to these specific cognitive functions. Participants were assessed at 6 points throughout the study, and results indicated a strong correlation with changes in neurocognitive performance, and changes in day-to-day tasks at each assessment period. Tucker (2011) also notes that the participants' "self-reported" measure of performance did not have a strong correlation. He determined researchers should be weary of relying on self-report when conducting such studies.

Cognition and Memory Decline Prevention in Older Adults

Studies suggest "cognitive training tasks" can enhance cognitive performance but little is known about how this type of training may improve functional performance in day-to-day activities (Kueider et al., 2012; Ball, 2007). More research needs to address types of cognitive intervention strategies (Hertzog, 2009; Mueller et al., 2012; Willis et al., 2006) for HOA's.

In a monograph exploring various activities that enhance cognitive performance, Hertzog et al. (2009) found that older adults' functional capacity can continue to be enhanced as long as there is involvement in stimulating activities that require the use of executive skills. *Executive skills* can be defined as higher order thinking processes, and involve planning, organizing, sequencing, and problem solving abilities (Gillen, 2013). The researchers cite three reasons for the hypothesis functional capacity can continue to be enhanced; the findings are based upon a review of scientific literature: (1) cognitive training studies have demonstrated that older adults can improve thinking and remembering through intensive training tasks (2) studies indicate that an intellectually stimulating lifestyle predicts better maintenance of cognitive skills (3) physical activity enhances cognitive function (pp. 1-2). Researchers explained that in the past, cognition

was viewed as a general overall component of functioning. However, they hypothesized that cognition is influenced by "relevant knowledge structures" and that "new learning builds on the scaffold of what is already known" (p. 5). From this perspective, cognitive function and everyday occupations are not mutually exclusive terms, because the ability to complete tasks relies on cognitive abilities as the foundation of functional performance. This research is consistent with other literature supporting older adults' need for cognitive skills due to the demand required for higher level thinking involved in ADL and IADL performance (Bogdanova & Verfaellie, 2012; Burton et al., 2006; Metz & Robnett, 2011; Orelleano et al., 2012; Willis et al., 2006).

Other researchers discuss cognition and memory decline in the aging brain in terms of a concept called *cognitive reserve. Cognitive reserve* (CR) is defined by Stern (2002) as, "the ability to optimize or maximize performance through differential recruitment of brain networks, which perhaps reflect the use of alternate cognitive strategies" (p. 451). Stern (2002) discusses the concept that cognitive reserve is present in healthy, and damaged brains. An individual who uses the brain more efficiently may exhibit increased CR in response to higher demand. In the case if the aging individual, a person with efficient CR would respond better to the typical decline in cognitive function due to aging, and be less impacted than someone with reduced amounts of CR.

In a meta-analysis on CR and cognitive function in healthy older adults, researchers examined the relationship between cognitive reserve and cognition in the domains of memory, executive function, visuospatial ability and language (Opdebeeck et al, 2015). One study by Stern (2002) was included in the meta-analysis which explained the concept of "active" and "passive" models of the brain. The passive model of the brain includes the physical components

such as: size, neuronal count and resiliency in regard to pathology; whereas the active model of the brain is comprised of the experiences the individual engages in, such as participation in cognitively stimulating activities. Stern (2002) continues to explain that, through increasing the cognitive reserve, the individual is better equipped to handle any further brain damage or pathology that may result as the individual ages. Stern (2009) refers to this use of cognitive reserve as "enlisting compensatory processes" (p. 2). Similarly to Stern, Mattson et al. (2002) researched brain function during the aging process and hypothesized that as the brain changes with age, it can either adapt, or breakdown due to the normal aging process. Mattson et al. (2002) explains there are various metabolic stressors along with environmental and genetic factors that contribute to brain decline. Matteson et al. (2002) also explains the most effective way to promote "successful aging" is through enhancing cognitive functions throughout the lifespan so the brain can learn to adapt to the changes. Due to the findings on cognitive reserve and cognitive function in older adults, as well as findings that cognitive training tasks may improve performance on cognitive assessments, and functional performance measures, it is important to research various methods, including cognitive training, which may impact ADL and IADL participation (Kueider et al., 2012; Metz & Robnett, 2011; Opdebeeck et al., 2015; Orellano et al., 2012; Reijenders et al., 2012).

Research on older adults' cognition also suggests a relationship between cognitive activity level, memory decline, and depression (Fratglioni et al., 2004; Hertzog et al., 2009; Mueller et al., 2013). In one longitudinal study on cognitive activity in older adults, researchers found a significant relationship between higher cognitive activity level and delayed memory decline (Mueller et al., 2013). The study examined cognitive activity engagement, executive functioning, memory, and depression in older adults. The study consisted of 62 community-

dwelling adults over the age of 60. The measures used were (1) Florida Cognitive Activities Scale, which is a self-report measure in which frequency of engagement in various "cognitive activities" is assessed, (2) Geriatric Depression Scale, a self-report measure of depressive symptoms, (3) California Verbal Learning Test, which tests memory recall, (4) Trail Making Subtest of the Delis-Kaplan Executive Function System which assesses the executive function skill of task switching (5) The D-KEFS 20 Questions Subtest which is a measure of abstract thinking (also considered to be a component of executive skills). All participants were assessed at baseline, and 44 participants returned for testing 15 months later. Correlations were calculated among the variables and multiple regressions were conducted to predict outcomes for the second assessment of the executive function tests. Researchers found that baseline depression levels were significantly correlated with baseline cognitive activity level, and that higher levels of cognitive activity predicted better performance on tasks involving memory and executive functioning. (Mueller et al., 2013). The study by Mueller et al., 2013 implies there is a relationship between cognitive decline and activity participation. Additionally, the study supports the ideas of many other authors who report cognitive engagement can benefit HOAs over time (Metz & Robnett, 2011; Orellano et al., 2012).

One study related to interventions aimed at preventing cognitive decline in older adults was conducted by Ball et al. (2002). The study included 2832 community dwelling older adults aged 65 to 94. Participants were randomly assigned to one of four groups including one control group. The groups (with the exception of the control group) each received a 10–session group training program in one of three areas including: memory, reasoning, or speed of processing. Outcome measures were performance-based and self-reported; the measures focused on ADLs and IADLs. Memory assessment measures focused on episodic verbal memory tasks. Primary

outcomes measured “everyday problem solving” (understanding medication labels, charts), and “everyday speed” (looking up phone numbers, finding items on a crowded shelf). Additional outcomes were pen and paper tests and included a “processing speed” assessment (identification and localization of information while additional cognitive demands are required), a “reasoning” assessment (pattern identification), and a “memory” assessment (episodic verbal memory tasks). Self-report measures assessed performance of ADL’s, IADL’s, and driving habits.

Researchers found that individuals had positive results from their training, and improved in specific cognitive skills over time. Some participants continued to demonstrate positive effects 24 months after the initial training. While these results are promising, the researchers could not conclude the cognitive improvement resulted in long term overall effects in ADL and IADL performance because there was not significant improvement in the day-to-day functional tasks (Ball et al., 2002).

While studies suggest there is a relationship between participation in cognitively stimulating activities and reduced rates of cognitive decline, there is no evidence that defines what constitutes a cognitively stimulating activity, nor what or how successful outcomes should be measured concerning functional performance (Hertzog et al., 2009; Kueider et al., 2012; Mueller et al., 2012). There is a need to provide tools which accurately measure performance variables and new technologies such as the Interactive Metronome may be useful in filling in the current gaps in literature related to healthy older adults and prevention for cognitive decline.

The Interactive Metronome®

The IM is a brain-based assessment and treatment tool that focuses on improving motor planning and sequencing through the use of rhythm, timing, and synchronization of motor movements (Interactive Metronome®, 2007). A typical IM session involves the client standing

or sitting with headphones on, and a trigger attached to the hand glove (see Appendix A). The individual be looking at a computer screen which provides visual feedback during the exercise. Throughout the session, a participant performs various exercises and the goal is for the client to hit the trigger as close to the reference tone (RT) as possible. The RT is the metronome beat, and the closer the individual is to the RT, the more synchronized the movement is. One example of an exercise is a participant clapping both hands together to hit the trigger as close to the RT as possible. As the trigger is hit, the computer system displays visual feedback showing if the trigger was hit too early, too late, or very close. Measurements are in milliseconds, if a participant hits the trigger within a specific range, the computer will record it as a "Super-Right-On" (SRO). SRO range can be set by the IM trainer, the suggested range is 30 milliseconds from the RT (15 above and 15 below). An additional form of feedback provided by the system is auditory feedback. The headphones provide auditory feedback in the form of reward tones and early or late tones. The auditory and visual cues may help the individual to speed up or slow down their beat when hitting the trigger throughout the exercise. The immediate feedback provided by the computer is believed to promote the reorganization of neural timing, and increase the efficiency and performance of the brain (Interactive Metronome®, 2015). A typical IM session lasts 30 to 45 minutes, but time can be adjusted based on each client's needs. Throughout the session, the participant performs various movement along with the beat of the RT. Visual and auditory stimuli may be adjusted according to the client's needs or preferences.

Researchers supporting use of the IM suggest the focus on rhythm and timing may improve motor planning and sequencing for some populations including those with attention deficit hyperactivity disorder (ADHD), cerebrovascular accident (CVA), coordination disorders, and mild traumatic brain injuries (TBI) (Cosper et al., 2011; Doucet, 2012; Hill et al., 2011;

Koomar et al., 2000; Nelson et al., 2013; Shaffer et al., 2000; Shank & Harron, 2015; Trujillo & Painter-Patton, 2015). There are currently no published studies on the use of IM with the healthy aging adult population. Although the literature is lacking in this area, it is important to examine the outcomes of other populations in order to better understand the impact of IM treatment on cognitive and motor skills.

One study conducted by Shank and Haron (2015) examined the effectiveness of IM treatment on hand function of children (n=48) with various motor and cognitive diagnoses, ranging from 6-17 years of age. The retrospective study compared pretest and posttest data from performance on the following: Long Form Assessment (LFA), Jebsen Taylor Hand Function Test, and Parent Questionnaire (assessed child behavior in areas including verbal skills, social skills, coordination, attention, and memory). The intervention consisted of two therapist-led, one-hour IM sessions per week for a total of 12-15 sessions. Results indicate statistically significant ($P < 0.0001$) change in scores on the LFA and the majority of participants moved to a higher level performance category based upon the norms provided by Interactive Metronome®; statistically significant change ($P < 0.0001$) was reported on the Jebsen Taylor Hand Function Test for both the dominant and non-dominant hand; and a 26% improvement was reported in child behaviors indicated on the parent questionnaires. Researchers concluded these results indicated a regimen of therapist-led IM is likely to enhance functional hand skills in a pediatric population, as well as enhance "internal timing abilities" (Shank & Harron, 2015). Researchers also determined age was not a factor in percentage of change for participant performance on the LFA which they found surprising due to the belief that, "the brain is more plastic in children younger than nine years" (Shank & Harron, 2015, pg. 399). These results are promising in light

of the current study which also includes a measure of hand function in comparison to LFA results.

Another study, by Cosper et al. (2009) examined the effectiveness of IM treatments for children (n=12) with attention and motor coordination deficits. The participants ranged from age 6-13. All participants were diagnosed with ADHD as well as either a developmental coordination disorder, or pervasive developmental disorder. Intervention consisted of 15 one hr IM treatment sessions over the period of 15 weeks. The researchers performed pretest and posttest measures to assess changes in motor coordination skills and attention skills. Bruininks-Oseretsky Test of Motor Proficiency-Short Form was used as the motor and coordination assessment, and the "Vigilance Task '1/9' Mode" included in the Gordon Diagnostic System was used as the measure of attention. Results indicated that participants made significant improvement in reaction time ($P < .05$) but no significant improvement in sustained attention ($P > .05$). Concerning the motor and coordination results, researchers found participants made significant improvements in visuomotor control ($P = 0.02$) and the Battery Composite Score ($P = .049$), and researchers determined these results were due to positive improvement in the subtests (balance, upper limb coordination, and upper limb speed).

An additional study examining effects of IM training on children with ADHD was conducted by Shaffer et al. (2001). The participants included boys (n=56), aged 6-12 who had a diagnosis of ADHD. Participants were randomly assigned to three matched groups: (1) 15 hours of IM training (2) training on selected video games (3) no intervention. Pretest and posttest measures included various assessments in falling into three categories: (1) attention and concentration (2) academic and cognitive skills (3) clinical functioning (child behavior, sensory processing, coordination, speed, and dexterity). Researchers presented pattern analysis data for

58 variables and concluded the IM group demonstrated a significant pattern increase in performance ($P < .0001$), as did the video game group ($P < .0058$), the control group did not demonstrate significant directional patterns ($P = .8955$). Researchers concluded the study suggests, "Interactive Metronome training can improve aspects of attention, motor, and perceptual-motor functioning; cognitive and academic performance; and the control of aggression in children with major attentional problems" (Shaffer et al., 2001, p. 160).

