

## **ABSTRACT**

LAPORTE, LANDON. Motor Skill Acquisition in Older Adults: The Effects of Age, Activity, and Stressor Exposure on the Learning of a Discrete Complex Motor Task. (Under the direction of Dr. Anne McLaughlin).

It is believed that there are age-related differences in the acquisition of motor skills (Pratt, Chasteen, & Abrams, 1994; Seidler, 2006; Rodrigue, Kennedy, & Raz, 2005; Kennedy & Raz, 2005; Perrot & Bertsch, 2007; Voelcker-Rehage, 2008). Previous motor skill research has primarily focused on differences between younger adults (ages 18-59) and older adults (over the age of 60) but has not addressed how older adults vary within their age group. Research has also shown how physical activity, social activity, and stress change with increased age and how these variables are associated with physical and cognitive ability (Kramer, Erikson, & Colcombe, 2006; Seeman, Lusignolo, Albert, & Berkman, 2001; McEwen, 2008). Since Etnier, Nowell, Landers, and Sibley (2006) found that cognitive and physical function are related to motor learning, it is important to examine if individual differences in the variables of physical activity, social activity, stress, and age are related to differences in motor skill acquisition. In this study, we examined older adults acquiring a motor skill and how their rate of acquisition was related to practice, differences in age, levels of physical activity, levels of social activity, or differences in reported stress. Results showed that practice, physical activity, and social activity all affected the acquisition of a motor skill. Chronological age and average stress level were nonsignificant predictors of motor skill acquisition.

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Motor Skill Acquisition in Older Adults: The Effects of Age, Activity, and Stressor Exposure  
on the Learning of a Discrete Complex Motor Task

by  
Landon LaPorte

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## **DEDICATION**

Twenty-nine years of work that has not been done by me, but by my amazing and dedicated mother, my loving and missed father, my courageous and loyal brother, and my generous and humorous sister.

## **BIOGRAPHY**

Landon LaPorte is in year four in the Department of Psychology (year three in the Human Factors and Ergonomics Program).

## **ACKNOWLEDGMENTS**

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## TABLE OF CONTENTS

LIST OF TABLES .....	vi
LIST OF FIGURES .....	vii
INTRODUCTION .....	1
Age-related Declines in Cognition.....	1
Motor Learning: A Brief Overview .....	2
Predictors of Motor Learning.....	5
Factors Associated with Predictors of Motor Learning .....	6
Age and Motor Learning.....	8
Interactive Gaming Systems and Motor Learning .....	10
OVERVIEW OF STUDY.....	12
METHOD .....	13
Participants.....	13
Materials .....	14
Design .....	18
Procedure .....	21
RESULTS .....	21
Model 1: Practice .....	24
Model 2: Age .....	25
Model 3: Practice, Age, Physical Activity, and Social Activity.....	26
Model 4: Stressor Exposure .....	31
DISCUSSION.....	32
Limitations .....	35
Future Directions .....	36
REFERENCES .....	38
APPENDIX.....	49
APPENDIX A.....	50
APPENDIX B .....	51

## LIST OF TABLES

Table 1 - Predictor multicollinearity.....	23
Table 2 - Throw success performance associated with differences in predictive variables ...	28

## LIST OF FIGURES

Figure 1 - The “Wiicord System” recorded participants as they interacted with the IGC.....	15
Figure 2 - Participants use the Nintendo Wii controller (Wiimote) as an input device.....	17
Figure 3 - Relationships between nested variables .....	20
Figure 4 - Mean performance of participants by throw bins .....	22
Figure 5 - Social Activity X Practice interaction effect.....	30
Figure 6 - Physical Activity X Practice interaction effect. ....	31

## **INTRODUCTION**

Much research has been conducted on how motor skill acquisition for older adults compares to younger adults, yet research is lacking on how motor skills acquisition is affected by age for older adults after the age of 60. Baltes (1997) noted discernible differences in health and psychological functioning that occur during older adulthood. Those at more advanced ages are at a much higher risk for dysfunction than those at younger ages. In addition to these age-related differences in cognitive and physical performance, it remains to be seen how variables such as physical activity, social activity, and stressor exposure are associated with motor skill acquisition in older adults. In this study we explored how older adults varied in their acquisition of a discrete complex motor task and how differences in age, average physical activity, average social activity, and average stressor exposure were associated with motor skill acquisition.

### **Age-related Declines in Cognition**

The number of individuals over the age of 60 has grown at a faster rate than the rest of the world's population (DESAPD, 2010). In the last 50 years the number of adults over age 60 has tripled and is projected to triple again in the next 50 years (DESAPD, 2010). For the first time in history the number of adults over age 60 will exceed children under age 15 by the year 2050 (DESAPD, 2010).

As this segment of the population grows and becomes a more influential component of culture and society, it is important to understand how the capabilities and limitations of older adults are related to their age. Baltes and Smith (2003) found that older adults

demonstrate within-group age differences in areas such as perceived vulnerability, predictability, positive outlook, loss of identity, autonomy, sense of control, and other age-associated physiological and functional losses. The oldest-old (individuals above 80 years old) also have a higher incidence of disease and institutionalization, a greater need for medical and care services, reduced social support networks, and contain a higher percentage of females when compared to the youngest-old (individuals between 60-79; Smith, Borchelt, Maier, & Jopp, 2002; Suzman, Willis, & Manton, 1992). However, limited research addresses how age differences within the older adult population can affect motor skill learning and what variables are related to such skill learning.

### **Motor Learning: A Brief Overview**

Motor learning, or the acquisition of a motor skill, is defined by Voelcker-Rehage (2008) as the successful acquisition and demonstration of a novel and previously unlearned movement or an organized and well-coordinated sequence of voluntary movements directed towards a desired outcome. Motor skills are defined as having three basic characteristics: 1) a motor skill is composed of a wide behavioral domain of simple or complex movements, 2) a motor skill is learned after training or practice, and 3) a motor skill is used to attain goals with motor behavior (Fitts, 1964; McGeoch, 1927; Pear, 1927).

Motor skills are further categorized to delineate between types of motor skills. Motor skills are sometimes categorized by their structure, complexity, or level of difficulty (Voelcker, Wiertz, Willimczik, 1999). Smith and Smith (1962) classified motor skills as being either postural, travel/locomotor, or manipulative. Davis and Burton (1991) proposed

five categories of classification based on functional movement: a) locomotion, b) locomotion of an object, c) propulsion, d) reception, and e) orientation. Schmidt (1975) differentiated skills further by identifying a) discrete skills (skills with a definitive beginning and end), b) continuous skills (skills with no definitive beginning or end), and c) serial skills (skills that require various steps or a series of movements). Adams (1987) further delineated motor skills by their difficulty and degrees of freedom to be either simple or complex. Simple motor skills are defined as motor movements with smaller degrees of freedom for performance and are easier to perform and measure (e.g., finger tapping). Complex motor skills are defined as movements with higher degrees of freedom and are more difficult for an individual to perform and often require numerous muscles and joints for their completion (e.g., throwing or jumping; Adams, 1987). It is important to understand these definitions and classification systems so that we may clearly describe motor skills used in this study.

Psychologists, kinesiologists, therapists, and a variety of other professionals have used an assortment of measurements to examine development of motor skill. These measurements of motor skill have included but were not limited to reaction time, error rate, accuracy, time to completion, trial to completion, and number of successful attempts (McLaughlin, Simon, & Gillan, 2010). Skill acquisition has been observed when individuals realize significant gains in these dependent measurements after the acquisition and practice of a new skill (Voelcker-Rehage, 2008) or when an individual has transferred the performance of the acquired skill to a related task or altered context (Schmidt & Bjork, 1992).

