

Eastern Washington University EWU Digital Commons

EWU Masters Thesis Collection

Student Research and Creative Works

2012

Effect of game activities on manual dexterity in older adults

Jael J. Hagerott

Eastern Washington University

Follow this and additional works at: <http://dc.ewu.edu/theses>



Part of the [Exercise Science Commons](#)

Recommended Citation

Hagerott, Jael J., "Effect of game activities on manual dexterity in older adults" (2012). *EWU Masters Thesis Collection*. 34.
<http://dc.ewu.edu/theses/34>

This Thesis is brought to you for free and open access by the Student Research and Creative Works at EWU Digital Commons. It has been accepted for inclusion in EWU Masters Thesis Collection by an authorized administrator of EWU Digital Commons. For more information, please contact jotto@ewu.edu.

EFFECT OF GAME ACTIVITIES ON MANUAL DEXTERITY IN OLDER ADULTS

A Thesis

Presented To

Eastern Washington University

Cheney, Washington

In Partial Fulfillment of the Requirements

for the Degree

Master of Science

By

Jael J. Hagerott

Spring 2012

THESIS OF Jael J. Hagerott Approved by

_____ DATE _____
Dr. Garth Babcock, Graduate Study Committee

_____ DATE _____
Dr. Roberta Russell, Graduate Study Committee

MASTER'S THESIS

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Eastern Washington University, I agree that the JFK Library shall make copies freely available for inspection. I further agree that copying of this project in whole or in part is allowable only for scholarly purposes. It is understood, however, that any copying or publication of this thesis for commercial purposes, or for financial gain, shall not be allowed without my written permission.

Signature _____

Date _____

ABSTRACT

The purpose of this study was to examine the effects of game activities on manual dexterity performance in older adults. Seventeen participants (mean age 84.3 years) from local assisted- and independent-living retirement communities were randomly assigned to an experimental or control group. Experimental group participants played selected game activities three days per week for an average of 34.6 minutes per game for a six-week period. Both control and experimental group participants completed the Purdue Pegboard as a pre- and post-test assessment of manual dexterity performance. A 2 X 2 repeated measures mixed ANOVA conducted for each subtest of the Purdue Pegboard revealed no significant differences ($p > .05$) between experimental and control groups when considering right hand function, both hands function, combined hand function, and assembly function tasks. However, the control group demonstrated significantly greater left hand function at pre- and post-test. It was concluded that a six-week intervention of game activities did not significantly improve manual dexterity performance in assisted- and independent-living older adults.

ACKNOWLEDGEMENTS

I would like to express my gratitude to my advisors, Dr. Garth Babcock and Dr. Roberta Russell for their support, direction, and tireless efforts during this process. To my parents, Daman and Cindy, an additional debt of gratitude for their unconditional love in all that I have done. And to the Lord for being my strength and shield in this endeavor.

TABLE OF CONTENTS

Abstract	iv
Acknowledgements	v
Chapter I: Introduction	
Operational Definitions	3
Delimitations, Limitations, & Assumptions	5
Purpose Statement	6
Chapter II: Review of Literature	
Manual Dexterity & Activities of Daily Living	9
Effects of Age on Manual Dexterity	11
Interventions	14
Chapter III: Methods and Procedures	
Participants	18
Instrument	19
Procedures	21
Statistical Analyses	25
Chapter IV: Results	
Descriptive Statistics	26
Inferential Statistics	28
Compliance Surveys	29

Chapter V: Discussion

Findings	31
Implications of Findings	35
Limitations and Areas for Further Research	36

Appendices

Appendix A	43
Appendix B	44
Appendix C	45
Appendix D	46
Appendix E	47
Appendix F	48
Appendix G	49

Chapter I: Introduction

In the last century, the older adult population has exponentially increased, and it is expected to continue to expand. It is estimated that the number of adults 60 years of age or older will triple from 606 million in 2000 to over 2 billion by 2050 (United Nations Department of Economic and Social Affairs Population Division, 2002). Thus, by 2050 individuals aged 60 or over will comprise 1 out of every 5 persons of the global population (United Nations Department of Economic and Social Affairs Population Division, 2002).

Aging is often associated with a decline in functional performance (Binder et al., 2002) through decreases in bodily function, cognitive skills, and motor skills (Incel, Sezgin, As, Cimen, & Sahin, 2009). Declines in functional performance negatively impact the ability of older adults to perform activities of daily living (ADL). Wiener, Hanley, Clark, and Nostrand (1990) have defined ADL as “the basic tasks of everyday life, such as eating, bathing, dressing, toileting, and transferring” (p. 1). Hence, the exponential rise in the aging population will increase the number of older adults who experience difficulty in performing ADL as a result of declines in physiological, cognitive, and motor functions.