The use of IM as a supplement to traditional intervention was explored in a pilot study, by Hill et al. (2000). This study researched the use of IM in addition to other intervention methods during stroke rehabilitation. The researchers initially administered the IM for only 10 minutes of the 60 minute session, by the end of three weeks, subjects were able to concentrate for 30 minutes of the 60 minute session on the IM treatment portion. Researchers reported the subjects, for the most part, enjoyed the IM. Some participants felt it was similar to a game because they received scores; they liked the variability of tasks required; the immediate visual and auditory; and the tactile feedback from the therapist (Hill et al., 2000). One of the participants increased the difficulty of the IM sessions by competing against himself for a higher score each time, and another incorporated more movements than the IM required to make the task more challenging. This study illuminates the flexibility of the use of IM during treatment. It also explores factors that may increase motivation for participation including: therapist and computer feedback, task completion and the "just right" level of challenge.

Another study examining the effectiveness of IM as a supplement to traditional therapy was conducted with individuals diagnosed with a traumatic brain injury (TBI). In this pilot study, researchers concluded that the addition of IM treatments to standard rehabilitation care may have a positive effect on individuals' neuropsychological status (Nelson et al., 2013). The pilot study

consisted of 46 active duty soldiers who reported cognitive complaints which resulted from a mild-moderate TBI. Researchers assessed the treatment and control group by using various measures of executive functioning, intelligence, visual and auditory performance and neuropsychological status. Results indicated significant improvement in attention (P = .044), immediate memory (P = .019), and delayed memory (P= .031). Researchers noted, although not statistically significant, there was improvement in outcome measures on cognitive assessments for the treatment group.

Studies have shown the IM is effective in improving motor control, attention to task, language processing, and regulation of aggression in children with ADHD (Shaffer et al., 2000). Shaffer et al. (2000) highlights the importance of improving motor planning, timing and rhythmicity in children with ADHD, because these skills are needed to construct complex patterns such as carrying out multistep actions. The ability to carry out multistep activities is a necessary skill for independent living, and is linked to ADL and IADL performance for adults, as well as children. The IM might be a successful tool because it can be modified to meet the needs of various populations. The IM trainer can change the computer screen to make it seem like a computer game, the exercises can be modified depending on the needs of the individual, triggers can be changed to accommodate physical abilities, adjustments within the system can allow a person to get more positive feedback to increase motivation, and visual and auditory feedback can be altered if the individual finds it distracting (Interactive Metronome®, 2015). Koomar et al. (2000) explains IM treatment might be viewed in light of the dynamic systems theory. From the dynamic systems perspective, the participant is considered the human system, the auditory and/or visual feedback can be modified to enhance the environment, and the IM trainer chooses the settings and activities which are most motivating for the participant (Koomar et al., 2000).

The IM could be used as an effective supplement to occupational therapy treatment with healthy aging adults. The IM activities are measurable, cognitively stimulating tasks that require concentration, and attention. The IM is flexible, and adjustments can easily made to accommodate feedback preferences, and physical abilities. Furthermore, literature suggests various populations have improved cognitive and motor performance through the use of this treatment tool.

Summary

In light of the growing body of knowledge pertaining to brain plasticity and cognition in HOAs, it is important to investigate how this population may be served most effectively. Research supports the hypothesis that cognition can be improved in older adulthood, and participation in cognitively stimulating activities may reduce cognitive decline. Therefore, researchers conducted the study with IM because it can be used as an assessment tool to measure performance change but also because the IM may be effective as a treatment tool to prevent cognitive decline or maintain current cognitive function in aging adults. If cognitive decline can be prevented or lessened in aging adults, then research suggests they may be more independent with functional task performance.

Chapter III

Methodology

Population

The population of interest in this study is “healthy aging adults”. For the purposes of this study, the aging population could also be defined as “normally” aging adults between the ages of 60-99. Normal aging may include a decline in physical, sensory, vestibular, cardiovascular, and cognitive health (Goodman & Bonder, 2014), and the population may be experiencing these effects of aging. However, in order to identify “heathy aging adults” the researchers selected a population sample within the following inclusion and exclusion parameters:

Inclusion Criteria

- Over the age of 60
- Ability to read, write, and understand English
- Intact Visual Abilities (corrected vision acceptable)
- Intact Auditory Abilities
- Ability to ambulate independently or with assistance of cane or walker

Exclusion Criteria

- Diagnosis of Dementia, Alzheimer’s or advanced stages of Parkinson’s Disease
- Bilateral paralysis or hemiparesis of upper and/or lower extremities
- Diagnosis of moderate or severe traumatic brain injury

Participants

A total of 13 participants who resided in a continual care retirement community completed the IM Treatment. Participant ages ranged from 73 to 92 with a mean of 81. All of the participants, except two, reported they were comfortable walking around without fear of falling. One participant used a walker for navigating, all other participants did not require the use of any walking aids. All participants had achieved at least a high school education, and the majority of the participants reported they had post-secondary education.

Research Design

A pretest, posttest research design with four assessment periods was utilized in the study. There was no control group, each participant established a baseline for their individual performance. The IM served as an intervention tool and assessment tool. In addition to the Long Form Assessment (LFA) and the Short Form Assessment (SFA), other assessments included in were measures of cognitive skills and fine and gross motor abilities. The Woodcock-Johnson III (WJ-III) and d2 Test of Attention (d2) addressed the cognitive components, the Nine Hole Peg Test (NHPT) assessed fine motor changes, and the Four Square Step Test (FSST) considered gross motor abilities.

The data in the study was collected as part of a larger study which also compared the LFA with the SFA, addressed the point of saturation for IM performance, and measured retention rates after rest periods. While data for the SFA was collected to fulfill these requirements, the SFA data was not analyzed here. Table 1 depicts the research design outline with a description of events taking place at each Testing Session and Treatment Period. Assessments used for data collection included the LFA, d2, FSST, NHPT, and WJ-III. The participants were administered all assessments four times: (1) Testing Session “A” as a baseline measure (2) Testing Session

"B" after six weeks of IM Treatment (12 sessions) (3) Testing Session "C" after six weeks without IM Treatment (4) Testing Session "D" after three weeks of IM Treatment (see Table 1).

Table 1: Research Design Description

Event	"A"	Treatment 6 Weeks	"B"	Rest Period	"C"	Treatment 3 Weeks	"D"
	LFA SFA d2 FSST NHPT WJ-III	12 Regular Training Sessions of IM protocol	LFA SFA D2 FSST NHPT WJ-III	6 weeks without IM	LFA SFA D2 FSST NHPT WJ-III	6 Regular Training Sessions of IM protocol	LFA SFA d2 FSST NHPT WJ-III

Instrumentation

The participants were assessed on IM performance change as well as performance change on d2, FSST, NHPT, and WJ-III which were included to assess the domains of cognition, fine motor skills, and gross motor skills. Typical aging results in changes in cognitive and physical performance; some physical changes occurring in older adulthood which may impact ADL performance include: fine motor coordination and dexterity, instability, postural alignment, sway, walking speed, and step length (Goodman & Bonder, 2014). Cognitive changes expected in older adulthood involved: problem solving, abstract reasoning, memory processing, and attention (Goodman & Bonder, 2014, p. 977) and could impact tasks involving initiation, organization, and sequencing (Gillen, 2103). With these considerations in mind, the assessments were selected because they were considered reliable measures of cognitive skills, and fine and gross motor abilities. The specific assessments were also selected in order to fulfill a request from a funded grant from IM®.

The IM was used as an instrument to measure performance change throughout the study, and the IM was also used as the intervention tool. These two uses are delineated by the Long

Form Assessment (LFA), which occurred only during assessment periods (see Appendix B), and the Regular Training Sessions which occurred during the Treatment Periods (see Appendix C). There is some overlap in tasks performed during the LFA and the Regular Training Sessions, but Regular Training Sessions were not included in the data collection because researchers wanted to obtain data from a single consistent measure taken at the same time period for each participant. Regular Training Sessions varied, and were sometimes modified for to accommodate participant needs so these sessions are not as structured as the LFA. The LFA, SFA, d2, FSST, NHPT, and WJ-III were completed during each of the four Testing Sessions.

The Woodcock-Johnson III Test of Cognitive Abilities (WJ III COG) and the Woodcock-Johnson III test of Achievement (WJ III ACH) are used to measure general intellect and specific cognitive functioning for ages 2-90+ (Schrank & Wendling, 2009). The WJ III COG along with its diagnostic supplement, measure seven broad areas including: comprehension-knowledge, long-term retrieval, visual-spatial thinking, auditory processing, fluid reasoning, processing speed and short-term reasoning. The WJ III COG includes 20 tests and the DS provides 11 additional tests; each test is norm referenced and provides information regarding a specific cognitive process. The WJ III ACH contains 22 norm referenced tests which measure skills in reading, writing, mathematics, oral language abilities and academic knowledge (Wendling, Schrank, & Schmitt, 2007).

This study utilized two subtests from the WJ III COG (i.e., visual matching test and decision speed test) as well as two subtests from the WJ III ACH (i.e., reading fluency test and the math fluency test). The tests on the WJ III COG which were used are the visual matching test and the decision speed test. The specific subtests were selected to assess performance changes in executive functioning tasks which may decline in aging adults: processing speed, decision speed,

and problem solving. The reading fluency test requires reading ability and basic comprehension; there is a focus on processing speed; the math fluency test requires basic arithmetic and also measures processing speed (Wendling et al., 2007); the visual matching test measures processing speed and visual perception; the decision speed test measures object recognition and symbolic comparisons; both tests focus on speediness of identification as a determinant of cognitive function (Schrank & Wenling, 2009).

The d2 Test of Attention (d2) is a timed cancellation test which measures selective attention and mental concentration (Brickencamp & Zillmer, 1998). The test presents visually similar stimuli consisting of rows of letters (d or p). The letters are marked with small dashes beside them (one, two, three or four dashes). There are 14 test lines with 47 letters in each line, a total of 658 items. The test taker has 20 seconds to scan across the lines and mark out all of the "d's" with two dashes. In the d2 Test of Attention manual, Brickencamp & Zillmer (1998), explainedcx the test measures processing speed, ability to follow instructions, performance quality, concentration, and attention. Performance is assessed by calculating the total amount of items processed and the error rates, which includes errors of omission and errors of commission. Errors or omission are when the individual does not cross out an item that should have been crossed out, whereas errors of commission are less common and occur when letters are crossed out when they should not have been. Total performance (TN-E) is calculated by the total number of items processed (TN), and the percentage of errors (E%); concentration performance (CP), and fluctuation rate (FR) are also calculated. Standard scores and percentile ranking are based on the TN-E.

The test was originally developed in Europe and norms are based on a German sample of over 6,000 individuals, which could raise concerns related to validity for our sample. However,

Bates & Lemay (2003) conducted a study in the United States on 364 adults, and concluded the test is a valid and reliable tool which measures visual scanning, processing speed and accuracy; they determined internal consistency coefficients were within the range .80 - .95. Brickenkamp and Zillmer, 1998 further examined internal consistency and reported internal stability of TN, TN-E and CP to be very high ($r > .90$) but E% is less affected and can be improved with re-testing. Construct validity was established through administering the d2, along with 3 other neuropsychological standardized United States tests to 506 college students (Zillmer & Kennedy, 1999). All assessments included in the study measured concentration and attention, which are components of executive functioning. Researchers concluded that total number of errors and concentration performance were, "significantly correlated with all measures of complex attention" (Zillmer & Kennedy, 1999, p. 728). A moderate correlation ($r=.47$, $p < .01$) was established for assessing complex scanning, visual tracking, and sustained attention; additionally, correlations were moderate for measuring concentration and distractibility ($r=.34$, $p < .01$). Researcher's concluded the d2 to be sensitive and reliable measure for US sample. Researchers ultimately concluded the d2 is effective in testing attention and concentration (Bates & Lemay, 2004; Brickenkamp & Zillmer, 1998; Zillmer & Kennedy, 1999).

The Four Square Step Test (FSST) measured the participant's ability to change directions and maintain balance while moving in forward and side-to-side directions; it was included as a measure of gross motor changes. Aging adults may experience physical changes affecting balance and walking speed (Goodman & Bonder, 2014). The FSST is a reliable and valid tool which has been tested on community dwelling adults over the age of 65. The FSST has high interrater reliability (.98) and high retest reliability (.99). Validity was established through correlation of the FSST to 3 reliable and valid measures of balance including: Timed Up and Go,

Functional Reach Test, and Step Test (Dite & Temple, 2002). Researchers concluded from these results the FSST is a reliable, valid tool with high sensitivity and specificity for identifying differences between groups test. The FSST is quick and easy to administer as a gross motor measure for participants.