To assist in the acquisition and performance of motor skills, generalized motor programs are used by individuals to apply internalized skills to novel or contextually different situations. As individuals learn and perform motor skills, generalized motor programs are internalized and then applied to several situations when necessary (Schmidt, 1975). These generalized motor programs are sets of motor commands specified before movement initiation. Once a generalized motor program is triggered it produces a physical action and manifestation of the intended movement. A generalized motor program can be composed of many motor movements that, when triggered sequentially or simultaneously, create the performance of a complete generalized motor program. For example, the generalized motor program of walking requires the performance of a leg raising movement, a leg extension movement, a leg lowering movement, an ankle flexion, and an ankle extension movement. When these movements are performed individually they produce the single intended movement described. However, when they are performed in the proper sequence an individual performs the walking generalized motor program. This generalized motor program can be applied to other walking situations with different parameters that elicit different uses of the motor program, such as walking fast or adjusting to obstacles in the walk path.

The walking generalized motor program provides an example of how alterations in parameters can lead to different responses. As generalized motor programs change or require more movements (as with the completion of complex skills) motor skills require more cognitive and physical resources (Schmidt & Lee, 2005). This increased need for cognitive

and physical resources yields poorer performance of complex motor skills, which typically require more generalized motor programs or more complex programs. Comparatively simple motor skills, which typically contain a lower number of generalized motor programs or simpler programs, require fewer physical and cognitive resources and are generally easier to perform (Meister et al., 2005). For the purposes of this study, a complex generalized motor program of throwing a virtual object was performed by participants who adjusted the program parameters to several different situations throughout the study.

### **Predictors of Motor Learning**

It has long been established that practice positively affects motor skill acquisition in a variety of ways (Snoddy, 1926; Crossman, 1959; Newell & Rosenbloom, 1981; Schmidt, 1975). However, a variety of other factors, such as cognitive ability, physical ability, and task complexity, are associated with individual differences in motor skill acquisition as well. Cognitive abilities such as attentional focus, explicit memory, perceptual speed, working memory, mindset, and neurodegenerative differences are known to predict motor skill acquisition and performance (Wulf, McNevin, & Shea, 2001; Bo, Borza, & Seidler, 2009; Wulf, Chiviakowsky, & Lewthwaite, 2012; Voelcker-Rehage, 2008). Individuals who demonstrated higher performance in these cognitive abilities demonstrated higher performance accuracies and shorter training periods, indicators of better motor skill learning.

Motor learning is also affected by basic physical ability. Individuals who are physically incapable of motor performance or the replication of a movement are understandably impaired in their acquisition of motor skills. However, not all individuals

that are physically able-bodied possess an equivalent competence to acquire motor skills. It is known that certain individual differences, such as muscular and physical health, biological cerebellar plasticity, nerve conduction speed, reaction speed, and tactile sensitivity are related to physical ability and brain structure (Stelmach & Nahom, 1992; Fabre, Chamari, Mucci, Masse-Biron, & Prefaut, 2002; Cabeza, 2001; Grady, 2000; Salthouse, 1985; Tomassini et al., 2011). Many of these physical abilities that are related to motor learning competence are also related to individual physical activity (Isaacs, Anderson, Alcantara, Black, & Greenough, 1992; Dustman et al., 1984). Using these findings about the associations of cognitive and physical ability to motor learning, it is important to examine how variables such as age, physical activity, social activity, and stressor exposure that affect cognitive and physical ability can affect how an individual acquires a motor skill.

### **Factors Associated with Predictors of Motor Learning**

Physical and cognitive ability are associated with differences in motor learning and these abilities are also affected by differences in physical activity, social activity, and stress. Physical activity in particular has been positively associated with cognitive and physical ability (Hands, Larkin, Parker, & Perry, 2009; Kramer, Erikson, & Colcombe, 2006; van Boxtel, Paas, Houx, Adam, Teeken, & Jolles, 1997; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). These findings suggest that individuals who exhibit more physical activity demonstrate a positive relationship with cognitive and physical abilities; which suggests also a positive relationship with motor learning (Etnier, Nowell, Landers & Sibley, 2006). One explanation may be that individuals who demonstrate generally higher levels of physical

activity also displayed higher biologic cerebellar plasticity and overall cognitive function, both variables that have shown to be positively associated with motor learning (Fabre, Chamari, Mucci, Masse-Biron, & Prefaut, 2002; Kramer et al., 1999; van Boxtel et al., 1997). It is also known that younger subjects with higher physical activity demonstrated higher motor learning and motor retention (Haga, 2008; Hands, Larkin, Parker, & Perry, 2009; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006).

Stress, however, has been shown to be negatively associated with both physical and cognitive function for individuals (McEwen, 2008). Individuals who are exposed to chronic stress suffered higher deterioration of the body, particularly the cardiovascular system, and a depreciated competence to perform motor skills (McEwen, 2008). McEwen and Sapolsky (1995) and Eysenck and Calvo (1992) stated that exposure to stress can deleteriously affect cognitive function by contributing to a loss of neurons in the hippocampus, an area previously found to be involved in declarative and working memory. Since these stress-related effects in the hippocampus hinder declarative and working memory, and motor learning is related to differences in memory (Bo, Borza & Seilder, 2009), it may be that the stress also negatively influences motor learning.

Beyond physical activity and exposure to stress, other variables affect physical and cognitive ability. Social activity can have positive effects on overall health (Berkman, 1995; Seeman, Lusignolo, Albert, & Berkman, 2001). By improving overall health through social support and activity, individuals experienced better cognitive function (Seeman, Lusignolo, Albert, & Berkman, 2001). Avlund and colleagues (2004) also noted a relationship between

social activity and physical ability, suggesting that individuals with limited social ties more readily exhibit physical decline. By understanding how individual differences in age, physical activity, social activity, and stress affect both cognitive and physical ability, it may be possible to understand how these factors relate to an individual's motor skill acquisition.

### **Age and Motor Learning**

**The age fallacy.** Although age is commonly used as a predictor of motor learning, it is at best an index representing likely age-related change in cognitive and physical abilities (Thorvaldsson, Hofer, & Johansson, 2006; Kennedy, Patridge, & Raz, 2008; Schugens, Daum, Spindler, & Birbaumer, 1997). Individuals that demonstrated higher levels of competence in cognitive and physical areas possessed a theoretically higher ability to learn motor skills, irrespective of age. Therefore, although individuals might have differed in age it was differences in cognitive and physical ability that was predictive of their motor learning - not their chronological age. Since cognitive and physical ability are affected by activity and stress it is important to examine how individuals vary in activity and stress as these variables might have a relation to motor learning beyond that of simply age.

**Age-related decline.** Because of these differences in physical and cognitive ability older adults are typically at a disadvantage in acquisition and performance. Many studies have shown that older adults demonstrated decreased abilities in the acquisition of a motor skill when compared to younger adults and that age-related decline commenced as soon as early adulthood (Pratt, Chasteen, & Abrams, 1994; Seidler, 2006; McNay & Willingham, 1998; Shea, Park, Wilde & Braden, 2006; Rodrigue, Kennedy, & Raz, 2005; Kennedy &

Raz, 2005; Bo, Borza, & Seidler, 2009; Harrington & Haaland, 1992; Boyd, Vidoni, & Siengsukon, 2008; Perrot & Bertsch, 2007; Voelcker-Rehage, 2008). Cognitively, older adults have shown a decreased ability in motor learning because of inabilities to adapt to visual feedback as well as younger adults (Seidler, 2006; Hedel & Dietz, 2004), to adapt to highly complex tasks (Voelcker-Rehage, 2008), to reduce movements into sub-movements by strategies such as chunking (Pratt, Chasteen, Abrams, 1994; Shea, Park, & Wilde, 2006), and to acquire skills in the same amount of practice (Rodrigue, Kennedy, & Raz, 2005; Fraser, Li, & Penhune, 2008). Older adults are also adversely affected by age-related declines in working memory (Harrington & Haaland, 1992; Kennedy, Patridge, & Raz, 2008), attentional focus, explicit memory, and perceptual speed (Voelcker-Rehage, 2008). These factors may influence motor learning by limiting how older adults acquire, comprehend, or retain skills.