An important component in the performance of ADL is manual dexterity (Incel et al., 2009). Chan (2000) has defined manual dexterity as “the skillful, controlled manipulation of a tool or any object by the fingers” (p. 537). Components that comprise manual dexterity include handgrip and finger pinch strength (Buchman, Wilson, Bienias, & Bennett, 2005; Desrosiers, Hebert, Bravo, & Rochette, 1999), motor performance capabilities (e.g. finger and hand steadiness) (Kornatz, Christou, & Enoka, 2005), and

tactile spatial acuity (e.g. finger sensation) (De Serres & Fang, 2004; Tremblay, Wong, Sanderson, & Cote, 2003). Shiffman (1992) demonstrated that decreases in manual dexterity performance negatively affect the ability of an older adult to perform ADL such as fastening buttons, writing notes, tying shoelaces, and retrieving objects from bags. In addition, current studies have indicated that decreases in manual dexterity performance have been associated with a decreased ability of older adults to self-medicate (Beckman, Parker, & Thorslund, 2005), read with a magnifying glass (Dickinson & Shim, 2007), and perform basic dental hygiene (Padilha, Hugo, Hilgert, & Dal Moro, 2007). Thus, decline in manual dexterity affects the ability of many older adults to perform ADL and may lead to a decrease in quality of life.

Given the relationship between manual dexterity and performance of ADL in older adults, focus has been placed on interventional methods to improve manual dexterity performance. Interventional methods have included strength training, skilled finger movement training, and game activities. Strength training has been used to improve bilateral grip strength and hand steadiness (Keogh, Morrison, & Barrett, 2007; Kornatz et al., 2005; Olafsdottir, Zatsiorsky, & Latash, 2008) while skilled finger movement training has been used to increase finger coordination, force control, and precision grip in older adults (Ranganathan, Siemionow, Sahgal, & Yue, 2001b). Though strength and skilled finger movement interventions have resulted in improvements in manual dexterity performance, no research currently has examined the effects of game activities on manual dexterity performance in older adults. Previous research has demonstrated that game activities may increase participant motivation, particularly among individuals with disabilities (Szturm, Peters, Otto, Kapadia, & Desai, 2008).

Additionally, research has demonstrated that game activities provide the necessary physical stimulus to improve manual dexterity performance in adults (Neistadt, McAuley, Zecha, & Shannon, 1993; Szturm et al., 2008).

Research has demonstrated that older adults find important meaning in game activities, including mental and physical fitness, continuity and temporal structure, competition, and a sense of belonging afforded by participation (Hoppes, Wilcox, & Graham, 2001). Dominoes, checkers, bingo, and solitaire have been reported as games of most interest to older adults (Hoppes, Hally, & Sewell, 2000). Recent research has also demonstrated that participation in leisure activities (e.g. game activity) improves perceptions of happiness and quality of life among older adults (Onishi et al., 2006).

Thus, research has demonstrated that manual dexterity declines with age and is strongly related to the performance of ADL in older adults (Incel et al., 2009). Numerous interventions have been implemented to increase manual dexterity performance (Keogh et al., 2007; Olafsdottir et al., 2008; Ranganathan, Siemionow, Sahgal, Liu, & Yue, 2001a); however, no studies have examined the relationship between participation in game activities and manual dexterity performance in older adults, despite research that has indicated that game activities provide enhanced motivation in older adults and improved manual dexterity in individuals with disabilities. Therefore, the purpose of this study was to assess the effect of game activities on manual dexterity performance in older adults.

Operational Definitions

Older adult.

In developed regions of the world, older adult has been defined as a person 65 years of age or older; and with the increase in life expectancy, has been further defined

into the following categories: the young-old (65-74 years), the middle-old (75-84), and the oldest-old (85+) (World Health Organization, 2010). For the purposes of this study, an older adult was defined as an individual of 65 or more years of age.

Independent-living residence status.

Independent-living residents were defined as those individuals capable of self-care and not requiring assistance with ADL (Weiner et al., 1990).

Assisted-living residence status.

The National Library of Medicine (2010) has defined assisted-living residents as those who are capable of some self-care but require assistance with some ADL such as transportation, bathing, and medication dispersal.

Functional performance.

Functional performance refers to the ability of an individual to complete basic ADL (Stuck et al., 1999).

Activities of daily living.

Activities of daily living were defined as tasks related to normal daily life, such as eating, bathing, dressing, toileting, and transferring (Wiener et al., 1990).