The Nine Hole Peg Test (NHPT) is a test is a commonly used fine motor assessment measuring finger dexterity. The test assesses the fine motor movements required to manipulate a small object (peg) on a peg board. Grice et al. (2003) collected normative data on a sample of 703 subjects ranging from age 21 – 71+ and determined the test has a high inter-rater reliability for the left (r=.98) and right (r=.99) hands; test-retest reliability was low to moderate for both left (r=.44) and right (r=.46) hands. Researchers concluded that while test-retest reliability was poor, it may not be clinically significant because the difference in times are 2/10 of a second (Grice et al., 2003). The NHPT addressed the fine motor component of the study.

The IM® is a brain-based assessment and treatment tool which focuses on improving motor planning, sequencing, coordination, and attention through neural reorganization (Interactive Metronome®, 2015). Beckleheimer et al. (2011) explained the IM is, "a computer based version of a traditional metronome which purports to target motor planning and sequencing by incorporating rhythm and timing during repetitive movements" (p. 96). The IM system includes a control unit, head phones, computer monitor, wrist cuff, and foot switch (see Appendix A). The IM requires participants to rely upon auditory and visual feedback while hitting a trigger on beat with the computerized metronome system.

The metronome assesses performance based on how many milliseconds away from the reference tone (RT) the trigger is actually hit. IM developers claim clinicians can objectively measure motor planning and sequencing based upon the milliseconds in relation to the RT

(Interactive Metronome®, 2007). The IM is a reliable tool because the control unit systematically measures the timing and rhythmicity of the repetitive movements. Normative data has been gathered for ages six through adult, and ongoing studies are gathering normative data for older adults. These results were compiled into the IM Indicator Table (see Appendix D). The normative data sample included 583 participants ranging from age 6 – 60+; it should be noted the data was compiled from a sample comprised of some individuals who were receiving IM as a therapeutic intervention, so it does not represent a normal population (Interactive Metronome®, 2015).

The IM provides various reports so participants' score can be compared to scores from previous sessions. Various reports can be generated including: Short Form Test (SFT), Long Form Assessment (LFA), and Regular Training Reports. Each of the reports primarily focuses on three areas: "task average", "task variability", and the "super-right-on percentage" (SRO%). The task average is a comparison of the time the trigger was hit to when the exact RT occurs, this average assesses how many beats from the actual sound the trigger hit occurs and is measured in milliseconds. A lower millisecond score indicates better synchronization, because it indicates the trigger hit is closer to the actual reference tone. The variability average is a comparison of one trigger hit to when the next trigger hit occurs, it assesses how much the individual varies from one hit to the next, or how rhythmical they are. The other score the IM generates is the SRO%. This is the percentage of time the trigger is hit at the same time as the reference tone. In regards to the SRO, the window of time can be adjusted so the participant feels like they are more successful.

The LFA report was the primary focus of the current study. The LFA report is a 20 to 30 minute evaluation, including 14 tasks the individual must complete (see Appendix B). The LFA

provides baseline data for the individuals' ability to motor plan and sequence, and attend to and process sensory and auditory information (Interactive Metronome®, 2007). Participation in the LFA requires motor and cognitive performance skills including: balancing, weight shifting, coordination, crossing midline, focused, selective, and sustained attention, task persistence, self-monitoring (awareness), and self-control (impulsivity). The LFA was modified slightly for the current study to accommodate all participants and included only upper extremity tasks. The LFA report generates three scores (task average, task variability, SRO%) for each of the 14 tasks; a comparison can be made between LFAs in different sessions, and between the individual tasks within a single session. IM developers also suggested the IM trainer monitors the individuals' ability to stay focused on the task and self-monitor without prompting or feedback, but there are no objective measures for these aspects of the LFA.

Procedure

Prior to data collection, IRB approval was granted. While awaiting IRB approval, two occupational therapy student research assistants (OTSRAs) were trained by the Principle Investigator (PI) in the administration of IM. Following training from the PI, the two students attended an IM Certification Course in Raleigh, NC.

The PI recruited participants living in a local continual care retirement community in Greenville, NC. The PI delivered brochures to Cyprus Glen and provided a presentation for interested individuals (see Appendix E). The presentation included an overview of IM, as well as time commitment required for participation; no monetary incentives were offered. The brochure provided contact information for the PI and the sub-investigator; interested individuals contacted one of the researchers directly. Snowballing method was used after the presentation, and interested individuals talked to acquaintances about participation. Interested individuals were

screened to determine if they met the inclusion and exclusion criteria. Initially, the researchers hoped to obtain 30 subjects, but only 15 agreed to participate. Recruitment was challenging with the population due to skepticism regarding the effectiveness of the IM, and the time required for participation. All selected participants received and signed the informed consent form.

IM developers and researchers suggested that in order for the treatment to be effective, the participant should receive treatment 3 times per week for a minimum of thirty minutes per session. However, researchers were interested in assessing if performance changes could occur with less duration and frequency so treatment sessions were modified from a previous research project to fit the needs of the healthy older adult population and included 9 tasks. In the current study participants completed only two session per week and the shortest session was 15 minutes. The previous protocol involved the lower extremities but the PI determined the protocol would be completed while seated and incorporate only the upper extremities. Two of the participants requested to perform the movements while standing and researchers consented to the request.

There were a total of four Testing Sessions and 18 Regular Training Sessions. The PI developed templates for the Regular Training Sessions based upon previous studies (see Appendix C). The researchers sometimes modified the sessions in order to accommodate individuals who fatigued easily or complained of muscle soreness. The PI, SI, and OTSRAs were each responsible for conducting IM Regular Training Sessions, but only the PI conducted Testing Sessions. The OTSRAs conducted Regular Training Sessions together to reduce inconsistencies among researchers. The treatment templates were used as a guideline for Treatment Sessions. However, because the IM data included in the study was based upon the LFA, the researchers determined these specific modifications would not be reported, but would be considered a limitation of the study.

Testing Sessions: The PI conducted the first session with each participant. The PI provided an introduction to the IM Treatment program, an overview of the exercises, and administered assessments (LFA, SFA, d2, FSST, NHPT, and WJ-III). The initial session and the three additional Testing Sessions lasted approximately 45-60 minutes. All sessions were conducted at the continual care retirement community in a quiet room with minimal distractions, and the room was allocated to the researchers for this purpose during assessment times.

Regular Training Sessions: A typical treatment session lasted 15-40 minutes depending on the duration of the exercises and how many rest breaks were required by participants (see Appendix C). The treatment sessions were conducted by the PI, SI, and the OTSRAs. All sessions at the continual care retirement community took place in the same room as the Testing Sessions. Participants attended sessions two times per week during treatment periods. During the session, the participant wore headphones and completed the assigned exercises for a specific amount of repetitions. For example, one session lasting 24.7 minutes (without breaks) included the following:

- Clapping for 175 repetitions
- Touching the switch on the right side with the right hand for 175 repetitions
- Touching the switch on the left side with the left hand for 175 repetitions
- Alternating right and left hand to touch the trigger in the middle for 175 repetitions
- Crossing the right hand over midline to touch the switch on the left side for 175 repetitions
- Crossing the left hand over midline to touch the switch on their right side for 175 repetitions
- Clapping for 175 repetitions

During each task the participants received visual and auditory feedback from the IM computer system. Visual feedback was presented by a green, yellow, or red flashing light on the screen (see Appendix F) which indicated how close the individual was to achieving the SRO (green light), and if the participant should speed up or slow down the trigger hits. The auditory feedback included the "cow bell" sound if the participant is in the yellow or green zone, and a "rubber band twang" sound if the participant is in the red zone. The majority of the participants found these additional sounds distracting and they requested that they be turned off during the sessions. Researchers also provided feedback in-between tasks, and at the end of the session including ways to enhance fluidity of movement, comments on changes in scores from previous sessions, and motivation for completing the session.

Feedback and motivation were important factors for participants' completion of the treatment program. Participant drop out was expected due to doctor's visits, life changes etc., but researchers made efforts to accommodate the participants' schedules and physical abilities. Two participants did not complete the program, one due to a busy schedule, and the other due to a health condition.

Data Analysis

Each participant was scored at four Testing Sessions ("A", "B", "C", "D") and raw scores were recorded in an excel spreadsheet. "Percentage of Change" was calculated to determine change over time, and change between the four Testing Sessions (Series A-B, B-C, C-D, A-C, B-D, and A-D). There were six time frames identified as a "series" which researchers analyzed. Descriptions of these six Series' are depicted in Table 2.

Table 2: Series Descriptions

Series	Time Frame
Series A-B	Testing Session A – Testing Session B Change between first Testing Session and 12 Regular Training Sessions
Series B-C	Testing Session B – Testing Session C Change between pre/post three week rest period
Series C-D	Testing Session C – Testing Session D Change between post-rest period and final Testing Session
Series A-C	Testing Session A – Testing Session C Change between Testing Session A, 12 Regular Training Sessions, and three week rest period
Series B-D	Testing Session B – Testing Session D Change between Testing Session after 12 Regular Training Sessions, three week rest period, and final Testing Session
Series A-D	Testing Session A – Testing Session D Change between first Testing Session and Final Testing Session

IM data included in the outcomes are the scores from the LFA only. The scores on the LFA calculated in this study, were Task Average for "Task 1" and "Task 14", and the SRO percentage for "Task 1" and "Task 14". These tasks were the clapping task included in each of the Regular Training Sessions. Task 1 and Task 14 were the same movement but Task 1 did not include guide sounds and Task 14 included the guide sounds. A comparison of these tasks enabled the researchers to explore the impact of guide sounds on the participants' performance, as many of the participants expressed they did not like the guide sounds because they were distracting. These tasks were also chosen because the data was compared with the SFA in another aspect of this research project. Researchers also compared LFA-Task 1 Assessment "A" and LFA-Task 1 assessment "D" with the Interactive Metronome Indicator Table which was developed by IM™ and based on established norms. The IM Indicator Table assigns a level of performance to a corresponding millisecond average based on normative data (see Appendix D). This procedure was repeated with LFA-Task 14 Assessment A and LFA-Task 14 Assessment D.

Researchers compiled tables of raw data from the following: LFA-Task 1 Task Average, LFA-Task 14 Task Average, LFA-Task 1-SRO, LFA-Task 14-SRO, d2, and NHPT. After raw data was compiled, researchers conducted T-Test analysis on the percentage of change in performance on the following: LFA-Task 1Task Average, LFA-Task 14Task Average, d2 and the NHPT. SRO percentage of change results were not tested for significance levels. The d2 score used was the "TN-E" which is the total number of items processed minus the total error score, the concentration performance and the fluctuation rate were not analyzed in this study. Raw scores were used in the analysis rather than percentile ranking because participants scored in top percentiles during their initial assessment, hence, the true variance of change in scores would not be evident if percentile rankings alone were analyzed.

The FSST and WJ-III test scores from the four Testing Sessions were also recorded on an excel spread sheet. Raw scores were converted into percentages of change at each Testing Session. The WJ-III and the FSST were included in the study to fulfill a grant requirement from IM® but researchers determined the FSST, and the WJ-III were not sensitive enough tests for this sample, and excluded them from final analysis. The WJ-III was not sensitive enough because all of the participants have achieved higher than a high school education level, and the majority received post-secondary education. The participants all obtained high ranking scores on their initial assessment and therefore gains were not reflected through the use of this cognitive assessment.

There were various reasons the FSST was not included in the final data analysis, the primary reason being that all individuals were not comfortable performing the test, so researchers could not obtain a complete data set. The other reason related to the sensitivity of the test for this sample. The participants who consented to the assessment were very confident in balance and

walking skills, and therefore had no challenge in the initial assessment. Much like the WJ-III, the participants who were confident in their abilities performed at a high level on the initial assessment so little, if any change was evident in their performance during the FSST.