Physically, older adults experience a natural degradation in overall muscular and physical health which can detrimentally affect the acquisition of new motor skills (Stelmach & Nahom, 1992). It is estimated that joint flexibility declines by approximately 25% in older adults resulting from significant joint deterioration, arthritis, and the calcification of cartilage (Smith & Sethi, 1975). Older adults can also be affected neurologically by decreasing levels of cerebellar plasticity which impairs cognitive and physical ability (Fabre, Chamari, Masse-Biron, & Prefaut, 2002). Such physical limitations can present challenges in the performance of motor skills for older adults. Because motor learning skills can demand a higher degree of flexibility, muscular performance, and coordination, older adults often experience diminished

performance as a result of these physical limitations (Stelmach & Nahom, 1992).

Because of these potential limitations, older adults are known to use a greater amount of cognitive and physical resources for performance, such as working memory and muscular activation, and have more trouble acquiring motor skills than younger age groups (Perrot & Bertsch, 2007). This is especially true for older adults as compared to younger adults in the acquisition of complex skills which require more mental and physical resources (Strayer & Kramer, 1994).

### **Interactive Gaming Systems and Motor Learning**

Research in motor skills has evolved over recent years with the introduction of a wide variety of technologies capable of enhancing motor practice and measuring performance. Sedentary gaming consoles and interactive gaming consoles (IGCs) are recognized as two emerging technologies used as input devices to study motor learning and motor skill acquisition (Bliss, Kennedy, Turnage, & Dunlap, 1991; Gopher, 1992; Fery & Ponserre, 2001; Delgado-Mata, Ruvalcaba-Manzano, Quezada-Patino, & Gomez-Pimentel, 2009; Rosser, Lynch, Cuddihy, Gentile, Klonsky, & Merrell, 2007). IGCs, such as the Nintendo Wii, X-box Kinect, and Sony Playstation Move, rely on innovative exertion interfaces such as electronic dance pads, motion platforms, haptic devices, and motion-tracking cameras, as opposed to standard electronic game interfaces (sedentary gaming systems) which use more traditional input devices such as a keyboard, mouse, joystick, or a hand-held game-pad (Papastergiou, 2009).

IGCs have been shown to increase physical activity, increase interaction motivation,

increase fitness levels, provide immediate feedback, and offer unique variations of environment and reward (Unnithan, Houser, & Fernall, 2006; Sell, Lillie, & Taylor, 2008; Papasterigiou, 2009). These interactive gaming systems, as well as sedentary systems, have provided effective training grounds for motor skill acquisition and learning in a variety of motor, athletic, and work tasks (Bliss, Kennedy, Turnage, & Dunlap, 1991; Gopher, 1992; Rosser et al., 2007; Fery & Ponserre, 2001). IGC systems have been utilized in teaching children motor skills (Delgado-Mata, Ruvalcaba-Manzano, Quezada-Patino, & Gomez-Pimentel, 2009) yet research has not fully explored use of IGCs for older adult motor skill acquisition. However, IGC systems have shown benefits for the older section of population by offering a preferred alternative to basic exercises such as walking or jogging (Graves, Ridgers, Williams, Stratton, Atkinson, & Cable, 2010), providing effective platforms for physical therapy and stroke recovery (Anderson, Annett, & Bischof, 2010; Halton, 2008; Deutsch, Robbins, Morrison, & Guarrera-Bowlby, 2009), improving balance and manual dexterity (Van Schaik, Blake, Pernet, Spears, & Fencott, 2008), and improving psychological well-being (Wollersheim et al., 2010).

Because of their repeated use in previous research, IGCs have become reliable devices for motor skill research. These systems have displayed a high reliability in classifying actions and movements as successful or unsuccessful. Therefore researchers can use IGCs to measure movements indistinguishable to less advanced technology or the common eye (Clark, Bryant, Pua, McCrory, Bennell, & Hunt, 2010). IGCs and gaming technologies have also benefited the field by allowing researchers to manipulate levels, tasks,

reward structures, feedback, and provide quantified outcome measures to make them desirable for motor skill research.

## **OVERVIEW OF STUDY**

As older adults become a larger portion of our world population and the overall life expectancy increases, it is vital to understand how older adult motor needs change with increases in age, activity, and stressor exposure. In this study, we examined how motor skill acquisition can be affected by advancing age after the age of 65, physical activity, social activity, and stressor exposure. To do this, participants acquired a motor skill over a period of practice. The motor skill learned was the complex and discrete task of throwing a virtual object in an interactive video game using an IGC. The learned generalized motor program of throwing a virtual object was applied to various levels and situations throughout a virtual game that required participants to perform the throwing motor movement. Each level presented participants with new parameters and requirements for the throw task. By altering these parameters, such as distance to target, object being thrown, vertical height of target, or size of target, participants were forced to adapt the generalized motor program to suit the level.

The first hypothesis was that participants would acquire the motor skill and display higher performance over practice. The second hypothesis was that age would be negatively associated with acquisition of the motor skill and that older adults in more advanced age would acquire the skill at a slower rate. The third hypothesis stated that individuals who engaged in a higher amount of physical and social activity minutes on average would acquire

the motor skill faster than those that did not engage in as many activity minutes regardless of age. The fourth and final hypothesis stated that individuals who were exposed to more stress would be negatively affected in the acquisition of the throwing skill.

## **METHOD**

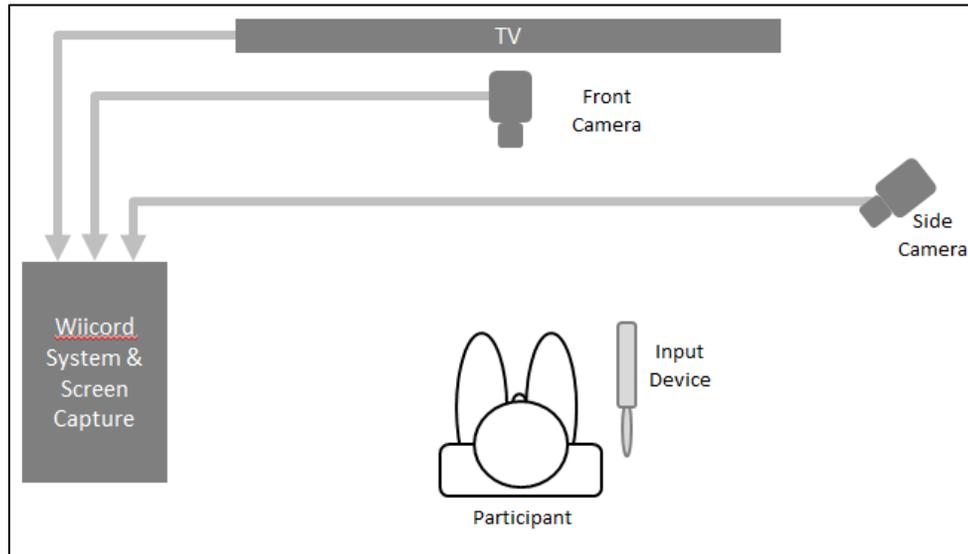
### **Participants**

Fifty-one participants (Age  $M = 76.5$ ,  $SD = 7.04$ , Male = 23, Female = 28) were recruited from retirement communities, senior public housing communities, community centers, and religious centers via flyers, community announcements, emails advertisements, and local bulletin advertisements approved by the North Carolina State University Institution Review Board (IRB). Requirements for participation included being over the age of 65, absence of diagnoses such as dementia or Alzheimer's disease, and fluency in the English language. Participants self-reported on all screening requirements. Participants received between \$90-\$100 compensation for their participation. Participants were recruited to participate in a study involving a cognitive pre-test, fifteen one-hour sessions, a matched cognitive post-test, and two follow-up assessments as part of a larger study. The study was set up at multiple sites at local retirement communities, community centers, and satellite office facilities to maximize participation and minimize participant travel. For the purposes of this study, analyses were performed on day 3-5 of the larger study when the participants were fully engaged in video game play and skill acquisition of the throwing motion without the assistance or direction of researchers. Days 1 and 2 were excluded from analysis because experimenters often were training participants on how to use the ICB controller and would

repeatedly hold the controller or hand of the participant while they were performing the action. Only days 3-5 were used for analysis as this represented the amount of time in which each participant performed the required number of throws for the experiment.