Manual dexterity.

Manual dexterity can be defined as the ability to manipulate objects and tools with the hands and fingers (Chan, 2000). Manual dexterity can be further delineated into both gross and fine manual dexterity (Desrosiers, Hebert, Bravo, & Dutil, 1995). Gross manual dexterity is related to the performance of less precise tasks with the hands. Fine manual dexterity is related to the performance of more precise manipulations with the fingers.

Game activities.

For the purposes of this study ‘game activities’ referred to the games selected during the pilot study (gin rummy, solitaire, dominoes, pinochle, Rummikub®, and Yahtzee®). These game activities required manipulations with the hands and fingers (Neistadt et al., 1993).

Delimitations

The following conditions were used to delimit this study:

1. The participants of this study included independent and assisted-living older adult residents (Falconer et al., 1991; Padilha et al., 2007; Ranganathan et al., 2001a).
2. The participants of this study were 65 years of age or older (Shiffman, 1992).
3. The participants of this study were physically able to complete card and board game activities; that is, participants did not have a physical condition (e.g. recent surgery, bone/joint disease) that severely impaired their ability to play game activities with the hands (Ranganathan et al., 2001a; Desrosiers et al., 1995).
4. The participants of this study did not regularly participate in the game activities selected in the pilot study (Seidler, 2007; Voelcker-Rehage & Willimczik, 2006).

Limitations

The following conditions were limitations of this study:

The study is limited in its generalizability to individuals that are 65 years of age or older who live in independent and assisted-living retirement communities.

Assumptions

The following were assumptions of this study:

1. It was assumed that participants adhered to the study protocol.
2. It was assumed that data collected on manual dexterity performance was reflective of participants' typical individual performance.

Purpose Statement

The purpose of this study was to examine the effect of game activities on manual dexterity performance in older adults.

Research Hypotheses

The following hypothesis was tested at $p \leq .05$ during this study:

1. Participation in game activities will increase manual dexterity performance in older adults as indicated by performance on the Purdue Peg Board test.

Significance

The older adult population is rapidly increasing and will experience declines in physiological, cognitive, and motor function due to the aging process (Binder et al., 2002; Incel et al., 2009). These declines will negatively affect the ability of older adults to perform ADL (Incel et al., 2009). Manual dexterity and performance of ADL have been shown to be strongly related and as such, interventions are being implemented to increase manual dexterity performance in older adults. Game activities have been shown to increase manual dexterity performance in individuals with disabilities and may provide an enhanced motivational component, making them a potentially effective interventional method in improving manual dexterity performance among older adults. The current

study sought to examine the effects of game activities on manual dexterity performance in older adults.

Chapter II: Review of Literature

The older adult population is expected to exceed two billion individuals by the year 2050, and as such, it is estimated that 1 out of every 5 individuals of the global population will be 60 years of age or older by 2050 (United Nations Department of Economic and Social Affairs Population Division, 2002). The increase in the older adult population has important implications given that aging is associated with an overall decline in functional performance brought about through decreases in physiological, cognitive, and motor functioning (Binder et al., 2002). Decreases in functional performance can impair the ability of older adults to perform activities of daily living (ADL) which often results in a loss of independence and quality of life (Incel et al., 2009).

Manual dexterity, an important component in the performance of ADL, has been shown to decrease in older adults, beginning at approximately 65 years of age (Carmeli, Patish, & Coleman, 2003; Ranganathan et al., 2001b). Decreases in manual dexterity performance associated with aging have been shown to negatively affect the ability of older adults to perform ADL such as fastening buttons, writing notes, tying shoelaces, and retrieving objects from bags (Shiffman, 1992). As such, interventions have focused on increasing manual dexterity performance in older adults. Interventions have included both strength training and skilled finger movement training (Keogh et al., 2007; Kornatz et al., 2005; Ranganathan et al., 2001a). Strength training has been used to improve grip and finger pinch strength and finger and hand steadiness (Keogh et al., 2007; Kornatz et al., 2005; Olafsdottir et al., 2008). Skilled finger movement training has been used to increase finger pinch strength and steadiness and maximum pinch force (Ranganathan et

al., 2001a). Additional research has indicated that game activities can improve manual dexterity performance in individuals with disabilities (Szturm et al., 2008). However, no studies have been conducted examining the effects of card and board game activities on manual dexterity in older adults. Therefore, it was the purpose of this study to assess the effects of card and board game activities on manual dexterity performance in older adults.