Chapter IV

Analysis of Data

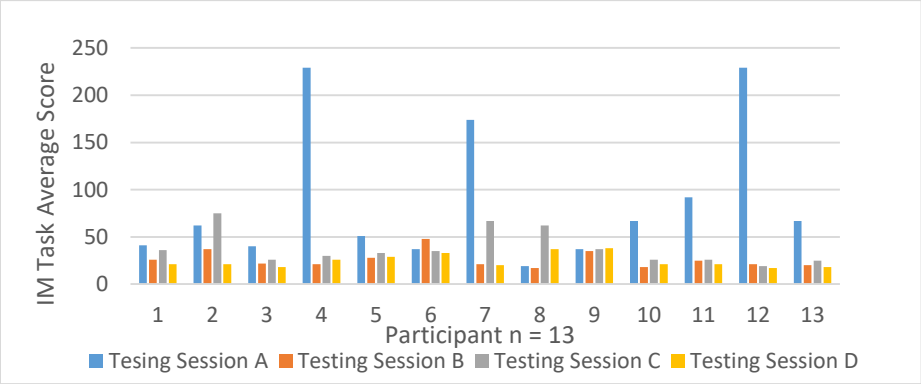
The following results reflect data analysis from six measures included in the study. Four of the measures are specific outcomes from the IM: Task 1 Task Average, Task 1 SRO, Task 14 Task Average, and Task 14 SRO, the remaining two measures are the raw data from the NHPT and the d2. Researchers assessed the raw scores from each of these six measures, as well as the percentage of change between the Testing Sessions (Series A-B, Series B-C, Series C-D, Series A-C, Series B-D, and Series A-D). Series descriptions are described below:

- Series A-B: baseline Testing Session through Testing Session after 12 Regular Training Sessions
- Series B-C: Testing Session after 12 Regular Training Sessions through Testing Session after three week rest period
- Series C-D: Testing Session after three week break through Testing Session after six additional Regular Training Sessions
- Series A-C: baseline Testing Session through Testing Session after 12 Regular Training Sessions, and three week rest period
- Series B-D: Testing Session after 12 Regular Training Session through Testing Session after three week rest break, and six additional Regular Training Sessions
- Series A-D: baseline Testing Session through Testing Session after 12 regular Training Sessions, three week rest period, and six additional Regular Training Sessions

Long Form Assessment – Task 1 Task Average – Raw Data:

Raw scores of Task Average's for each participant are presented in Figure 1. Figure 1 shows Task Average at each of the four Testing Sessions (A, B, C, D). A complete list of raw data results for the Long Form Assessment Task 1 can be found in Table G1 (Appendix G). Higher scores indicate less synchronicity and therefore, lower scores are considered improvement. The raw data illustrates that each of the participants, with the exception of two (Participant 8 and Participant 9), increased performance from Assessment A to Assessment D. All participants, except one, improved scores during Testing Session B (after 12 IM sessions) and then decline in performance at Testing Session C (after the 6 week break). Although there was a decline in performance at Testing Session C, the majority of participants achieved highest overall scores during the final Testing Session (D) after participants received the additional 6 sessions of IM.

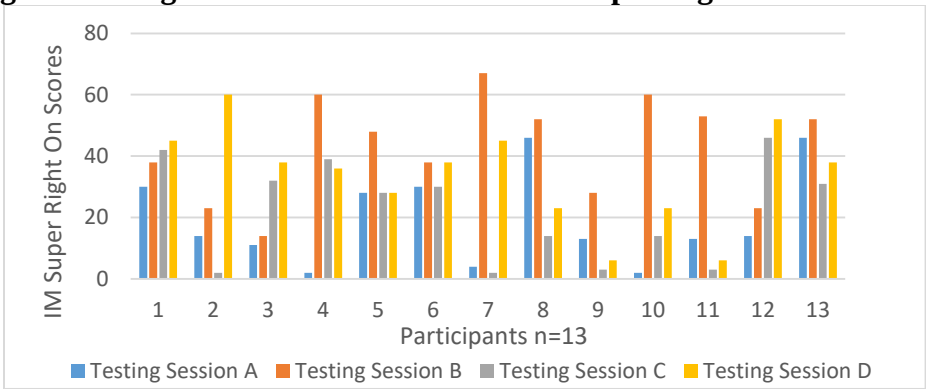
Figure 1: Long Form Assessment -Task 1 Task Average -Raw Data



SRO scores and SRO Percentage of Change for Long Form Assessment Task 1 are indicated in Table G2 (Appendix G). Figure 2 depicts raw data for SRO Scores for each participant at the four Testing Sessions. The majority of participants achieved highest scores at Testing Session B. Similarly to data from Task 1 Task Average, most participants' scores declined after the six week break. Overall, the patterns in improvement and decline are less consistent in the SRO data across the four points of measure than Long Form Assessment Task 1

Task Average. Researchers were unable to draw conclusions from the data due to the variability among data points.

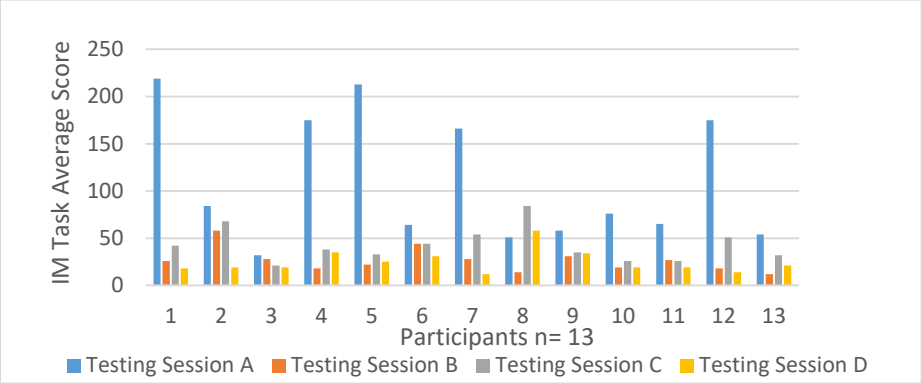
Figure 2: Long Form Assessment – Task 1 - Super Right On – Raw Data



Long Form Assessment – Task 14 Task Average – Raw Data:

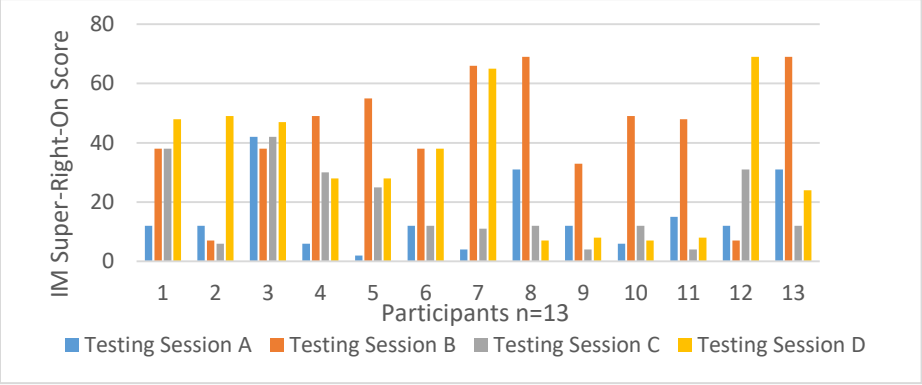
Raw scores of Task Average's for each participant are presented in Figure 3. Figure 3 shows Task Average at each of the four assessment periods (A, B, C, D). A complete list of raw data results for the Long Form Assessment Task 14 can be found in Table G3 (Appendix G). Higher scores indicate less synchronicity and therefore, lower scores are considered improvement. The raw data illustrates each of the participants, with the exception of one, (Participant 8) increased performance from Testing Session A to Testing Session D. Similarly to Task 1, the majority of participants declined after the 6 week break (Testing Session C) and improved after 6 additional IM Regular Training Sessions and surpassing the previous high scores achieved during Testing Session B.

Figure 3: Long Form Assessment-Task 14 Task Average -Raw Data



SRO scores and SRO Percentage of Change for Long Form Assessment Task 1 are indicated in Table G4 (Appendix G). Figure 4 depicts raw data for SRO Scores for each participant at the four Testing Sessions. Similarly to SRO scores from Task 1, there is less consistency in individual performance of SRO scores than Task Average scores. Nine participants improved overall from Testing Session A to Testing Session D. The majority of participants achieved highest scores at Testing Session B, after the initial 12 Regular Training Sessions.

Figure 4: Long Form Assessment – Task 14 - Super Right On – Raw Data



Task 1 and Task 14 Comparison:

The IM indicator table was used to assess participant performance at Testing Session A and Testing Session D, results are indicated in Table 3. Participants' highest level of

performance in Task Average for Task 1, Testing Session A was "Above Average," and the majority of the participants fell beneath the "Below Average" category. During Testing Session D, the Task Average for Task 1 shows participants performing "Average" at the lowest levels, with the majority of the participants in the "Superior" category. Participants were in the same Levels of Performance for Task 14 indicating similar improvements in overall scores for both tasks.

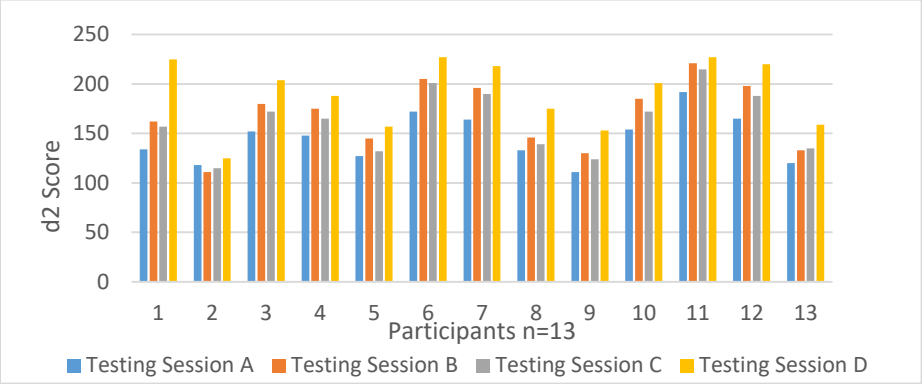
Table 3: Task Average for Task 1 and Task 14 – IM® Indicator Table Performance Level

Level of Performance	Number of Participants LFA –Task 1 A	Number of Participants LFA-Task 14 A	Number of Participants LFA-Task 1 D	Number of Participants LFA-Task 14-D
Extreme Deficiency	2	2		
Severe Deficiency	3	3		
Below Average	2	2		
Average	5	5	1	1
Above Average	1	1	3	3
Exceptional			1	1
Superior			8	8

d2 Test of Attention:

Figure 5 depicts raw data for participant performance on the d2 at each of the four Testing Sessions ("A", "B", "C", "D"), A complete list of data is included in Table G5 (Appendix G). Higher scores are indicative of positive change. The data indicates that all participants improved overall scores from the first assessment to the final assessment. Figure 5 shows some participants declined during Testing Session C (after the six week rest break). However, while participant scores dropped during Testing Session C they rose again and surpassed Testing Session B.

Figure 5: d2 Raw Data



Nine Hole Peg Test:

Figure 6 depicts raw data for participant performance on the NHPT at each of the four Testing Sessions ("A", "B", "C", "D"), A complete list of data is included in Table G6 (Appendix G). Lower scores are indicative of positive change, as that indicates the participant completed the task in a shorter amount of time. Raw data suggests there is overall improvement in scores for all participants from Testing Session A to Testing Session D. Results from the NHPT do not depict the same pattern as the other assessments, there is a less consistent pattern of decline during Testing Session C but increased performance in Testing Session D is still noted.

Figure 6: NHPT Raw Data

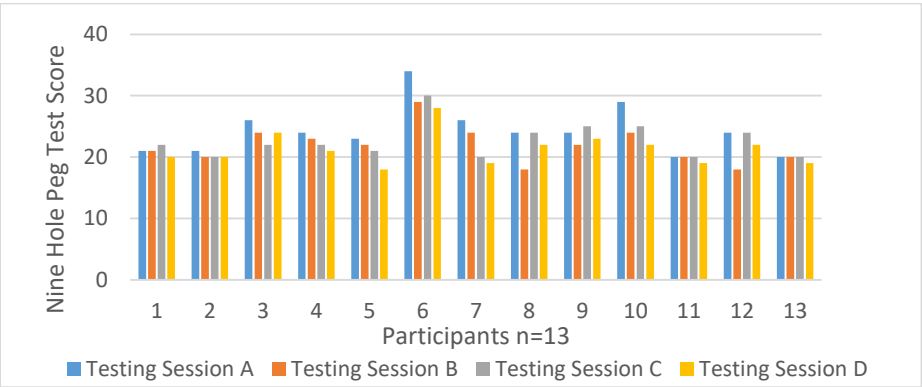


Table 4 illustrates percentage of change averages between Testing Sessions: Series A-B, Series B-C, Series C-D, Series A-C, Series B-D, and Series A-D. Overall, the table shows participants' mean percentage of change scores improved in each assessment during Series A-B (baseline - after 12 sessions of IM), mean scores declined during Series B-C (after 12 sessions of IM - after six week break), mean scores improved during Series C-D (six week break - 6 additional IM sessions), mean scores improved during Series A-C (baseline measure – after 6 week break), and mean scores improved during Series A-D (baseline – final Testing Session). The only Series where percentage of change improvement and decline differed among assessments was during Series B-D (after 12 sessions of IM – final Testing Session). In this Series mean participant performance declined in Task 1 and Task 14 but improved in d2 and NHPT.