## **Materials**

**Apparatus.** During the one-hour sessions, participants interacted with an IGC (the Nintendo Wii) by playing the Electronic Arts action puzzle game *Boom Blox*. This game were chosen because of their range of problem solving in completing complex levels and complex movement demands of the participant - such as throwing, shooting, and grasping. Although *Boom Blox* was not developed specifically for older adults, the game was accessible enough for children and challenging enough for adults (Whitlock, McLaughlin, & Allaire, 2012). The game required that participants manipulate virtual blocks within a three-dimensional space using various tools. Blocks within the game reacted to forces such as gravity, friction, and momentum as in the physical world. Participants interacted with the IGC and game for one hour each day, acquiring multiple motor skills, including the complex skill of “throwing” a virtual object. These throws were recorded along with video from the front and side angles of the participant via a custom-made portable laptop system (Figure 1). A 37-inch flat-screen LCD television with a resolution of 1920 x 1080 pixels was used for gameplay. This experimental setup was standard across all study sites.



**Figure 1** - The “Wiicord System” recorded participants as they interacted with the IGC.

**Motor task data.** The observed motor skill, throwing a virtual object with a Wiimote controller satisfied several classifications put forth by previous researchers. The observed motor skill met requirements stated previously for general motor skills (Pear, 1927; McGeoch, 1927; Fitts, 1964): the observed motor skill was discrete with a definite beginning and end (Schmidt, 1975), the observed motor skill was manipulative (Smith & Smith, 1962), and the observed motor skill was complex because it required of many physical degrees of freedom as well as muscles and joints (Adams, 1987). The throwing movement was naturally embedded in the game and was required to learn by participants if they were to succeed at the game. The purpose of throws in the game was to knock down or destroy a target on the gameplay screen using a variety of throwing objects that threw in similar

fashions (e.g., a virtual “baseball” or “bowling ball”). Different objects would create different responses within the game based on the virtual weight or size of the object. Throwing a virtual object constituted a generalized motor program for the participant that could be applied to various levels and situations throughout the game. A throw in the game was defined as a movement that began with a “lock-on” to a target in the virtual environment of the game, accomplished by pressing the “A” button on the Wiimote controller (Figure 2). This “lock-on” was then followed by an upwards then downwards movement of the shoulder, arm, and hand of the player. Successful throws ended with a release of the “lock-on” button and the appearance of a thrown object on the gameplay screen. Two components were coded to analyze throw success: 1) *Lock-on*: where the participant pressed a button on the Nintendo Wii controller to fix the aim of the device on a target on the gameplay screen, and 2) *Throw Success*: where coders determined if the object that was being thrown appeared on the gameplay screen or not. A poorly timed or uncoordinated movement resulted in no object appearing on the gameplay screen and an unsuccessful throw attempt.



**Figure 2** - Participants use the Nintendo Wii controller (Wiimote) as an input device.

**Activity data.** Physical and social data were collected from participants each day of the study with a Daily Activity Checklist (Hultsch, Hertzog, Small, & Dixon, 1999; Appendix A). The checklist measured how much a participant engaged in a type of activity in the previous twenty-four hours to gameplay by listing the activity specifically and the duration of minutes spent participating in the activity (i.e., if a participant spent twenty minutes swimming during the previous twenty-four hours, that participant would check the box for “swimming” and log “20” as the number of minutes). These minutes were averaged over the duration of the study for each participant. By averaging the daily activity minutes for both physical and social activities, the researchers determined which participants were

more physically or more socially active on average. This allowed the researchers to make comparisons between more and less active participants. This checklist was collected for each day that a participant took part in a gaming session. One participant did not adhere to reporting instructions so their activity data were omitted from final analyses.

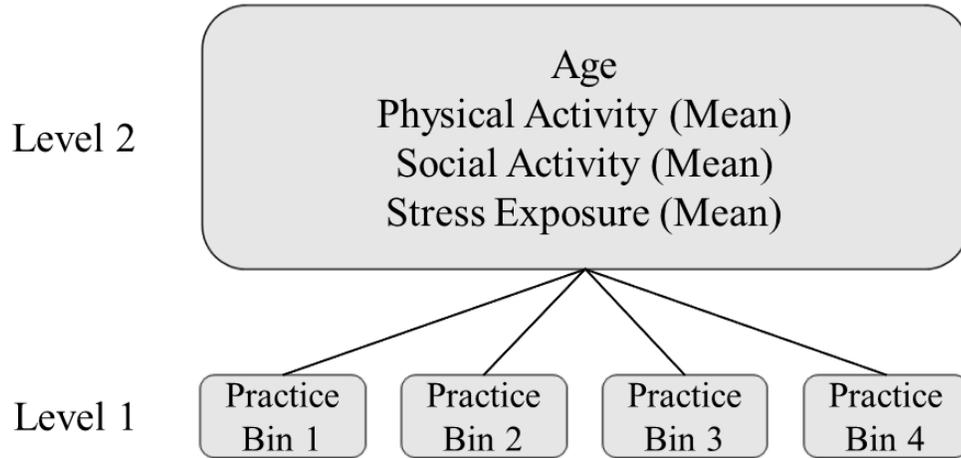
**Stressor exposure data.** Daily packets also required individuals to report the occurrence of stressors each day. The stressor questionnaire, the Daily Inventory of Stressful Events (Almeida, Wethington, & Kesler, 2002; Appendix B) prompted individuals to report the presence of stress for the previous twenty-hour hours before participating in the gaming session. Participant stressors were recorded by a binary system of stress occurrence (1) and stress non-occurrence (0). If the participant reported any stressors for the previous twenty-four hours that previous day was deemed to be stressful (1). If the participant reported no stressors then the previous day was deemed to not be stressful (0). Stressor exposure occurrence was aggregated and then averaged by number of days the participant was in the study to determine the average stressor exposure for that participant. Participants were compared on their average stressor exposure to determine which participants experienced more stress or less stress. These data allowed researchers to make comparisons between participants to determine the effects of stressor exposure on acquiring the motor skill.

## **Design**

All models used multilevel modeling techniques for analysis. To test our first hypothesis, we examined how successful task performance varied over recorded trials of throwing. To test our second hypothesis, we examined how age was related to the

acquisition of the motor skill. To test the third hypothesis, the predictors of mean physical and social activity minutes were included in a model along with age to determine if activity positively affected performance and if these effects interacted with age. The fourth hypothesis was tested by including a measure of average stressor exposure in the final model to determine if throwing success was affected by average stressor exposure.

It is important to note how variables were nested for each participant. Practice served as the primary Level 1 variable where each participant had multiple occasions (instances of practice). Practice was nested within each day for person, but since days varied for individuals to achieve 95 throws, this level of nesting was omitted and instead focus was placed on the nesting of bins within people. Physical activity minutes and social activity minutes were both Level 2 variables and represented the average amount of physical or social activity, respectively, by the individual over the study. Other Level 2 variables examined at the between-person level were age and average stressor exposure level of the participant. The relationship between variables is demonstrated in Figure 3 below.



**Figure 3** - Relationships between nested variables

The primary dependent measure for the study was throw success, measured dichotomously for each throw as successful or unsuccessful. A throw success was defined as the previously described lock-on and appearance of a visible object on the gameplay screen resulting from the throwing motion. An unsuccessful throw was defined as the absence of an object on the gameplay screen at the completion of an attempted throw movement. Throws were organized for analysis by creating groups, or bins, of 5 consecutive throws. For example, throws 1 through 5 were grouped in bin 1, throws 6 through 10 were grouped in bin 2, and so on. Throw success per bin was determined by creating a percentage of successful throws per every bin (i.e., if Person A had 3 successful throws out of 5 throw attempts in bin 1, the throw success percentage for bin 1 would be 60% [ $3/5 = 0.6$ ]). Five throws per bin was used as it provided researchers with the ability to observe learning over time at standard

intervals. Hypothesized predictors of success included practice, age, average physical and social activity, and stressor exposure.