Critical topics relevant to the understanding of manual dexterity in older adults include the relationship between manual dexterity and the performance of ADL, the effects of age on manual dexterity, and the current interventional methods used to improve manual dexterity performance. It is the purpose of this chapter to review research relevant to manual dexterity performance as it relates to the effects of aging and to interventional methods that have been utilized in older adults.

Manual Dexterity and Performance of ADL

Individuals use their hands to grasp, hold, and manipulate objects for the purposes of performing everyday tasks such as eating, bathing, and grooming (Incel et al., 2009; Kilbreath & Heard, 2005; Ranganathan et al., 2001a; Shiffman, 1992). Kilbreath and Heard (2005) demonstrated that older adults often use their hands to perform grasping, holding, and manipulative tasks, and that a majority (54%) of tasks are completed bimanually (e.g. with both hands) as opposed to unimanually (29%). Bimanual tasks can be delineated into (a) cooperative symmetrical movements (e.g. carrying a laundry basket), (b) asymmetric but cooperative movements (e.g. pouring a beverage while holding a cup), and (c) separate, unrelated movements (e.g. holding bag with one hand while opening door with other hand) (Kilbreath & Heard, 2005). Kilbreath and Heard noted that the size, shape, and texture of objects used in ADL determine the grasping,

holding, and manipulating maneuvers that older adults perform. Hence, it is evident that older adults perform grasping, holding, and manipulative ADL bimanually, and that the performance of these tasks will be influenced by the size, shape, and texture of an object.

The extent to which an individual can perform manual dexterous tasks plays a significant role in their capacity to perform ADL (Kilbreath & Heard, 2005). Research indicates that older adults experience a decline in manual dexterity which results in difficulty completing ADL (Beckman et al., 2005; Dickinson & Shim, 2007; Padilha et al., 2007; Shiffman, 1992). Shiffman (1992) noted that decreases in manual dexterity performance can impair the ability of older adults to perform tasks such as buttoning a shirt, tying a shoelace, or writing a note. Beckman et al. (2005) found that 14.6% of older adults (77+ years) were unable to open medication bottles due to impairments in manual dexterity performance. Similarly, Dickinson & Shim (2007) demonstrated that decreases in manual dexterity performance resulted in slower reading rates with a magnifying glass among older adults as compared to younger adults. In the same way, declines in manual dexterity have also been associated with an increase in dental plaques on teeth and dentures among older adults which has been speculated to be a causative factor in the increased rates of oral mucosa infections among the older adult population (Padilha et al., 2007).

Therefore, research has demonstrated that decreases in manual dexterity performance due to aging negatively affect the ability of older adults to perform ADL (Shiffman, 1992; Ranganathan et al., 2001b; Incel et al., 2009). Given the importance of manual dexterity in the performance of ADL and the maintenance of independence

among older adults, it is imperative to understand the physiological effects of aging on manual dexterity.

Manual Dexterity and the Effects of Aging

It is generally accepted that manual dexterity performance declines with age. This decline is evident through decreases in components of manual dexterity performance, including handgrip and finger pinch strength (Buchman et al., 2005; Desrosiers et al., 1999; Incel et al., 2009; Ranganathan et al., 2001b), finger and hand steadiness (Kornatz et al., 2005; Ranganathan et al., 2001b), and tactile spatial acuity (De Serres & Fang, 2004).

Handgrip and finger pinch strength, essential in the ability to grip and hold objects, declines with age among older adults. Ranganathan et al. (2001b) found that older adults aged 65-79 years experienced a 30% decrease in grip strength compared to adults aged 20-35 years. Similarly, Incel et al. (2009) found significant differences ($p < .005$) in grip and pinch forces between older adults (mean age of 69.16 ± 3.73) and young adults (mean age of 30.21 ± 5.91). Decreases in handgrip and finger pinch strength have been attributed to age-related sarcopenia, selective loss of fast-twitch muscle fibers, and an incomplete reinnervation of remaining motor units (Ranganathan et al., 2001b).

Research has indicated that while both older adult men and women experience a decline in grip and pinch strength, there is a difference between the sexes concerning the degree of handgrip and finger pinch strength loss. Incel et al. (2009) found that older adult men maintained significantly ($p < .01$) stronger grip and pinch forces for both dominant and non-dominant hands compared to older adult women. This finding was in agreement with that of Buchman et al. (2005) who found that older adult men retained a

greater amount of muscular strength compared to older women. However, it appears that the strength differences between older adult men and women are negated in the oldest-old adults (85+ years) (Buchman et al., 2005). Desrosiers et al. (1999) found that the oldest-old men experience more significant decreases in grip strength (6%) compared to the oldest-old women (3%). Both Buchman et al. and Desrosiers et al. concurred that the greater degree of strength loss in the oldest-old men (85+ years) was due to their initial superior strength levels compared to that of oldest-old women.