Table 4: Percentage of Change Results between Four Testing Sessions

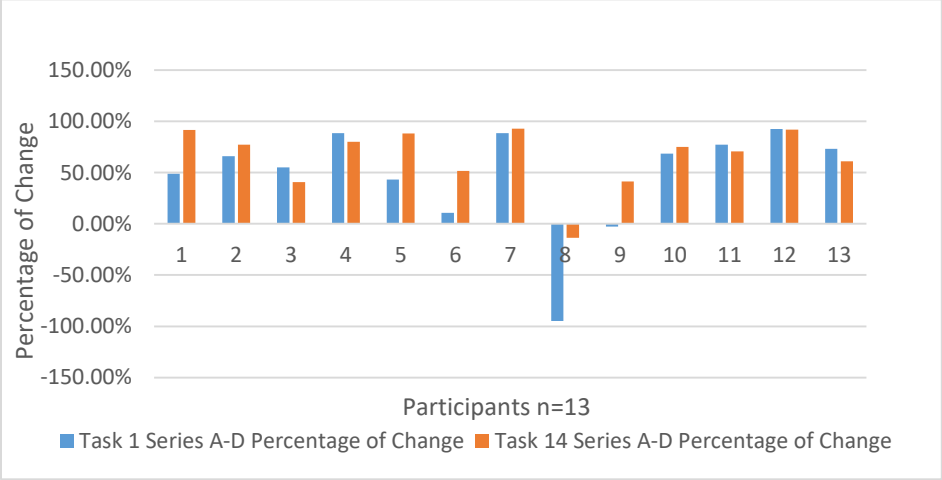
	SERIES A-B	SERIES B-C	SERIES C-D	SERIES A-C	SERIES B-D	SERIES A-D
TASK 1 TA	**49.15%**	**-57.41%**	**27.72%**	**21.26%**	**-0.66%**	**47.32%**
TASK 1 SRO	**623.44%**	**-32.36%**	**419.63%**	**193.67%**	**3.09%**	**347.85%**
TASK 14 TA	**65.00%**	**-92.60%**	**36.37%**	**46.78%**	**-18.33%**	**65.30%**
TASK 14 SRO	**508.77%**	**-25.10%**	**139.00%**	**145.19%**	**80.18%**	**333.86%**
D2	**15.15%**	**-3.56%**	**18.28%**	**10.94%**	**14.01%**	**31.35%**
NHPT	**9.15%**	**-4.52%**	**5.94%**	**5.91%**	**1.94%**	**11.62%**

Long Form Assessment Task 1 mean scores indicate participants' improved overall performance by 47.32%. The most significant decline in performance was during Series B-D where participant task average dropped by 57.41%. Participants mean scores improved overall in Long Form Assessment Task 14 by 65.30% and a decline in scores was noted during Series B-D at 92.60%. Figure 8 demonstrates a side-by-side comparison of percentage of change in Task

Average Task 1 and Task Average Task 14 for each participants' overall improvement (Series A-D). Figure 7 indicates that a small majority of participants had higher rates of improvement in Task 14 than Task 1.

Overall, participant scores improved in each of the six measures during Series A-B, Series A-C, and Series A-D. Participant scores declined in each of the six measures during Series B-C. Series A-D is the only Series where there is a discrepancy in the consistent pattern of improvement or decline, in Task Average Task 1 and Task Average Task 14 there was a slight decline but in all other measures there was improvement.

Figure 7: Participant Scores Series A-D Comparison of Task 1 and Task 14



T-Test Data:

T-Test results are indicated in Table 5. The T-Test Table indicates significance ($P < .05$) for percentage of change in Task Average Task 1, Task Average Task 14, d2, and NHPT. In each assessment there were statistically significant changes in Series A-B, Series C-D, Series A-C, and Series A-D. There were not significant changes in all assessment periods during Series B-C and Series B-D. In Series A-D there was significant improvement in percentage of change from baseline Testing Session (A) to the final Testing Session (D). The table also illustrates significant

change in Series B-C for each assessment except the NHPT, this Series represents decline in performance. Lastly, the least amount of significant change is noted in Series B-D, where the d2 is the only assessment with significant change.

Table 5: T-Test Results

ASSESSMENT	SERIES A-B	SERIES B-C	SERIES C-D	SERIES A-C	SERIES B-D	SERIES A-D
LF TASK 1	*0.0131	*0.0364	*0.0169	*0.0401	0.5697	*0.0114
LF TASK 14	**0.0011	*0.0126	*0.0020	*0.0044	0.7678	**0.0012
D2	**0.0000	**0.0006	**0.0000	**0.0000	**0.0000	**0.0000
NHPT	*0.0027	0.3517	*0.0027	*0.0240	0.4100	**0.0007

***Significant at .05 **Significant at .001**

Summary of Data

Overall, participant means indicate statistically significant positive percentage of change on each of the four assessments during Series A-D. Additionally, researchers noted a decline in performance after the six week break from IM. 11 of the 13 participants improved in each of the assessments measured, and all of the participants' performance improved in at least two of the assessments. There was a decline in performance during Series B-C, where all but one of the participants' performance declined in at least one of the assessments measured.

Chapter V

Conclusion & Recommendations

Summary

This was a quasi-experimental pretest, posttest study to measure percentage of change in IM performance, and measures of cognitive skills, and fine motor abilities of healthy aging adults. 13 participants completed the study and researchers assessed changes in participants' scores on the IM, d2 and the NHPT. Results indicate positive improvements on all assessments administered. The following questions were posed to examine the impact of IM participation on cognitive and fine motor scores for the healthy aging population:

- What is the percentage of change in Task Average of participants' scores on Task 1 and Task 14 of the Long Form Assessment across the four points of measure?
- What is the percentage of change in participants' scores on the d2 Test of Attention and Nine Hole Peg Test across the four points of measure?
- How might these changes indicate improvement in cognitive operations?
- How might these changes indicate improvement in motor performance?

Results

Raw Data: As stated previously, a large majority of participants achieved higher scores during Testing Session D than Testing Session A in Task 1 and Task 14 of the Long Form Assessment. This result was expected in IM performance, as this was participants' first exposure to the tool and some participants reported there was a bit of "learning curve" or adjustment period. When examining raw data results for Task Average performance, it should be noted that the majority of

participants improved drastically between Testing Session A and Testing Session B, most likely due to increased comfort level with using the IM. Additionally, participants' whose scores did not increase greatly, performed well during Testing Session A and there was less room for improvement. Similarly to anticipated overall improvement, due to practice with IM, researchers also expected increased scores between Series A-B because participants received 12 Regular Training Sessions after the initial baseline measure, therefore participants had the opportunity to practice and become better. Researchers were excited to discover these improvements carried over with participant performance on the NHPT and the d2.

Researchers were also pleased to discover the relationship between improvement and decline with individual performance between the Testing Sessions. This indicates that the six week break impacted participants' performance in IM, but also impacted performance on measure of cognition and fine motor. Research suggests that IM participation may improve motor control, attention to task, motor planning, timing and rhythmicity in some populations (Cosper et al., 2011; Doucet, 2012; Hill et al., 2011; Koomar et al., 2000; Nelson et al., 2013; Shaffer et al., 2000; Shank & Harron, 2015), which in turn, may impact functional performance. In light of these studies, the Regular Training Sessions, may be considered "cognitive task-training" due to the repeated exposure of IM. While researchers cannot conclude there was a direct impact on learning, some research suggests that task performance can be enhanced through task-training techniques and that brain plasticity in healthy older adults can contribute to improved processing and attention skills (Hertzog, 2009; La Rue, 2010; Opdebeeck et al., 2015). Individual participant improvement in cognitive and fine motor measure indicates that IM training may be a contributing factor, although no direct correlation can be made, as there was no control group in the current study.

Percentage of Change Results: When the data analysis was completed it was noted that the mean scores indicated participants overall performance increased by 47.32% (Series A-D). It should be noted that some outliers in the data skewed mean averages, the range of participants' percentage of change in the A-D Series was -94.74% - 92.58%; indicating some participants declined substantially during the IM protocol. There were individuals who identified that they had lost motivation to complete the protocol regime, but did so because of their commitment to the study. Additionally, researchers noted during Regular Treatment Sessions that participants' task averages, and SRO scores varied drastically from day-to-day depending on how they were feeling, if they were tired, sick, distracted, etc. It is important to acknowledge that one Testing Session may not truly capture a participant's performance because performance was often variable depending on outside factors. Another factor which impacted participant performance was intrinsic motivation. Some participants were eager to achieve higher scores each session and asked researchers about their levels of performance, while others were not as concerned about improvement or decline. Results for SRO scores were also impacted by motivation factors, as some participants tracked how many times the "hit in the green" whereas others felt they "just got lucky" when achieving an SRO. SRO percentage of change was impacted by the variable scores and researchers were not able to obtain as much helpful data due to inconsistency of performance.

Earlier it was identified that the most notable decline occurred in the B-C Series, indicating task averages were lower after the six week break than they were after completing six weeks of IM treatment program. This would be an expected decline given the lack of intervention going on at that time. A slight decline in overall performance is also evident in the B-D Series; raw data indicates that five of the participants declined in performance during this

testing period. The decline in this analysis was unforeseen, but quite possibly the amount of endurance required to complete the study may have reach a maximum performance level. Another possible way to interpret this decline is that participants received less IM Regular Treatment sessions after the six week break and possibly there was a need for 12 additional session rather than six in order to bring them back up to their previous level of performance. However, as stated above, it is also possible participants may have not been performing at their best on a specific Testing Session date.

The d2 was the only assessment in which each Series yielded statistically significant results. This suggests that participant performance was impacted by the six week period without IM, but the decline was not great enough to impact Series B-D. These results show that although participants were tested after 12 IM Sessions, they still achieved significantly higher scores after the six week break and only six additional IM sessions. These results suggest that some of the attention skills participants gained during the initial 12 IM sessions may have contributed to continued success in other assessments throughout the study. These results are promising in light of literature which suggests that attention is considered a basic cognitive function that may be the basis for other cognitive functions (Gillen, 2013). The d2 measures processing speed, concentration, attention, and ability to follow instructions (Brickencamp & Zilmer, 1998), and some studies discussed within the literature review found a relationship with the decline of speed of processing and functional abilities (Wahl et al. 2010).

Researchers noted that there were similarities in overall performance change between Task Average Task 1 and Task Average Task 14. This is surprising because participants reported the guide sounds were distracting and did not use them during the Regular Training sessions. IM developers suggest that distractions from guide sounds may indicate impairments in selective and

divided attention (Interactive Metronome®, 2007). Additionally, Edwards et al., (2005) explains that divided attention skills are one of many prerequisites for dual task performance which can, in turn impact ADL participation. While no direct correlation to improved selective or divided attention can be made from increased performance on Task 14, it is worthy of acknowledging this result as surprising because participants chose to remove guide during all Regular Training Sessions, yet increased overall tolerance and performance when these sounds were included during Testing Periods.

The NHPT did not have statistically significant results during Series B-D or Series B-C, however, researchers found it promising there was overall improvement in the assessment and feel that when performing a fine motor assessment such as the NHPT, clinically significant changes are worthy of considering. If one of the participants were participating in therapy and the NHPT was used as a measure of change then the individual would have been making progress based on NHPT improvement. Additionally, researchers did not anticipate as much change with the NHPT because some of the participants had pre-existing conditions, such as Type 2 Diabetes which impacts sensation in the hand and makes fine motor manipulation challenging.

Conclusions

Research Question 1:

Results on the Long Form Assessment Tasks 1 and 14 indicate a positive percentage of change in participant performance from the first testing period to the final testing period; levels of significance for this change were much higher than anticipated by researchers.

Research Question 2:

Results on the d2 Test of Attention and the Nine Hole Peg Test indicate a positive percentage of change in participant performance from the first testing period to the final testing period. Researchers were unable to draw conclusions from data collected concerning the Woodcock Johnson-III and the Four Step Square Test due to lack of sensitivity of assessments for the sample.

Research Questions 3 and 4:

Researchers can conclude that participants' skillset for the administered assessments improved throughout the course of the study. Researchers cannot conclude cognitive and motor improvements on these assessments are generalizable to daily activities. Researchers concluded clinically significant improved performance on the NHPT is indicative of positive change and potentially increased independence with functional task performance. Additionally, researchers found it promising that positive significant changes occurred between all testing periods for the d2, and believe this may indicate participants' attention and processing improved during the study, which could impact functional performance. However, without a control group, researchers are unable to correlate increased performance with IM participation.