Day 1 and 2 were not used because participants were engaged in training. Day 3 to Day 5 were used for the study to examine how participants varied in their throw success over these days. Researchers used throws 0-95 throws starting on the third day of each participant as it was the minimum number of throw performances that all participants completed for days of study. Some participants performed 95 throws before the 3-day cap but all were able to complete at least 95 by Day 5, or by the third day of analysis.

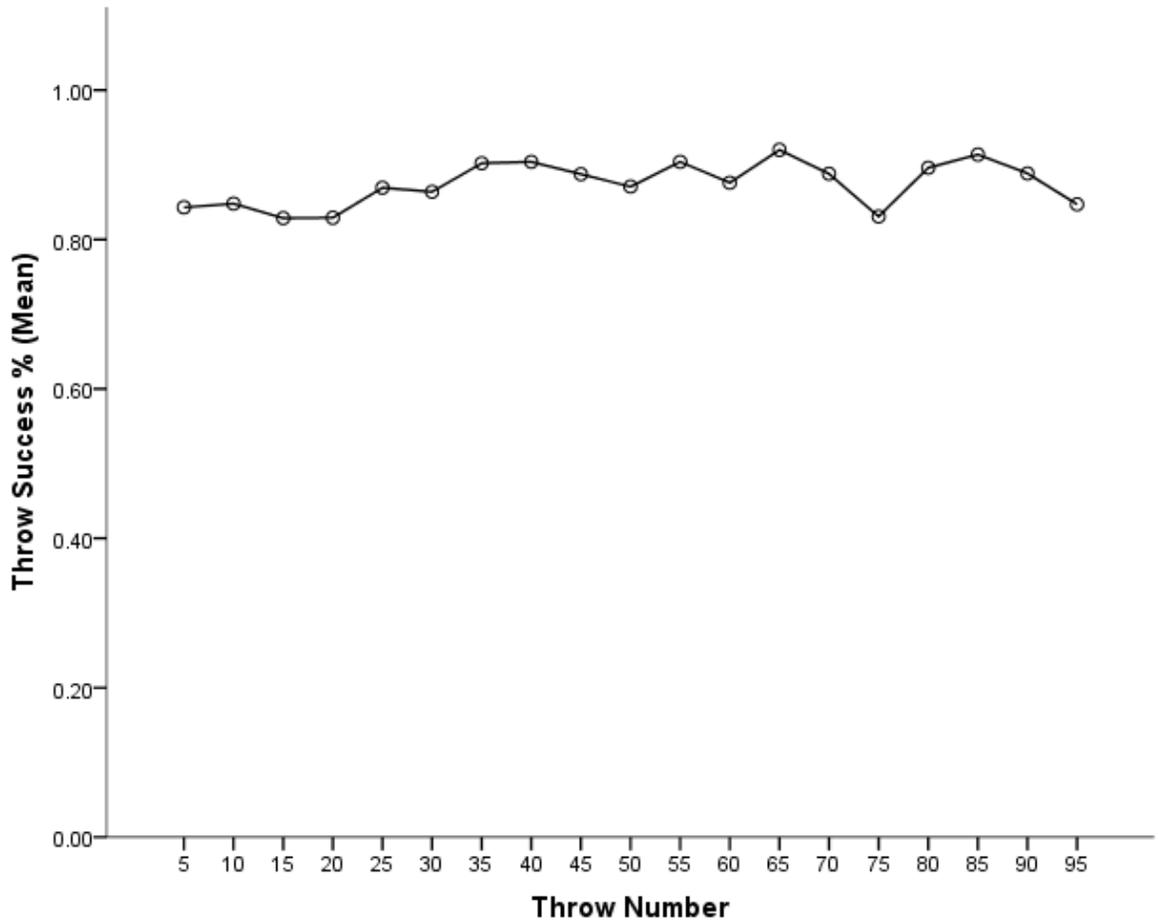
### **Procedure**

Participants proceeded through a predetermined progression of game levels for the study. All participants completed training levels at the beginning of the study to learn the basic skills needed to interact with the game. Participants were self-paced in their progression through the game levels and could repeat levels if desired. All participants progressed through the game levels in a predefined order, with levels gradually becoming more difficult and requiring different skills and strategies. However, participants could repeat levels if desired and were not limited in time exposure to each level. Throw data were collected during all game play sessions.

## **RESULTS**

The skill acquisition of the overall sample is shown in Figure 4. Participants performed the skill with a high degree of success from the beginning trials on Day 3, yet did

improve in their performance across 95 throws. However, some participants might have experienced a ceiling effect on their learning.



**Figure 4** - Mean performance of participants by throw bins

Before further analyses were conducted, variables were examined to determine if

multicollinearity existed between Level 2 predictors (Table 1). Tests for multicollinearity indicated that predictors were correlated. However, since each variable had the same number of observations and magnitudes of correlation were low (below 0.23), the percentage of variance that variables share is not a cause for concern and further analyses can be conducted.

**Table 1**

*Predictor Multicollinearity*

<b>Predictors</b>	<b>Age</b>	<b>Physical Activity (Mean)</b>	<b>Social Activity (Mean)</b>	<b>Stressor Exposure (Mean)</b>
Age				
Physical Activity (Mean)	0.10*			
Social Activity (Mean)	0.20*	0.23*		
Stressor Exposure (Mean)	0.10*	-0.01	-0.09	

**Note:** \* $p < 0.01$  level (2-tailed)

**Intraclass Coefficient**

Four separate multilevel models were run to examine the relationship between the acquisition of the throw movement, defined as throw success (TS), and corresponding variables. Each separate model represented simultaneous regression analyses that were run concurrently at the within-person level (Level 1) and the between-person level (Level 2; Raudenbush & Bryk, 2002). To determine the within- and between-person variability in throw success an intercept only model was conducted to determine the intraclass correlation (ICC). This preliminary model, also referred to as the fully unconditional model, was

conducted to warrant continuation of multilevel analyses (e.g., Nezlek, 2001; Raudenbush & Bryk, 2002). The ICC allowed for the partition of total variance in throw success (TS) into within-person (intraindividual variability) and between-person differences (interindividual variability). The equations for this unconditional model were:

$$\text{Level 1: } TS_{it} = \beta_{0it} + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + u_{0i}$$

where  $\beta_{0it}$  represented the intercept of participant  $i$ 's throw success on practice bin  $t$  and  $r_{it}$  represented the residual within-person variability in throw success.  $\gamma_{00}$  represented the grand mean of throw success across all sessions and persons and  $u_{0i}$  represented the variance between people in the success of their throws. Results from this analysis indicated that 28.7% of the variability in successful throwing was between people ( $\tau_{00} = 0.0104$ ,  $z = 4.43$ ,  $p < .01$ ) where  $\tau_{00}$  represented the between person variance and 71.3% was within people ( $\sigma^2 = 0.0260$ ,  $z = 21.1$ ,  $p < .01$ ) where  $\sigma^2$  represented the within person variance. Therefore, the fully unconditional model indicated that sufficient variability existed at both levels to warrant further analyses with additional predictors at those levels.

### **Model 1: Practice**

After establishing sufficient variance at both the within-person and between-person levels, an initial model was conducted to determine the effects of practice over time (measured by the previously described bins containing 5 throws each) on throw success. This model addressed the first hypothesis. The equations for Model 1 were:

$$\text{Level 1: } TS_{it} = \beta_{0it} + \beta_{1it} (\text{Practice}) + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + u_{0i}$$

$$\beta_{1i} = \gamma_{10}$$

In Level 1 the intercept,  $\beta_{0it}$ , was defined as the expected level of throw success at practice time 0 for person  $i$ . The slope,  $\beta_{1i}$ , was the expected change in throw success associated with subsequent trials over practice. The error term,  $r_{it}$ , represented a unique random effect associated with person  $i$  (i.e., how much an individual fluctuated in throw success over practice). The individual intercepts ( $\beta_{0it}$ ) and slopes ( $\beta_{0i}$  and  $\beta_{1i}$ ) became the outcome variables in the Level 2 equations, where the average throw success level for the sample at baseline (i.e., when practice = 0) was represented by  $\gamma_{00}$  and the average change over practice for the sample was represented by  $\gamma_{10}$ . The extent to which people varied from the sample average of throw success was represented by  $u_{0i}$ , and the extent to which people varied from the sample slope was represented by  $u_{1i}$ .