Similar to the decreases in handgrip and finger pinch strength, older adults also experience a decrease in finger and hand steadiness. Finger and hand steadiness is an important component of manual dexterity performance as it allows individuals to maintain constant, smooth trajectories when performing fine manipulative tasks (Kornatz et al., 2005). Kornatz et al. (2005) found that finger and hand steadiness begins to decline at approximately 60 years of age. Similarly, Ranganathan, Siemionow, Sahgal, Liu, and Yue (2001a) demonstrated that older adults (65-79 years) experienced greater fluctuations in force production when performing relative and maximal finger pinch steadiness tasks. While both older adult men and women experienced greater decreases in finger and hand steadiness compared to younger adults, older adult women demonstrated significantly greater ($p < .05$) force fluctuations at 5% and 10% of maximum pinch force for both the index-thumb and middle finger-thumb pairings compared to older adult men. Hence, this finding indicates that older adult women experience a greater decline in finger pinch steadiness compared to that of older adult men. Regardless of the differences in finger and hand steadiness between older adult men and women, decreases in finger

and hand steadiness in older adults as a whole have been attributed to greater variability in motor unit discharge rates (Kornatz et al., 2005).

In addition to declines in hand strength and steadiness, older adults also experience a decrease in tactile spatial acuity. Tactile spatial acuity (e.g. finger sensation) refers to the ability of an individual to perceive the spatial features of objects with the fingers (Tremblay et al., 2003) which provides pertinent information as to the degree of force to exert when picking up an object and how to manipulate an object in the hands (Kilbreath & Heard, 2005). De Serres and Fang (2004) demonstrated that older adults (71 ± 3.3 years) required a distance of 3mm to discriminate between two points applied to the fingertip of the thumb or index finger compared to younger adults (25.3 ± 2.4 years) who required a distance less than 2 mm. The authors noted that the increase in the touch/pressure threshold (e.g. indicative of a decrease in tactile spatial acuity) negatively affected the ability of older adults to manipulate objects (De Serres & Fang, 2004). Similar to the results obtained by De Serres & Fang, Tremblay et al. (2003) demonstrated that older adults experienced declines in tactile spatial acuity which impaired their manual dexterity performance. Hence, current research has demonstrated that decreases in tactile spatial acuity associated with old age can negatively affect the ability of individuals to manipulate objects (De Serres & Fang, 2004; Tremblay et al., 2003).

While tactile spatial acuity declines with age, research has indicated that older adult women maintain greater tactile spatial acuity compared to older adult men (Desrosiers, Hebert, Bravo, & Dutil, 1996). Research examining differences in tactile spatial acuity between older adult men and women has demonstrated that older adult women exhibited lower touch/pressure thresholds, indicative of greater tactile spatial

acuity, compared to older men (Desrosiers et al., 1996). A possible explanation as to the differences in tactile spatial acuity between older adult men and women is that older men typically present with more calluses than older women, decreasing their ability to distinguish lower touch/pressure thresholds (Desrosiers et al., 1996). However, while older adult women typically exhibit greater tactile spatial acuity, research has indicated no gender difference in the ability to distinguish moving stimuli compared to static stimuli (Desrosiers et al., 1996).

As evidenced by the findings presented in this section, aging is generally associated with a decrease in manual dexterity performance brought about by decreases in grip and pinch strength, finger and hand steadiness, and tactile spatial acuity. Given the importance of manual dexterity in the performance of ADL and the age-associated decline in manual dexterity, it is important to consider interventions that can negate the effects of aging on manual dexterity in older adults. Hence, the following section will address current interventions that have been used to improve manual dexterity performance.

Interventions

Research has focused on various interventional methods to negate the effects of aging on manual dexterity performance in older adults. Recent studies have demonstrated the efficacy of strength training in improving grip and pinch strength as well as finger and hand steadiness in older adults (Keogh et al., 2007; Kornatz et al., 2005; Olafsdottir et al., 2008). Skilled finger movement training has been found to increase manual dexterity performance in older adults through improvements in pinch and hand steadiness, speed in placing small objects accurately, and motorneuron excitability

(Ranganathan et al., 2001a). Game activities have been used as an intervention method among individuals with disabilities, primarily due to the increased motivational component that game activities provide (Szturm et al., 2008). However, little research has examined the use of game activities as an interventional method in improving manual dexterity performance among older adults.