Recommendations

The study could have been improved by including assessments which were sensitive enough to measure change in the sample. The selected assessments were appropriate for previous studies conducted with the Interactive Metronome but were not suitable for the current sample. Additionally, it is difficult to draw conclusions regarding the implications for improvement on assessments without a control group to serve as a comparison. Each assessment was administered 4 times, and without a control group researchers cannot conclude how much improvement was due to familiarity of the assessment or because there were cognitive and motor performance

improvements. It may have been helpful to include an IM training session prior to testing so all participants had some exposure to the IM before establishing a baseline. Lastly, the study would be improved by the addition of a "Participants' Perception" component so researchers could further determine if changes in performance were generalizable to day-to-day life.

Limitations

There are some limitation to examine within the current study. The first is that participants in the study are a homogenous sample for various reasons: the participants are volunteers which could impact outcome in at least two different ways (1) the volunteer sample may have included participants who were more motivated to better themselves and therefore, more likely to improve overall scores, or (2) the opposite impact may be that these individuals represent a sample that has more free time and were less active than some of their peers; some researchers suggest inactivity may negatively impact cognitive performance (Hertzog et al., 2009; Mueller et al., 2012). Additionally, the sample was comprised of individuals who all lived at the same continual care retirement community in Greenville, NC, whose residents are typically from middle-to-upper class socioeconomic levels.

Another limitation is the possibility of inconsistencies among researchers. Regular Training session templates ensure the procedures are the same for each session, but it is possible some researchers may offer more motivation to the clients or make suggestions that lead to greater improvement. Furthermore, the actual Regular Training Sessions were physically challenging for some participants which prevented them from completing all repetitions outlined in the Regular Training session templates. This may have created inconsistencies in overall performance because some participants received more IM treatment than others. Researchers

made every attempt to follow IM Treatment protocols but there were some deviations to accommodate participant needs.

The final limitations are there was no control group in the study, and assessments did not include a measure of functional performance. Without a control group, researchers cannot conclude that overall improvement was related to IM participation. The assessments chosen do not provide data that reflects functional performance changes, so it was not possible to measure the impact of cognitive changes on older adults' day-to-day lives.

Final Implications

Studies indicate IM may enhace some cognitive operations in various populations. The current study on healthy older adults suggests the use of IM may improve participants' scores on measures of cognition and fine motor performance. Studies suggest decreased cognitive abilities are associated with reduced participation in ADLs and IADLs (Allaire, Gamaldo, Ayote, Sims, & Whitfield, 2009; Burton et al., 2006; Johansson, Marcusson, & Wressele, 2012); and, in keeping with the philosophies of AOTA and WHO, it is important for practitioners to focus on preventative tools to support compromised populations' participation in daily activities.

In light of evidence showing IM improves motor planning, motor control, timing, and attention, (Cosper et al., 2011; Doucet, 2012; Hill et al., 2011; Koomar et al., 2000; Nelson et al., 2013; Shaffer et al., 2000; Shank & Harron, 2015) practitioners may consider using IM as a cognitive and motor training tool. Future studies should further address the use of IM with the healthy aging population, and address if improved cognitive and motor skills throughout IM participation supports improved functional participation in daily life. Studies suggest there is a lack of empirical evidence related to specific tools which can be used to reduce cognitive decline, and it would be beneficial to conduct research on IM participation with various

cognitive measures so researchers could gain more insight into specific areas of cognition impacted by participation in IM. Additionally, computerized cognitive training tools may support reduced healthcare costs for the growing aging population by decreasing the need for face-to-face therapy (Kueider et al., 2014; Kueider, Parisi, Gross, & Rebok, 2012).

The IM may be incorporated into therapy for healthy aging adults as a preventative method, and future studies could address IM participation with adults showing signs of cognitive decline in order to gain more insight into the impact of IM on improving cognition, and functional performance.

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Appendix A
Interactive Metronome Equipment

Appendix B
Long Form Assessment Tasks

Task	Task Name	Task Description
T1	SF Both Hands	Stand with both hands comfortably in front of your torso area and several inches apart from each other. On the beat, clap lightly and then continue simultaneously moving your hands around in opposite circular motions, allowing them to come together exactly in the middle of the circle on each consecutive beat. Do not stop the motion after each clap, for it should be continuous.
T2	SF Both Hands – With Guide Sounds	Stand with both hands comfortably in front of your torso area and several inches apart from each other. On the beat, clap lightly and then continue simultaneously moving your hands around in opposite circular motions, allowing them to come together exactly in the middle of the circle on each consecutive beat. Do not stop the motion after each clap, for it should be continuous.
T3	Both Hands	Sit with both hands comfortably in front of your torso area and several inches apart from each other. On the beat, clap lightly and then continue simultaneously moving your hands around in opposite circular motions, allowing them to come together exactly in the middle of the circle on each consecutive beat. Do not stop the motion after each clap, for it should be continuous.
T4	Right Hand	Sit with your right arm hanging down several inches from your right side. On the beat, tap the trigger against your side and then around in a circular motion to tap your side again on each consecutive beat. So people tap on their thigh others tap on their knee. This motion should be continuous and fluid, not jerky, back and forth, or ballistic.
T5	Left Hand	Stand with your left arm hanging down several inches from your left side. On the beat, tap the trigger against your side and then around in a circular motion to tap your side again on each consecutive beat. This motion should be continuous and fluid, not jerky, back and forth, or ballistic
T6	Both Toes	While sitting in a chair place the switch in the middle in front of the laptop. Using both hands, alternate from right to left hitting the switch to the beat of the IM.
T7	Right Toe	While sitting in a chair place the switch in the middle in front of the laptop. Using just the right hand hit the switch to the beat of the IM. Continue this motion for each consecutive beat.
T8	Left Toe	While sitting in a chair place the switch in the middle in front of the laptop. Using just the left hand hit the switch to the beat of the IM. Continue this motion for each consecutive beat.
T9	Both Heels	While sitting in a chair place the foot switch on the table in front of the laptop. With your arms even with your shoulders tap the right side of the foot switch and then alternate taping the left side of the foot switch with your left hand, keeping both arms at shoulder width alternating between each side. Continue this motion for each consecutive beat.
T10	Right Heel	While sitting in a chair place the foot switch on the table in front of the laptop. With your arms even with your shoulders tap the right side of the foot switch keeping your right arm at shoulder width keep to rhythm of the IM each side. Continue this motion for each consecutive beat.

T11	Left Heel	While sitting in a chair place the foot switch on the table in front of the laptop. With your arms even with your shoulders tap the left side of the foot switch keeping your left arm at shoulder width keep to rhythm of the IM each side. Continue this motion for each consecutive beat.
T12	Right Hand/Left Toe	While sitting in a chair place the foot switch on the table in front of the laptop. With your arms even with your shoulders tap the left side of the foot switch with your right hand keeping your right arm at shoulder keep to rhythm of the IM taping the left side with your right hand. Continue this motion for each consecutive beat..
T13	Left Hand/ Right Toe	While sitting in a chair place the foot switch on the table in front of the laptop. With your arms even with your shoulders tap the right side of the foot switch with your left hand keeping your right arm at shoulder keep to rhythm of the IM taping the left side with your right hand. Continue this motion for each consecutive beat.
T14	Both Hands – With Guide Sounds	Sit with both hands comfortably in front of your torso area and several inches apart from each other. On the beat, clap lightly and then continue simultaneously moving your hands around in opposite circular motions, allowing them to come together exactly in the middle of the circle on each consecutive beat. Do not stop the motion after each clap, for it should be continuous.

Appendix C
Regular Treatment Sessions Template
Sessions 1-13

LFA- Long Form Assessment for DeeDee — **Session 1 / 13**

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 120 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	120 / 2.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 120 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	120 / 2.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Left Hand 120 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	120 / 2.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Cross Over Left hand 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over Left hand		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Cross Over right hand 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over right hand		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: Both Hands 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 10: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 10, Reps: 1083, Minutes: 20.1

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LFA- Long Form Assessment for DeeDee — **Session 2 / 13**

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Alternating Hand Center Trigger 125 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	125 / 2.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 125 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	125 / 2.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Both Hands 125 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	125 / 2.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Left Hand 125 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	125 / 2.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Both Hands 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 8, Reps: 773, Minutes: 14.3

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LFA- Long Form Assessment for DeeDee — **Session 3 / 13**

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Alternating center 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating center		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Both Heels 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Heels		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Right Heel 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Right Heel		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Left Heel 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Left Heel		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Both Hands 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 8, Reps: 973, Minutes: 18.1

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LFA- Long Form Assessment for DeeDee

Session 4 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 162 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	162 / 3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 175 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Left Hand 175 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Cross Over Left hand 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over Left hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Cross Over right hand 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over right hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 10: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 10, Reps: 1335, Minutes: 24.5

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LFA- Long Form Assessment for DeeDee

Session 5 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Alternating Hand Center Trigger 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Both Heels 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Heels		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Both Hands 150 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	150 / 2.8 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Right Heel 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Right Heel		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Left Heel 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Left Heel		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Total Tasks: 9, Reps: 1123, Minutes: 20.7

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LFA- Long Form Assessment for DeeDee

Session 6 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Alternating Hand Center Trigger 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Both Heels 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Heels		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Right Heel 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Right Heel		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Left Heel 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Left Heel		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 9, Reps: 1248, Minutes: 22.9

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LFA- Long Form Assessment for DeeDee

Session 7 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 175 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Left Hand 175 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Cross Over Left hand 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over Left hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Cross Over right hand 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over right hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 10: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 10, Reps: 1348, Minutes: 24.7

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LFA- Long Form Assessment for DeeDee — **Session 8 / 13**

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 175 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Left Hand 175 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Cross Over Left hand 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over Left hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Cross Over right hand 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over right hand		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: Both Hands 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 10: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 10, Reps: 1348, Minutes: 24.7

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LFA- Long Form Assessment for DeeDee — **Session 9 / 13**

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Alternating Hand Center Trigger 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Both Heels 175 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Heels		
Repetition / Duration	175 / 3.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Both Hands 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 8, Reps: 1073, Minutes: 19.8

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LFA- Long Form Assessment for DeeDee

Session 10 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 225 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	225 / 4.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 200 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Left Hand 200 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Cross Over Left hand 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Cross Over Left hand		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Cross Over right hand 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over right hand		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: Both Hands 225 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	225 / 4.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 10: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 10, Reps: 1673, Minutes: 31

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LFA- Long Form Assessment for DeeDee

Session 11 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Both Hands 225 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	225 / 4.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Right Hand 200 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Right Hand		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Left Hand 200 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Left Hand		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Cross Over Left hand 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Cross Over Left hand		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: Cross Over right hand 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Cross Over right hand		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: Both Hands 225 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	225 / 4.2 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 10: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 10, Reps: 1673, Minutes: 31

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LFA- Long Form Assessment for DeeDee

Session 12 / 13

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: Alternating center 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Alternating center		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: Both Heels 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Heels		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: Both Hands 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: Alternating Hand Center Trigger 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Alternating Hand Center Trigger		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: Both Hands 250 Reps No Guide Sound; Scene: Default Dynamic; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	250 / 4.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Task 9: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Exercise Name	LAST ONE!!! STOP AFTER THIS		
Repetition / Duration	15 / 0.3 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	30	Burst Threshold	4

Total Tasks: 9, Reps: 1288, Minutes: 23.8

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LFA- Long Form Assessment for DeeDee — **Session 13 / 13**

Task 1: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 2: SF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	SF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 3: LF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched

Exercise Name	LF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 4: LF Right Hand 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Right Hand		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 5: LF Left Hand 30 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	LF Left Hand		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 6: LF Both Toes 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Both Toes		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 7: LF Right Toe 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Right Toe		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 8: LF Left Toe 30 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	LF Left Toe		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 9: LF Both Heels 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Both Heels		

Task 10: LF Right Heel 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Right Heel		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 11: LF Left Heel 30 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	LF Left Heel		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 12: LF Right Hand / Left Toe 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Right Hand / Left Toe		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 13: LF Left Hand / Right Toe 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Left Hand / Right Toe		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 14: LF Balance Right Foot / Tap Left Toe 30 Reps No Guide Sound; Scene: Default; Visual: Auditory

Exercise Name	LF Balance Right Foot / Tap Left Toe		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 15: LF Balance Left Foot / Tap Right Toe 30 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Balance Left Foot / Tap Right Toe		
Repetition / Duration	30 / 0.6 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 16: LF Both Hands 54 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	LF Both Hands		
Repetition / Duration	54 / 1 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 17: Both Hands 200 Reps No Guide Sound; Scene: Default; Visual: Enriched without Flash

Exercise Name	Both Hands		
Repetition / Duration	200 / 3.7 Min.	Tempo	54
Guide Sound	OFF	Difficulty	100
SRO	15	Burst Threshold	4

Task 18: LAST ONE!!! STOP AFTER THIS 15 Reps No Guide Sound; Scene: Sunset; Visual: Enriched without Flash