Results from this random coefficients regression model (Table 2) showed a significant increase in throw success with increased practice ( $\gamma_{10} = 0.002$ ,  $t = 2.19$ ,  $p = 0.03$ ).

### **Model 2: Age**

To address the second hypothesis that skill acquisition would be affected by the interaction of age and practice a model was conducted examining the main and interaction effects of age and practice for participants. Age was treated as a quantitative continuous variable. The equations for Model 2 were:

$$\text{Level 1: } TS_{it} = \beta_{0it} + \beta_{1it} (\text{Practice}) + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01} (\text{Age}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11} (\text{Age})$$

Here  $\beta_{0i}$  corresponded to the intercept for throw success with the predictors of practice and age. Residual within-person variance for throw success was represented by  $r_{it}$ ,  $u_{0i}$  signified the residual between-person variance in throw success as before, and  $u_{1i}$  was associated with the between-person variance. Beta coefficients were outcome variables in the Level 2 equations. Therefore, negative beta coefficients would suggest that increases in practice and age for a participant would link to a worse performance on the completion of successful throws.  $\gamma_{00}$  represented the average level of throw success at practice time 0 and when age equaled 0,  $\gamma_{01}$  represented the average age differences in throw success,  $\gamma_{10}$  represented the within-person change in throw success over practice, and  $\gamma_{11}$  represented the cross-level interaction of age and practice.

This second model yielded no significant associations between the predictors of age and practice on throw success (Table 2). Therefore, no age differences existed in the acquisition of this motor skill and older adults at different ages exhibited no differences in the acquisition of the motor skill. It is important to note that even practice, which was significant as a sole predictor, became nonsignificantly associated with throw success when controlling for age. It is also noteworthy that age had no effects on the rate of acquisition by participants and even the oldest old were capable of acquiring the observed motor skill.

### **Model 3: Practice, Age, Physical Activity, and Social Activity**

To determine whether physical activity and social activity were associated with skill acquisition regardless of age a model was constructed that examined the effects of mean physical activity (PA) and mean social activity (SA) on throw success over practice while controlling for age. The equations for Model 3 were:

$$\text{Level 1: } TS_{it} = \beta_{0it} + \beta_{1it} (\text{Practice}) + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01} (\text{Age}) + \gamma_{02} (\text{PA}) + \gamma_{03} (\text{SA}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{12} (\text{PA}) + \gamma_{13} (\text{SA})$$

As before,  $\beta_{0i}$ ,  $\beta_{1i}$ ,  $r_{it}$ ,  $u_{0i}$ , and  $u_{1i}$  correspond to previously defined values. Here  $\gamma_{00}$  represented the average level of throw success when all other variables equal 0 and  $\gamma_{01}$  represented again the average age differences in throw success.  $\gamma_{02}$  and  $\gamma_{03}$  represented the average physical activity and social activity differences in throw success, respectively, while controlling for each other and age.  $\gamma_{12}$  and  $\gamma_{13}$  represented the cross-level interactions of physical activity and practice and social activity and practice, respectively, while controlling for the other. The Age X Practice interaction seen in Model 2 was not included in this model as it was non-significant in the previous model.

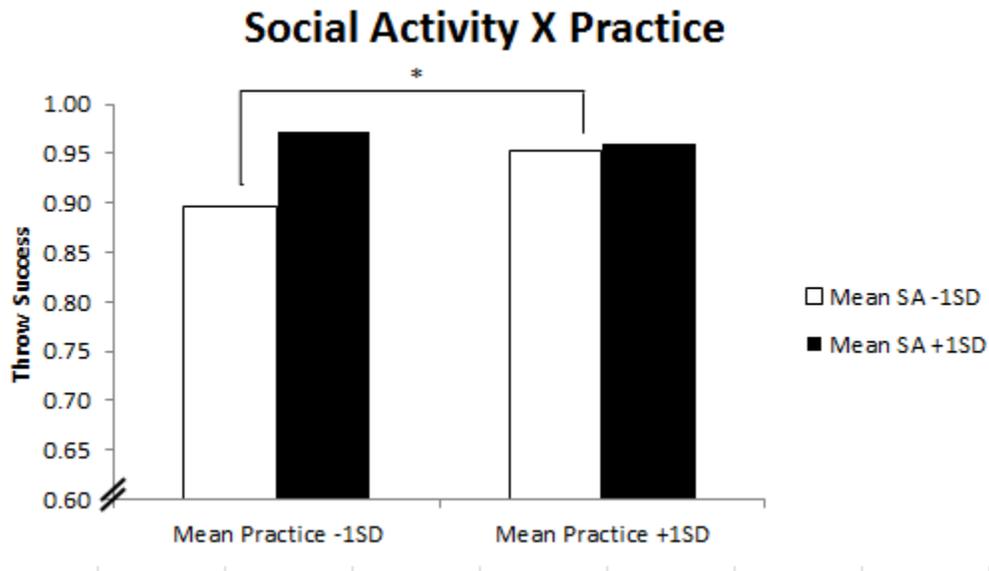
**Table 2***Throw success performance associated with differences in predictive variables*

Predictors	Estimate (SE)			
	Model 1	Model 2	Model 3	Model 4
<i>Fixed effects</i>				
Level 1				
Mean Throw Success (Intercept)	0.85560 (0.01745)*	0.85360 (0.19230)*	0.94510 (0.17110)*	0.87200 (0.03276)*
Practice	0.00209 (0.00095)*	0.01218 (0.01040)	0.00200 (0.00010)*	-0.00049 (0.00179)
Level 2				
Age	-	0.00003 (0.00251)	-0.00119 (0.00226)	-
Age X Practice	-	-0.00013 (0.00014)	-	-
Physical Activity (Mean)	-	-	0.00136 (0.00052)*	-
Social Activity (Mean)	-	-	0.00029 (0.00025)	-
Physical Activity (Mean) X Practice	-	-	-0.00006 (0.00028)*	-
Social Activity (Mean) X Practice	-	-	-0.00004 (0.00001)*	-
Stressor Exposure (Mean)	-	-	-	-0.01176 (0.05946)
Stressor Exposure (Mean) X Practice	-	-	-	0.00397 (0.00327)
<i>Random effects</i>				
Intercept (u)	0.01043	0.01060	0.01053	0.00977
Residual (r)	0.02585	0.02585	0.02590	0.02426

**Note:** \* $p < 0.05$

When the physical and social activity predictors were entered into this model, practice was again a significant predictor of throw success. A main effect existed for mean physical activity minutes, indicating that individuals who were more physically active on average demonstrated more throw success (Table 2). This main effect was not significant for social activity.

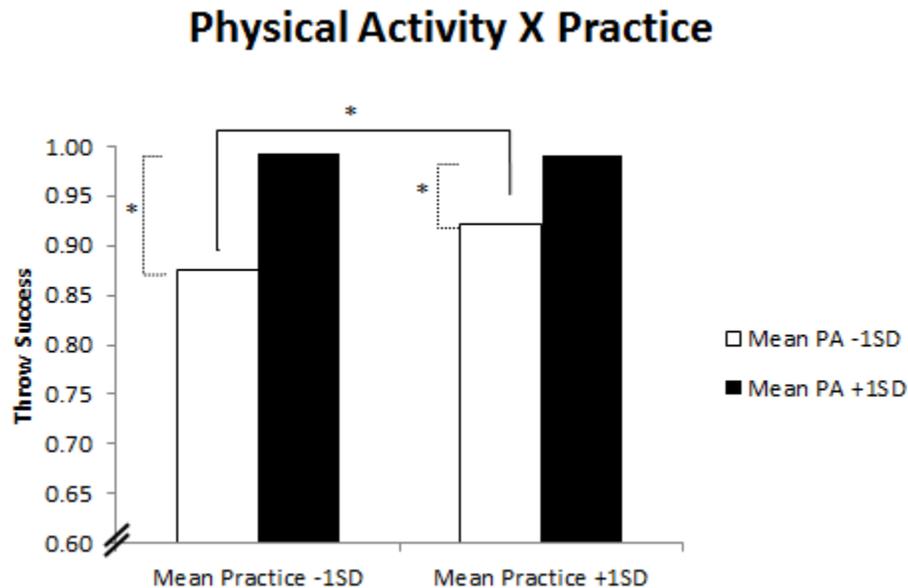
A significant Social Activity X Practice interaction was found. A test of significant contrasts revealed that a significant relationship was demonstrated by less socially active participants. This analysis determined that only individuals with a low average of social activity minutes demonstrated significant increases in performance over practice in throw success, unlike individuals with high social activity. Highly socially active people may have experienced a ceiling effect on their performance and did not show differences in performance over practice (Figure 5).