Game activities have been proven as effective therapeutic tools among the older adult population (Hoppes et al., 2001). The effectiveness of games as a therapeutic tool can be attributed to the meaning that older adults derive from participating in game activities. Hoppes et al. (2001) found that of utmost importance to older adults was the mental and physical fitness afforded by participation in game activities. Older adults also indicated that game activities provided continuity, competition, temporal structure, and a sense of belonging which relieved the change in life circumstances brought about by increasing age.

The functional status of older adults often determines interest in both frequency and mode of game activity played. Hoppes et al. (2000) found that independent living older adults demonstrated the most interest in games (22 games per respondent) followed successively by nursing home residents (12.4 games), adult day-care clients (10 games), and assisted-living residents (9.5 games). When determining game interest, older adults indicated that dominoes (67%), checkers (59%), bingo (58%), bowling (48%), and basketball (40%) were the most favored games. Independent-living older adults favored dominoes (69%) compared to assisted-living residents who favored solitaire, checkers, and bingo (all at 90%). Adult day-care clients indicated that checkers was the most favored game (89%) (Hoppes et al., 2000).

In addition to the meaning older adults derive from participation in game activities, research has also demonstrated that game activities provide the necessary physical stimulus to improve manual dexterity performance (Neistadt et al., 1993; Szturm et al., 2008). Game activities require the use of the shoulder flexors, elbow extensors and flexors, wrist extensors, and three-point pinching maneuvers, all of which are vital components to the performance of manual dexterous activities (Neistadt et al., 1993). Szturm et al. (2008) found that participation in game activities through computer-assisted therapy resulted in increased manual dexterity performances in individuals with hand function limitations. Subjects who suffered chronic motor impairments of the fingers and hands due to cervical spinal injury, stroke, and cerebral palsy participated in selected game activities by manipulating objects of varying size, shape, and tactile surfaces in response to stimuli presented on a computer screen. All individuals demonstrated decreases in performance time on the Jebsen-Taylor Hand Function Test, a standardized measurement of fine and gross motor hand function, indicating improvements in hand function and manual dexterity performance. Given the results of this study, the implementation of game-driven exercise programs for individuals suffering from hand and finger impairments can result in improved finger motion and hand function (Szturm et al., 2008).

Manual dexterity is essential for the performance of ADL (Incel et al., 2009; Ranganathan et al., 2001b), and as such, research has focused on interventional methods to improve manual dexterity performance among older adults. Recent research has focused on strength training as a means for increasing grip strength, pinch strength, and finger and hand steadiness (Kornatz et al., 2005; Olafsdottir et al., 2008). Yet other

findings have indicated the efficacy of skilled-finger movement in improving manual dexterity in older adults (Ranganathan et al., 2001a; Szturm et al., 2008). Game activities have been used to improve manual dexterity performance in individuals with disabilities (Szturm et al., 2008), but despite research that indicates that older adults find great meaning in game activities (Hoppes et al., 2001), no research has focused on game activities as an interventional method to improve manual dexterity performance in the older adult population.

Conclusion

Aging has a detrimental effect on manual dexterity in older adults as seen through decreases in handgrip and finger pinch strength, motor performance capabilities, and tactile spatial acuity. Due to the relationship between ADL and manual dexterity, it is important to implement interventions addressing the various components of manual dexterity performance. Interventions such as strength training and skilled finger movement exercises have been proven effective in increasing manual dexterity in older adults. However, minimal research concerning the effect of game activities on manual dexterity performance in older adults has been conducted, thus providing rationale for the implementation of this study.

Chapter III: Methods

The purpose of this study was to examine the effect of game activities on manual dexterity performance in older adults. A pre-post test randomized group design was incorporated, involving experimental and control groups in which participants in the experimental group participated in game activities during a six-week experimental treatment period. Manual dexterity performance data was collected one week prior to and one week after the intervention period. Topics discussed in this chapter will include participants, instruments, procedures, and design and analysis.

Participants

Participants were recruited from local retirement communities in Spokane, Washington. A convenience sample was used due to the prevalence of older adult retirement communities in Spokane thus providing ample opportunity for participant recruitment. Using normative data from Desrosiers et al. (1995), a power analysis revealed that 18 subjects were needed to achieve a power of 80% (DSS Research, 2010). Inclusion criteria for the selection of participants included (a) independent or assisted-living residence status, (b) older adult men and women ≥ 65 years of age, (c) physically able to perform card or board game activities, (d) no regular participation, defined as participating ≤ 2 times per week, in the game activities selected for this study, and (e) completion of informed consent. Approval from the Eastern Washington University Institutional Review Board was sought and gained prior to the implementation of the pilot and experimental studies.