Appendix D
IM® Indicator Table

I nteractive Metronome Indicator Tdb e

Age	6	7 to 8	9 to 10	11 to 12	13 to 15	16+
Extreme Def ciency	280+	270+	260+	240+	215+	200+
Severe Deficiency	175-279	170-269	160-259	155-239	150-214	147-199
Be ow Average	120-174	90-169	80-159	75-154	72-149	70-146
Average	90-119	65-89	55-79	45-74	43-71	41-69
Above Average	56-89	45-64	38-54	36-44	33-42	30-40
Exceptional	40-55	32-44	28-37	26-35	23-32	22-29
Super or	Be ow 40	Be ow 32	Be ow 28	Below 26	Be ow 23	Below 22

IMC(15)-03.11.15

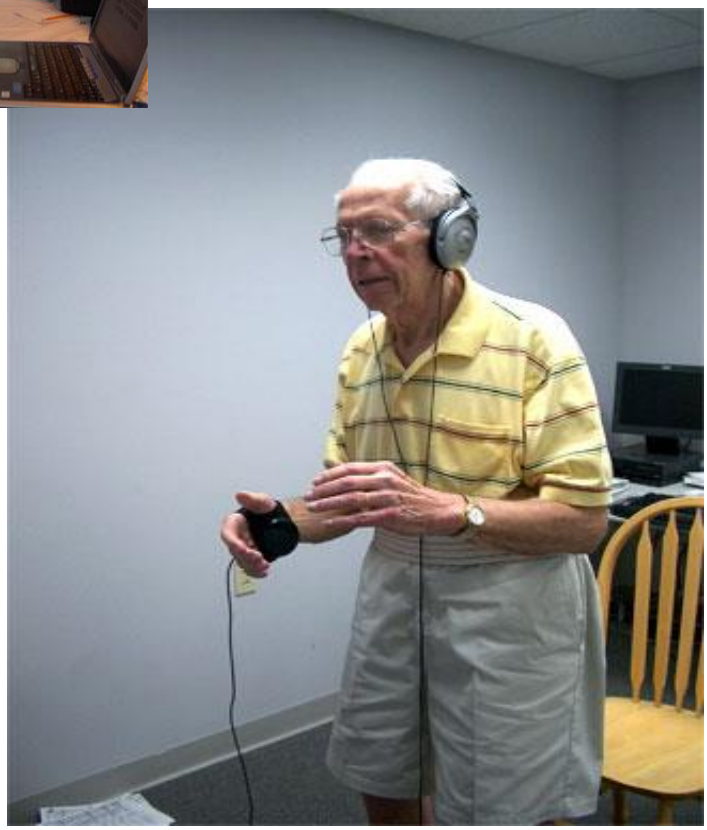
Appendix E
Interactive Metronome Presentation Brochure

What is the Interactive Metronome™ ?

The Interactive Metronome™

Movement and Cognitive

Improvements in the Senior Adult



The Interactive Metronome (IM) combines the musical concept of a metronome with a patented technology program that accurately measures, assesses and improves a person's rhythm and timing. It is an advanced assessment & treatment program developed to improve the processing abilities that affect motor planning and sequencing, which are central to human activity. This improvement, we hope, is extended in one's daily activities in self care, and cognitive alertness.

IM addresses:

1. Brain timing
2. Rhythmicity
3. Synchronicity
4. Increasing the speed and coordination of informational signals within the brain
5. Improving the processing abilities that affect attention, motor planning, and sequencing

6. Coordination

What do we hope to learn?

The purpose of this research study is to understand if participating in an occupational therapy intervention using the IM treatment protocol as a modality has a positive effect on one's motor and cognitive processing abilities. The information from this study will help therapists better develop effective treatment plans for individuals who are changing along their life span, but hope to remain physically and mentally active.

What do we need from you?

As a participant in the study, you will complete a short series of standard rehabilitation evaluations used to determine how effectively you use your arms and hands; along with setting a base line for cognitive processing skills. These evaluations take about 30-45 minutes and ask you to move your arm and pick up and move simple objects; or perform other simple tasks. These are simple short cognitive processing tests and attention tests that will be asked of you as well. The evaluations will help the researchers measure the amount of movement you have in your arms, fingers, and hand, and the scores from these evaluations will serve as a baseline, which will be used to determine if there are improvements in arm/hand functioning after participation in the research treatment sessions. The same goes for setting baselines for the cognitive and attention tests. You will then be asked to participate in the Interactive Metronome treatment sessions. These will take between 30-and 45 min with short tasks lasting 2-3 min each. Upon completing these sessions, you will be asked to take the same tests that were given in the beginning to determine the changes you have made. We hope that any change in scores will be due to the beneficial effects of the IM treatment sessions. Most people start to see changes after 5 – 6 sessions, but part of this study will help us determine when these changes start to occur.

A second part to this study is to ask if you would be willing to come back after 2-3 months of time has passed and repeat the process again. This will help us determine how long the and how effective the sessions last with each person.

How Can I participate? And When is this going to happen?

This study needs your help. We are hoping to start the sessions in **June and July this summer**. Please contact Allison Terzian to sign up and participate in the study, and for information on how to get involved. If you have questions you can contact the primary investigator.

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Appendix F
IM® Visual Feedback Screen

(http://www.golffitsos.com/GFSOS%20services.htm)

Appendix G1
Long Form Assessment Task 1 Data

Table G1: Task Average Raw Scores and Percentage of Change Results

Participant	A	B	C	D	% Change A-B	% Change B-C	% of Change C-D	% of Change A-C	% of Change B-D	% of Change A-D
1	30	38	42	45	26.67%	10.53%	7.14%	40.00%	18.42%	50.00%
2	14	23	2	60	64.29%	-91.30%	2900.%	-85.71%	160.8%	328.57%
3	11	14	32	38	27.27%	-128.5%	18.75%	190.9%	171.4%	245.45%
4	2	60	39	36	2900.%	-35.00%	-7.69%	1850.%	-40.00%	1700.%
5	28	48	28	28	71.43%	-41.67%	0.00%	0.00%	-41.67%	0.00%
6	30	38	30	38	26.67%	-21.05%	26.67%	0.00%	0.00%	26.67%
7	4	67	2	45	1575.%	-97.01%	2150.%	-50.00%	-32.84%	1025.%
8	46	52	14	23	13.04%	-73.08%	64.29%	-69.57%	-55.77%	-50.00%
9	13	28	3	6	115.3%	-89.29%	100.0%	-76.92%	-78.57%	-53.85%
10	2	60	14	23	2900.%	-76.67%	64.29%	600.0%	-61.67%	1050.%
11	13	53	3	6	307.6%	-94.34%	100.0%	-76.92%	-88.68%	-53.85%
12	14	23	46	52	64.29%	100.0%	13.04%	228.5%	126.0%	271.43%
13	46	52	31	38	13.04%	-40.38%	22.58%	-32.61%	26.92%	-17.39%
Mean	20	43	22	34	623.44%	-32.36%	419.93%	193.67%	3.09%	347.85%

Appendix G2
Long Form Assessment Task 1

Participant	A	B	C	D	% of Change A-B	% of Change B-C	% of Change C-D	% of Change A-C	% of Change B-D	% of Change A-D
1	41	26	36	21	36.59%	-38.46%	41.67%	12.20%	19.23%	48.78%
2	62	37	75	21	40.32%	-102.7%	72.00%	-20.97%	43.24%	66.13%
3	40	22	26	18	45.00%	-18.18%	30.77%	35.00%	18.18%	55.00%
4	229	21	30	26	90.83%	-42.86%	13.33%	86.90%	-23.81%	88.65%
5	51	28	33	29	45.10%	-17.86%	12.12%	35.29%	-3.57%	43.14%
6	37	48	35	33	-29.73%	27.08%	5.71%	5.41%	31.25%	10.81%
7	174	21	67	20	87.93%	-219.1%	70.15%	61.49%	4.76%	88.51%
8	19	17	62	37	10.53%	-264.7%	40.32%	-226.32%	-117.65%	-94.74%
9	37	35	37	38	5.41%	-5.71%	-2.70%	0.00%	-8.57%	-2.70%
10	67	18	26	21	73.13%	-44.44%	19.23%	61.19%	-16.67%	68.66%
11	92	25	26	21	72.83%	-4.00%	19.23%	71.74%	16.00%	77.17%
12	229	21	19	17	90.83%	9.52%	10.53%	91.70%	19.05%	92.58%
13	67	20	25	18	70.15%	-25.00%	28.00%	62.69%	10.00%	73.13%
Mean	88.08	26.08	38.23	24.62	49.15%	-57.41%	27.72%	21.26%	-0.66%	47.32%

Table G2: Super-Right-On Raw Data and Percentage of Change

Appendix G3
Long Form Assessment Task 14 Data

Participant	A	B	C	D	% of Change A-B	% of Change B-C	% of Change C-D	% of Change A-C	% of Change B-D	% of Change A-D
1	219	26	42	18	88.13%	-61.54%	57.14%	80.82%	30.77%	91.78%
2	84	58	68	19	30.95%	-17.24%	72.06%	19.05%	67.24%	77.38%
3	32	28	21	19	12.50%	25.00%	9.52%	34.38%	32.14%	40.63%
4	175	18	38	35	89.71%	-111.11%	7.89%	78.29%	-94.44%	80.00%
5	213	22	33	25	89.67%	-50.00%	24.24%	84.51%	-13.64%	88.26%
6	64	44	44	31	31.25%	0.00%	29.55%	31.25%	29.55%	51.56%
7	166	28	54	12	83.13%	-92.86%	77.78%	67.47%	57.14%	92.77%
8	51	14	84	58	72.55%	-500.00%	30.95%	-64.71%	-314.29%	-13.73%
9	58	31	35	34	46.55%	-12.90%	2.86%	39.66%	-9.68%	41.38%
10	76	19	26	19	75.00%	-36.84%	26.92%	65.79%	0.00%	75.00%
11	65	27	26	19	58.46%	3.70%	26.92%	60.00%	29.63%	70.77%
12	175	18	51	14	89.71%	-183.33%	72.55%	70.86%	22.22%	92.00%
13	54	12	32	21	77.78%	-166.67%	34.38%	40.74%	-75.00%	61.11%
Mean	110.15	26.54	42.62	24.92	65%	-92.60%	36.37%	46.78%	-18.33%	65.30%

Table G3: Task Average Raw Scores and Percentage of Change Results

Appendix G4
Long Form Assessment Task 14

Participant	A	B	C	D	% of Change A-B	% of Change B-C	% of Change C-D	% of Change A-C	% of Change B-D	% of Change A-D
1	12	38	38	48	216.6%	0.00%	26.32%	216.67%	26.32%	300.00%
2	12	7	6	49	-41.67%	-14.29%	716.67%	-50.00%	600.00%	308.33%
3	42	38	42	47	-9.52%	10.53%	11.90%	0.00%	23.68%	11.90%
4	6	49	30	28	716.6%	-38.78%	-6.67%	400.00%	-42.86%	366.67%
5	2	55	25	28	2650.%	-54.55%	12.00%	1150.0%	-49.09%	1300.%
6	12	38	12	38	216.67%	-68.42%	216.67%	0.00%	0.00%	216.67%
7	4	66	11	65	1550.%	-83.33%	490.91%	175.00%	-1.52%	1525.%
8	31	69	12	7	122.5%	-82.61%	-41.67%	-61.29%	-89.86%	-77.42%
9	12	33	4	8	175.0%	-87.88%	100.00%	-66.67%	-75.76%	-33.33%
10	6	49	12	7	716.6%	-75.51%	-41.67%	100.00%	-85.71%	16.67%
11	15	48	4	8	220.0%	-91.67%	100.00%	-73.33%	-83.33%	-46.67%
12	12	7	31	69	-41.67%	342.86%	122.58%	158.33%	885.71%	475.00%
13	31	69	12	24	122.5%	-82.61%	100.00%	-61.29%	-65.22%	-22.58%
Mean	15.2	43.5	18.4	32.8	508.77%	-25.10%	139.00%	145.19%	80.18%	333.86%