**Figure 5** - Individuals with lower mean social activity demonstrated significant increases in performance over practice unlike individuals with higher mean social activity. (Note: \*  $p < 0.05$ ).

Much like individuals with low social activity, low physically active people demonstrated significant increases in performance over practice in their acquisition of the throwing skill. Individuals who were more physically active did not show significant changes (Figure 6). Tests of significant contrasts informed researchers that less physically active and more physically active participants were significantly different at both time points. Individuals who were less physically active did show significant increases in performance with practice as determined by a test of simple slopes. Individuals with higher physical activity significantly outperformed lower physically active participants at both early and later times. Although less physically active participants demonstrated significant performance

increases over practice, they did not perform at the higher levels of more physically active participants.



**Figure 6** - There were significant differences between individuals with different levels of physical activity at early and late stages of the study. Individuals with lower physical activity showed significant increases in performance with increased practice. (Note: \*  $p < 0.05$ ).

#### Model 4: Stressor Exposure

The final model addressed the effect of mean stressor exposure on throw success and determined if individuals who had higher average stressor exposure levels were affected in their throw success. To determine if the fourth hypothesis was supported, a model was constructed with mean stress exposure and practice as variables in the equation. The equations for Model 4 were:

$$\text{Level 1: } TS_{it} = \beta_{0it} + \beta_{1it} (\text{Practice}) + r_{it}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01} (\text{Stressor Exposure}) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11} (\text{Stressor Exposure})$$

As before,  $\beta_{0i}$ ,  $\beta_{1i}$ ,  $r_{it}$ ,  $u_{0i}$ , and  $u_{1i}$  correspond to previously defined values. Here  $\gamma_{01}$  represented the average stressor exposure differences in throw success and  $\gamma_{11}$  represented the interaction of mean stressor exposure and practice.

This model yielded no significant associations between the mean stressor exposure and practice on throw success. Therefore, whether an individual experienced more stressors on average or not had no observable significant effect on the acquisition of the motor skill for the individual. There were also no observed significant interaction effects of stressor exposure and practice on throw success. These results are also shown in Table 2. Practice was a nonsignificant predictor of throw success in this model.

## **DISCUSSION**

This research supported the claim that practice was associated with motor skill acquisition and that this relationship holds for older adults above the age of 65 (Crossman, 1959; Newell & Rosenbloom, 1981; Schmidt, 1975; Snoddy, 1926). Contrary to previous findings (Bo, Borza, & Seidler, 2009; Boyd, Vidoni, & Siengsukon, 2008; Harrington, & Haaland, 1992; Kennedy & Raz, 2005; McNay & Willingham, 1998; Perrot & Bertsch, 2007; Pratt, Chasteen, & Adams, 1994; Rodrigue, Kennedy, & Raz, 2005; Shea, Park, Wilde & Braden, 2006; Seidler, 2006; Voelcker-Rehage, 2008), there were no age differences in skill

acquisition across the older adult age demographic. Age had no observable effect on the acquisition and all ages acquired the skill at similar rates. Although the observed skill was simple and relatively easy to acquire, this finding indicates that older adults are as capable at earlier ages of older adulthood and at later ages of older adulthood in the acquisition of a complex, discrete motor skill. This also supports the notion that older adults, regardless of their age, should not be discouraged about their ability to acquire new skills. This finding aligns with previous conclusions about age serving as an index of other physical and cognitive abilities and not being a reliable predictor of performance (Kennedy, Patridge, & Raz, 2008; Schugens, Daum, Spindler, & Birbaumer, 1997; Thorvaldsson, Hofer, & Johansson, 2006).

This research also determined that an individual's level of social activity was related to the rate of motor skill acquisition. Only individuals with lower levels of social activity significantly increased their performance with practice as opposed to their highly socially active counterparts. These results indicated that individuals who spent less time engaged in social activity were able to significantly increase in their skill performance over time. Because ceiling effects might have limited the performance of highly socially active people to demonstrate increased performance in the motor skill, these findings cannot fully support previous research on social activity benefits (Chappell & Funk, 2010; Seeman, Lusignolo, Albert, & Berkman, 2001). Although results might vary with a more difficult skill, this research determined less socially active individuals have initial performances at levels that

allow for them to realize significant gains over time. Therefore, less socially active individuals might perform worse at the beginning but do significantly increase their performance over time to perform at similar levels to highly socially active individuals.

Similar to social activity, physical activity was associated with skill acquisition. It was determined that highly physically active individuals performed significantly better on the motor skill than less physically active individuals. This supports previous work by Etnier, Nowell, Landers, and Sibley (2006) who found this relationship between physical activity and motor skill. Although individuals with lower mean physical activity levels did significantly increase their performance over practice, unlike the highly physically active individuals, they were significantly worse than highly active individuals at both earlier and later points of performance.

It was determined that stressor exposure was not related to throw success for participants. Although previous findings suggest that individuals with higher stressor exposure experience diminished ability in motor performance (McEwen, 2008), there was no significant relationship supported by the current data. This suggests that individuals with low and high levels of stressor exposure acquired and performed the motor skill at similar levels of performance and accuracy.

These findings inform future work in motor skill training by demonstrating the effects of individual differences. Motor skill training programs for the future should take into account whether their individuals are highly physically or socially active in their

development of training protocols. Although future research should focus on how more complex skills are affected by age-related differences, this research suggests that age-related decline for motor skill acquisition might not be as pronounced in older adults as previously assumed. It also of note that older adults were not as affected by stress in their skill acquisition as predicted, which might suggest that older adults are more capable of coping with stressors or that stressor exposure had little to do with motor skill acquisition.

### **Limitations**

This study was limited by a variety of factors. Though the throwing movement was complex, it was not difficult. Participants could master the skill quickly and some demonstrated a high level of performance from the first trials onward. This presumably allowed a ceiling effect on performance.

There also existed significant multicollinearity between predictor variables at Level 2. This multicollinearity could have affected the observation of true relationships between variables and should be controlled in future experiments with the use of constructs or the exclusion of certain predictors.

Another limitation was the variability of time in which participants achieved their first 95 throws. With no minimum or maximum number of throws per level or per session, some participants completed 95 throws on Day 1 whereas some participants took the full 3 days to complete the 95 throws. With typically 23 hour breaks in between sessions, some participants might have experienced lapses in the retention of the skill if they took more than

one day to complete 95 throws. Participants could have also differed in their exposure to certain levels since they were allowed to repeat levels. This could have allowed certain participants to interact with more throw intensive levels with varying levels of requirement and strategy.

One other limitation of the study was the lack of explained variance by the analyses. All four models did not offer high levels of explained within-person and between-person variance. This limits the ability to generalize the study's results and also suggests that other factors were responsible for variance in performance.

### **Future Directions**

As the older adult portion of the population increases in size, society must take note of the needs of older adults and how they vary not just at entrance to older adulthood, but also as the individual transitions through older adulthood. It is vital to explore this topic to understand how development continues throughout older adulthood and how age-related decline, daily activity, and stressors can affect the daily lives of older adults. Learning occurs throughout the lifespan and further research should focus on how older adults acquire more difficult and complex skills.