Research has demonstrated that manual dexterity performance begins to decrease in older adults between the ages of 60 and 70 years (Desrosiers et al., 1996; Ranganathan et al., 2001b) and can be affected by residence status (Falconer et al., 1991; Padilha et al., 2007). The World Health Organization (2010) has defined an older adult as an individual of 65 years of age or more. Given the relationship between aging, residence status, and manual dexterity performance, independent and assisted-living older adults aged 65 years or more were used to examine the effects of game activities on manual dexterity performance (Falconer et al., 1991; Ranganathan et al., 2001a). In addition, research has demonstrated that older adults have the ability to learn and retain new motor skills (Fraser, Li, & Penhune, 2009; Seidler, 2007). Thus, to accurately examine changes in manual dexterity performance, participants unfamiliar with the selected game activities were recruited.

Instruments

Purdue Peg Board.

The Purdue Peg Board (Lafayette Instrument Model 32020) was used to assess manual dexterity performance of the participants. This instrument was chosen over other tests of manual dexterity due to its concise administration procedures, ease of transportation, and ability to measure fingertip dexterity concurrently with finger, arm, and hand function (Hardin, 2002). Normative data has documented unilateral and bilateral task norms according to group and gender (Desrosiers et al., 1995). Research has demonstrated a test-retest reliability of .82 to .91 for three-trial administrations (Tiffin & Asher, 1948). Intra-rater reliability was established prior to the implementation of the pilot study.

The Purdue Peg Board is comprised of four test batteries, and includes the following equipment: an instruction manual, one test board, a collection of pins, collars, and washers, and score sheets to record data. The investigator demonstrated the testing procedure to the participant before the participant completed three practice trials (Tiffin & Asher, 1948). During testing, participants were required to remain in a seated position at a table approximately 30 inches in height (Tiffin & Asher, 1948) to maximize performance capabilities during the testing period (Buffington, MacMurdo, & Ryan, 2006). Using a stopwatch, the investigator began the testing period with the command “Begin,” upon which the participant attempted to place as many pins as possible. The investigator ended the testing period with the command “Stop” upon which the participant ceased performing the test.

The participants completed three trial administrations of each of the four test batteries. Test batteries 1-3 required that the participant place as many pins in respective holes as possible within 30 seconds, first using the right hand (test 1), then the left hand (test 2), and finally both hands simultaneously (test 3). The score for each respective test was the total number of pins placed in the corresponding holes in 30 seconds. The fourth test battery required that the participant use both hands to assemble and place as many pin, washer, collar, and additional washer combinations as possible within 60 seconds. The score was calculated as the total number of combinations completed in 60 seconds. The test batteries were performed in the above listed order, unless the participant was left handed in which the order of the first two test batteries was reversed (Tiffin & Asher, 1948).

Compliance Survey.

A compliance survey was administered to both experimental (Appendix A) and control (Appendix B) groups, respectively, on a weekly basis during the intervention period for the purposes of monitoring participants' compliance with the study protocol. Questions addressed weekly game participation (e.g. "Did you play any card or board games this week?"), frequency of game participation (e.g. "How many times did you play card or board games this week?"), duration of game participation (e.g. "What was the average amount of time you played each game?"), and the specific game activities that were played (e.g. dominoes, checkers, bridge). Experimental group survey questions pertained to game activities played in addition to those that were used for the purposes of the study protocol (e.g. "Did you play card or board games this week when you were not playing games as a part of this study?").

Procedures

A pilot study was conducted prior to the initiation of the experimental study to determine the following three criteria: (a) the game activities to be used during the intervention period, (b) the average amount of time needed to complete the selected game activities, and (c) the number of participants needed to complete each game activity. Participants were recruited from a local retirement community in Spokane, WA. Participants attended an orientation meeting that outlined the purpose, procedures, and potential risks and benefits of the study. At the time of the orientation meeting, participants were provided with an informed consent (Appendix C). The investigator returned within one week to collect the informed consent and begin the pilot study (N = 6).

A collaborative list of possible card and board game activities was identified based on recommendations from local retirement community activities staff and previous research conducted by Hoppes et al. (2000) and placed in a game inventory (Appendix D). Participants were asked to complete the game inventory according to being ‘very interested’ (3 points), ‘somewhat interested’ (1 point), or ‘not interested’ (0 points) in each respective game activity. Data collected from the game inventory resulted in the selection of the six games that received the greatest sum of points. The game activities selected by participants included gin rummy, Rummikub®, dominoes, solitaire, Yahtzee®, and pinochle. The participants then completed the games over a five day period while the investigator recorded the number of hand manipulations per game, the number of participants needed to complete the activity, and the time taken to complete the activity (Table 1).