Table G4: Super-Right-On Raw Data and Percentage of Change

Appendix G5
d2 Test of Attention

Participant	A	B	C	D	% of Change A-B	% of Change B-C	% of Change C-D	% of Change A-C	% of Change B-D	% of Change A-D
1	134	162	157	225	-20.90%	3.09%	-43.31%	-17.16%	-38.89%	-67.91%
2	118	111	115	125	5.93%	-3.60%	-8.70%	2.54%	-12.61%	-5.93%
3	152	180	172	204	-18.42%	4.44%	-18.60%	-13.16%	-13.33%	-34.21%
4	148	175	165	188	-18.24%	5.71%	-13.94%	-11.49%	-7.43%	-27.03%
5	127	145	132	157	-14.17%	8.97%	-18.94%	-3.94%	-8.28%	-23.62%
6	172	205	201	227	-19.19%	1.95%	-12.94%	-16.86%	-10.73%	-31.98%
7	164	196	190	218	-19.51%	3.06%	-14.74%	-15.85%	-11.22%	-32.93%
8	133	146	139	175	-9.77%	4.79%	-25.90%	-4.51%	-19.86%	-31.58%
9	111	130	124	153	-17.12%	4.62%	-23.39%	-11.71%	-17.69%	-37.84%
10	154	185	172	201	-20.13%	7.03%	-16.86%	-11.69%	-8.65%	-30.52%
11	192	221	215	227	-15.10%	2.71%	-5.58%	-11.98%	-2.71%	-18.23%
12	165	198	188	220	-20.00%	5.05%	-17.02%	-13.94%	-11.11%	-33.33%
13	120	133	135	159	-10.83%	-1.50%	-17.78%	-12.50%	-19.55%	-32.50%
Mean	145.38	168.23	161.92	190.69	-15.19%	3.56%	-18.28%	-10.94%	-14.01%	-31.35%

Table G5: Raw Scores and Percentage of Change Results

Appendix G6
Nine Hole Peg Test Data

Participant	A	B	C	D	% of Change A-B	% of Change B-C	% of Change C-D	% of Change A-C	% of Change B-D	% of Change A-D
1	21	21	22	20	0	-4.76%	9.09%	-4.76%	4.76%	4.76%
2	21	20	20	20	4.76%	0.00%	0.00%	4.76%	0.00%	4.76%
3	26	24	22	24	7.69%	8.33%	-9.09%	15.38%	0.00%	7.69%
4	24	23	22	21	4.17%	4.35%	4.55%	8.33%	8.70%	12.50%
5	23	22	21	18	4.35%	4.55%	14.29%	8.70%	18.18%	21.74%
6	34	29	30	28	14.71%	-3.45%	6.67%	11.76%	3.45%	17.65%
7	26	24	20	19	7.69%	16.67%	5.00%	23.08%	20.83%	26.92%
8	24	18	24	22	25.00%	-33.3%	8.33%	0.00%	-22.2%	8.33%
9	24	22	25	23	8.33%	-13.6%	8.00%	-4.17%	-4.55%	4.17%
10	29	24	25	22	17.24%	-4.17%	12.00%	13.79%	8.33%	24.14%
11	20	20	20	19	0.00%	0.00%	5.00%	0.00%	5.00%	5.00%
12	24	18	24	22	25.00%	-33.3%	8.33%	0.00%	-22.2%	8.33%
13	20	20	20	19	0.00%	0.00%	5.00%	0.00%	5.00%	5.00%
Mean	24.31	21.92	22.69	21.31	9.15%	-4.52%	5.94%	5.91%	1.94%	11.62%

Table G6: Raw Scores and Percentage of Change Results

Appendix H
IRB Approval

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Leonard Trujillo
CC:

Date: 6/18/2014
Re: UMCIRB 14-001065
The Effectiveness of the IM with Healthy Aging Adults

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 6/11/2014 to 6/10/2015. The research study is eligible for review under expedited category #4, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
Cyprus glenn IM Info.docx	Clinical Investigators Brochure
Cyprus glenn IM Info.docx	Recruitment Documents/Scripts
IM No More thant minimal risk - LGT-June.doc	Consent Forms
IM Protocols for Aging Adults.pdf	Study Protocol or Grant Application

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

Appendix I
Participant Consent Form

Study ID:UMCIRB 14-001065 Date Approved: 7/16/2015 Expiration Date: 4/24/2016

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: The Effectiveness of the Interactive Metronome with Healthy Aging Adults: a Longitudinal Study
Principal Investigator: Leonard G Trujillo (Leo)
Institution/Department or Division: Occupational Therapy
Address:600 Moye Blvd HSB RM#3305, Greenville, NC 27858
Telephone #: 252-477-6195 - Cell 252-258-0363

Study Sponsor/Funding Source: Cypress Glen, St. Peter's Catholic Church, Pitt County Council on Aging and Interactive Metronome

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Researchers at East Carolina University (ECU) as well as the Interactive Metronome Corporation along with Directors from Cypress Glen participate in and study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to make a stronger case of using the Interactive Metronome as an effective tool to help improve the aging individual's daily lives. Some specific areas that we hope to make a difference in a person's balance, improving organization skills, and what we refer to as cognitive processing skills. Cognitive processing includes such things as being able to pay attention to tasks with less distraction and for longer periods of time; being able to remember the most recent event or what was just being discussed in a conversation as well as being able to formulate complex tasks or make plans. The decision to take part in this research is yours to make. By doing this research, we hope to learn how effective the Interactive Metronome is on the motor and mental skills, and if these expected positive improvements last over a month – to 3 months period of time.

Why am I being invited to take part in this research?
You are being invited to take part in this research because we consider you to be a healthy adult that is at least 60 years old and you may be interested in improving or sustaining your current motor and mental skills. By agreeing to be a participant you see yourself in good health and would possibly refer to yourself as a healthy aging adult. If you volunteer to take part in this research, you will be one of about 30 people to do so.

Are there reasons I should not take part in this research?
During this study the treatment time will progress from approximately 20 min of time to 30 min of time. It would be preferred if you can stand during that time, but could sit if needed. The actual time spent takes about 45 min. It is preferred that you have hearing in both ears. Hearing aids are acceptable, but you should be aware that you will be asked to wear headphones that go over one's ears during the treatment time. If you need to we will be able to adjust the volume. We will be using computer screens which will give you feedback, if you have difficulty with your visual acuity to distinguish what is being shown on the screen you will need to inform the researcher so they can make adjustments accordingly. It is important that you be willing to inform the researcher of your needs so we can make the adjustments accordingly.

Initial:_____

Study ID:UMCIRB 14-001065 Date Approved: 7/16/2015 Expiration Date: 4/24/2016

The Effectiveness of the Interactive Metronome with Healthy Aging Adults: a Longitudinal Study

What other choices do I have if I do not take part in this research?
You can choose not to participate. This is just an additional activity being supported by your agency to offer you more opportunities to remain active and live your life to its fullest.

Where is the research going to take place and how long will it last?
The research procedures will be conducted in an area provided by your sponsoring agency such as the activities center room. We will establish times in the afternoons to bring the Interactive Metronome to you directly. You will need to come to the designated area room during the times we agree on, a minimum of two times a week and possibly 3 times if you agree to the time available. The total amount of time you will be asked to volunteer for this study is two one and a half hour evaluations sessions and then 12 additional treatment sessions that will last 20 to 35 min of treatment time but usually last 45 min each. Because this is a longitudinal study, one that lasts over a specifi period of time we will ask you to return between 1 month and 3 months from completing this first round and complete the process again. We plan to start this in mid June and end the by the end of July returning in September for the second round, with hopes of completing this before the Holiday seasons come in November. So the first part of the study should take around 8 to 9 hours total time, there will be a short period of time where no sessions will be conducted and then we will repeat the sessions, but only doing half the first training for another 6 hour time for a compiled 16 – 18 hours of time involved.

What will I be asked to do?
You are being asked to do the following: The Interactive Metronome requires that you listen to rhythmic sounds and attempt to tap a switch to the timing of the sound trying to match the time you hit the switch to the timing of the rhythmic sound. Some of the switches will be on the floor and you will tap them with your heel or toe. If balance is a problem for you, you may ask or it be recommended that you sit during any of the activities. The total time will progress from 20 min per session in the beginning, to that of just fewer than 30 minutes for the last three sessions. The real time is closer to 45 min. There are different activities that will run from 2 minutes to almost 5 min by the final sessions in the total process. During this time you will be wearing headphones that you will take on and off and receive instructions from the researcher. These are the same activities that are being used in clinics across America in many out patient programs.

What are the possible benefits I may experience from taking part in this research?
We do not know if you will get any benefits by taking part in this study. This research might help us learn more about how older adults respond to the Interactive Metronome and if its affects last over time. There may be no personal benefit from your participation but the information gained by doing this research may help others in the future. Most often there are measureable changes made, but it is sometimes difficult for the individual to make notice of these changes as they become the new norm for most of us. The IM is designed to addresses: Brain timing, Rhythmicity , Synchronicity , Increasing the speed and coordination of informational signals within the brain , Improving the processing abilities that affect attention, motor planning, and sequencing and Coordination. By participating in this research study, you may also experience these benefits.

Will I be paid for taking part in this research?
We will not be able to pay you for the time you volunteer while being in this study. Exception: If you are part of the St Peter's Group because of travel expenses you will be compensated with a $50.00 gift card. Other groups will not because of the expectation of providing community service. If you have questions in this regard please ask Dr Trujillo about this option. However, if you were receiving this treatment in a for profit private clinic each session you would be asked to pay approximately $120 per session $1,440 is therapy costs.

What will it cost me to take part in this research?

Initial: _____

The Effectiveness of the Interactive Metronome with Healthy Aging Adults: a Longitudinal Study

It will not cost you any money to be part of the research. The sponsor of this research will pay the costs of: the IM equipment and computers used along with the leased time used in providing the sessions. The cost to you is your time and effort to participate.

Who will know that I took part in this research and learn personal information about me?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- The sponsors of this study.
- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.
- Additionally, the following people and/or organizations may be given access to your personal health information and they are: Activities Director at Cypress Glen, Greenville, NC.

How will you keep the information you collect about me secure? How long will you keep it?
The data that we are collecting will be protected at several levels and we want you to know we strongly understand your need to have your privacy protected and all means possible to maintain it using the best options available. To begin with this consent form will be the only printed document that has your full name written on it. This document will be stored in a locked file drawer, in Dr. Trujillo's university office that is locked during times he is not in the office suite. His door has very limited access to only those who have sub Masters Keys or Masters key for the College. At the end of this document we will identify an identification code that will be used on all future documents in conjunction with your first name. That same identification code will be the one used with registering you with the IM computer program that will be accessed via a password-protected computer. In addition to the password protected PC the IM program encrypts your data and information and only the program can decrypt the data collected. In order to access your data one would have to know your IM Identity, only your direct researcher and Dr. Trujillo will know your identification codes. Very little sensitive data if being collected, Name, age/ Birthdate, gender, handedness and statement of general health. In addition the test evaluation forms from the evaluation will be kept in the same file folder where this consent form will be kept to maintain security and privacy of this data collected. If translated into electronic data it would be stored in an encrypted password protected data storage system similar to pirate drive provided by ECU. Because this study is identified to take place for approximately one year for data collection and then a 2nd year for data analysis these files will be maintained for a 2 year length of time. After that time any information that could be pointed back to you as an individual who participated in the study will be stripped of the data for possible future research process. The data when it is reported will be done so in aggregate format – which means report as a group of individuals who live in a residence in Eastern North Carolina and not specific to a group of older adults at your agency. We hope to publish studies in this regard to include a possible Graduate Student Thesis.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. If you find your schedule needs to be adjusted to better continue that can be arranged. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator Leo Trujillo at 252-744-6195 (Monday through Friday during the day between 8:00 AM and 5:00 PM. You can leave a message if you wish to or if you want to use the staff at Cypress Glen you may do so by contacting Allison Terzain who is your Life enrichment coordinator at the facility. She will serve as your conduit and contact Leo Trujillo. For those at Pitt County Council on Aging you would contact Diane

Initial: _____

The Effectiveness of the Interactive Metronome with Healthy Aging Adults: a Longitudinal Study

Skalko, Executive director 252-752-1717/3 or email her at dsklako@pittcoa.com . Those associated with St Peter's can voice your concerns with the St Peter's Office 252-757-3259 extension 201 and the office staff will direct your question to the appropriate person. As the principle investigator Leo Trujillo is available at anytime via his cell phone at 252-268-0363. You may also voice any concerns or feedback directly to the researcher you are working with and they are training to make accommodations or respond to most of your needs directly,

If you have questions about your rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the ORIC, at 252-744-1971.

Is there anything else I should know?

We think this covers most any question that you may have had in order to make a decision about being a participant in this study. Remember it will have two parts each lasting a total of 14 sessions the first and last being evaluations and the middle 12 being the treatment sessions that will last around 30 min of your time.

I have decided I want to take part in this research. What should I do now?

The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

_____

Participant's Name (PRINT) **Signature** **Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

_____

Person Obtaining Consent (PRINT) **Signature** **Date**

Personal Identification IM ID:

Name: _____ ___ _____
First MI Last

Initials: __ __ __ (If no middle name or initial place a "Z" in its place)
F M L

Year of Birthdate: __ __ __ __

IM ID: __ __ __ __ __ __ __

Initial: _____