From this research we can also demonstrate the benefits of an emergent technology in the world of motor skill acquisition: the IGC. Although used as an input and measurement device in this study, it is important to note the increasing value of these technologies in future research and training centered on motor skill training and learning. It is also important to harness this technology because video game technologies are increasingly being used by the

older adult population (Flew & Humphreys, 2005; Vance, McNees, & Meneses, 2009). This study demonstrated the capability of an IGC to serve as an input and training device for future work on developing games requiring physical inputs and influence users to engage in novel motor movements.

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## **APPENDIX**

**APPENDIX A**

**Daily Activity Checklist**

**Place an "X" on the line to right of each activity that you have engaged in the past 24 hours and the approximate duration in minutes.**

<b>Example</b>	<b># of Minutes</b>	
<b>Shopping</b>	X	<b>45</b>

<b>Social Activities</b>	<b># of Minutes</b>	
Eating Out		
Visiting		
Party		
Church		
Dancing		
Service Club		
Choir		
Playing Cards		
Volunteering		
Other (Specify)		

<b>Physical Activities</b>	<b># of Minutes</b>	
Walking		
Bicycling		
Gardening		
Tennis		
Jogging		
Sailing		
Swimming		
Stretching		
Gym		
Yoga		
Other (Specify)		

**Appendix B**

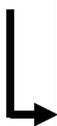
**For questions 1-7, please tell us about stressful experiences that may have happened to you in the past 24 hours. If you check “NO” for a question, skip to the next one. If you check “YES”, then please provide the additional information inside the box before moving on to the next question.**

1. In the last 24 hours, did you have an argument or disagreement with anyone?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. <u>Who</u> was it with? ___ Spouse ___ Your Child(ren) ___ Your Grandchild(ren) ___ Other Family Member ___ Friend ___ Neighbor ___ Co-worker ___ Someone Else _____
b. What was the <u>main topic</u> of the argument? ___ Money/Financial Issues ___ Family obligation/responsibilities ___ Household-related tasks ___ Work /Volunteer-related tasks ___ Scheduling ___ Other _____
c. How <u>stressful</u> was this for you? ___ Not At All    ___ A Little    ___ Somewhat    ___ Very
d. How much <u>control</u> do you feel you had over this situation? ___ None    ___ A Little    ___ Some    ___ A lot
e. Is the issue resolved?    ___ No    ___ Yes

2. In the last 24 hours, did anything happen (other than what you have already mentioned) that you could have argued or disagreed about, but you decided to let it pass?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. Who was it with?

- \_\_\_ Spouse
- \_\_\_ Your Child(ren)
- \_\_\_ Your Grandchild(ren)
- \_\_\_ Other Family Member
- \_\_\_ Friend
- \_\_\_ Neighbor
- \_\_\_ Co-worker
- \_\_\_ Someone Else \_\_\_\_\_

b. What was the main topic of the potential argument or disagreement?

- \_\_\_ Money/Financial Issues
- \_\_\_ Family obligation/responsibilities
- \_\_\_ Household-related tasks
- \_\_\_ Work /Volunteer-related tasks
- \_\_\_ Scheduling
- \_\_\_ Other \_\_\_\_\_

c. How stressful was this for you?

- \_\_\_ Not At All    \_\_\_ A Little    \_\_\_ Somewhat    \_\_\_ Very

d. How much control do you feel you had over this situation?

- \_\_\_ None    \_\_\_ A Little    \_\_\_ Some    \_\_\_ A lot

e. Is the issue resolved?    \_\_\_ No    \_\_\_ Yes

3. In the last 24 hours, did anything happen in your workplace or volunteer setting (other than what you have already mentioned) that most people would consider stressful?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. Who else was involved?

- \_\_\_ No one else
- \_\_\_ Spouse
- \_\_\_ Your Child(ren)
- \_\_\_ Your Grandchild(ren)
- \_\_\_ Other Family Member
- \_\_\_ Friend
- \_\_\_ Co-worker
- \_\_\_ Someone Else \_\_\_\_\_

b. Was there an argument or disagreement?

- \_\_\_ No    \_\_\_ Yes

c. What was the main source of the stress?

- \_\_\_ Income or job security
- \_\_\_ Mistakes
- \_\_\_ Having too much to do
- \_\_\_ Scheduling
- \_\_\_ Other \_\_\_\_\_

d. How stressful was this for you?

- \_\_\_ Not At All    \_\_\_ A Little    \_\_\_ Somewhat    \_\_\_ Very

e. How much control do you feel you had over this situation?

- \_\_\_ None    \_\_\_ A Little    \_\_\_ Some    \_\_\_ A lot

f. Is the issue resolved?    \_\_\_ No    \_\_\_ Yes

4. In the last 24 hours, did anything happen at home (other than what you have already mentioned) that most people would consider stressful?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. <u>Who</u> else was involved?
___ No one else
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____
b. Was there and argument or disagreement?
___ No ___ Yes
c. What was the <u>main source</u> of the stress?
___ Household maintenance
___ Neighborhood concerns
___ Having too much to do
___ Scheduling conflicts
___ Financial issues
___ Pet problems
___ Other _____
d. How <u>stressful</u> was this for you?
___ Not At All ___ A Little ___ Somewhat ___ Very
e. How much <u>control</u> do you feel you had over this situation?
___ None ___ A Little ___ Some ___ A lot
f. Is the issue resolved? ___ No ___ Yes

5. In the last 24 hours, did anything happen to a close friend or relative (other than what you have already mentioned) that turned out to be stressful for you?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. What relation is this person to you?

- Spouse
- Your Child(ren)
- Your Grandchild(ren)
- Other Family Member
- Friend
- Neighbor
- Co-worker
- Someone Else \_\_\_\_\_

b. What happened to this person?

- Financial problem
- Legal problem
- Health or safety issue
- Work-related issue
- Death
- Emotional problem
- Relationship problem
- Other \_\_\_\_\_

c. How stressful was this for you?

- Not At All     A Little     Somewhat     Very

d. How much control do you feel you had over this situation?

- None     A Little     Some     A lot

e. Is the issue resolved?     No     Yes

6. In the last 24 hours, did anything stressful happen (other than what you have already mentioned) regarding your personal health?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. Who else was involved?

- \_\_\_ No one else
- \_\_\_ Spouse
- \_\_\_ Your Child(ren)
- \_\_\_ Your Grandchild(ren)
- \_\_\_ Other Family Member
- \_\_\_ Friend
- \_\_\_ Neighbor
- \_\_\_ Co-worker
- \_\_\_ Someone Else \_\_\_\_\_

b. What was the main problem?

- \_\_\_ Accident
- \_\_\_ Potential accident
- \_\_\_ Medication-related issue
- \_\_\_ Health insurance issue
- \_\_\_ Illness
- \_\_\_ Receiving treatment
- \_\_\_ Problems during health care visit
- \_\_\_ Other \_\_\_\_\_

c. How stressful was this for you?

- \_\_\_ Not At All    \_\_\_ A Little    \_\_\_ Somewhat    \_\_\_ Very

d. How much control do you feel you had over this situation?

- \_\_\_ None    \_\_\_ A Little    \_\_\_ Some    \_\_\_ A lot

e. Is the issue resolved?    \_\_\_ No    \_\_\_ Yes

7. In the last 24 hours, did anything else happen (other than what you have already mentioned) that most people would consider stressful?

\_\_\_\_\_ NO

\_\_\_\_\_ YES

NO YES



a. <u>Who</u> else was involved? ___ No one else ___ Spouse ___ Your Child(ren) ___ Your Grandchild(ren) ___ Other Family Member ___ Friend ___ Neighbor ___ Co-worker ___ Someone Else _____
b. Was there an argument or disagreement? ___ No ___ Yes
c. What was the <u>main source</u> of the stress? ___ Weather ___ Traffic/transportation ___ Political ___ News event ___ Mistakes/confusion ___ Ethical/moral conflict ___ Other _____
d. How <u>stressful</u> was this for you? ___ Not At All ___ A Little ___ Somewhat ___ Very
e. How much <u>control</u> do you feel you had over this situation? ___ None ___ A Little ___ Some ___ A lot
f. Is the issue resolved? ___ No ___ Yes