Table 1. Pilot Study Game Activities

Game	Participants	Time to Completion (in minutes)	Average Manipulations
Solitaire	1	15	93
Yahtzee	2	44	71.5
Pinochle	4	76	73.75
Dominoes	2	53	63
Gin Rummy	2	39	60
Rummikub	3	40	60

Upon completion of the pilot study, the investigator began recruitment procedures for the initiation of the experimental study. The following sections outline the procedures regarding the recruitment, pre-intervention assessment, intervention, and post-intervention assessment used in the experimental study

Recruitment.

The investigator began the recruitment process by contacting local retirement communities, presenting the purpose of the study, and requesting a letter of consent (Appendix E) from each facility stating their agreement to participate in the study. Prior to beginning the study, the investigator posted flyers in visible locations throughout the facility as well as provided flyers (Appendix F) to independent and assisted-living residents within the facility in the manner most often used by the facility in dispersing information to residents. The flyer contained information concerning the inclusion criteria of the study in addition to the date and time for an orientation meeting. The orientation meeting included information outlining the purpose, testing procedures, and possible risks and benefits of the study. At the time of the orientation meeting candidates were provided informed consent (Appendix G). The investigator returned within one week to collect informed consent and to begin randomization of participants into experimental and control groups.

Pre-intervention assessment.

Study participants were randomly selected into either an experimental or control group. The investigator began scheduling times with participants for pre-intervention assessments. Both experimental and control group participants performed the Purdue Peg Board as a pre-assessment of manual dexterity performance. The testing occurred during the week prior to the intervention period and was performed individually in the designated activities room of each respective retirement community.

The investigator, following the guidelines of the manufacturer, manually transcribed participants' scores on the score sheets for each respective test and then

entered the recorded data into Microsoft Excel spreadsheets. Each participant received three trial administrations of the Purdue Peg Board with the mean score for each test battery being recorded for data analysis (Tiffin & Asher, 1948). Due to the nature of the study, participant data was not anonymous, though identities of participants were known only to the primary investigator and were maintained confidential.

All data collected was de-identified and accessible only to the investigator and the respective advising committee.

Intervention

During the six-week intervention, participants in the experimental group participated in the game activities as determined by the pilot study. All game activities were played according to their established rules, respectively. The game activities were performed in groups of 2 to 6 participants, approximately 30 minutes/day, 3 days/week during the six-week period. The frequency and duration of the experimental treatment was based on research conducted by Kornatz et al. (2005) and Ranganathan et al. (2001a) as well as data collected from the pilot study. Participants in the control group were instructed to perform their normal daily activities during the intervention period. Additionally, both experimental and control group participants completed a weekly survey (Appendices A, B) for the purposes of monitoring participant compliance with the study protocol.

Post-intervention assessment.

Post-intervention assessment was conducted one week after completion of the intervention period. Participants in both the experimental and control groups completed

the Purdue Peg Board in the same manner as during the pre-intervention assessment period.

Statistical Analysis

Descriptive statistics were used during data analysis to report the frequency of male and female participants as well as the means and standard deviations of the participants' age. Means and standard deviations were also used to report scores generated from the Purdue Peg Board. A 2 x 2 repeated-measures factorial ANOVA (SPSS, Inc.) was conducted for each subtest of the Purdue Pegboard for the purposes of assessing differences between experimental and control groups as well as assessing within group changes from pre- to post-test. A $p \leq .05$ was considered significant for all statistical analyses.

Chapter IV: Results

The purpose of this study was to examine the effect of game activities on manual dexterity performance in older adults. Eighteen participants (16 females, 2 males) were selected to participate in this study. Participants were selected from two assisted-living retirement communities in Spokane, WA. Eight participants (6 females, 2 males) were selected from Facility 1, while 10 participants (all females) were selected from Facility 2. One participant from Facility 2 was absent at the post-test session, thus resulting in a total of 17 participants included in data analysis. The mean age of the participants was 84.3 years. The demographics, descriptive statistics, and results of the data analysis for this study are presented in this chapter.

Descriptive Statistics

Experimental group.

Nine participants (8 females, 1 male) were randomly selected to the experimental group. Participants were organized into two game playing cohorts, one at each facility. Facility 1 included four participants (3 females, 1 male) while Facility 2 included five participants (all females). The mean age of the group was 84.8 years (*SD* 4.66). Eight participants (7 females, 1 male) indicated right hand dominance, while one participant (female) indicated left hand dominance.

During the six-week intervention, the mean time participants from both cohorts engaged in game playing activity was 34.6 (*SD* 5.6) minutes per session. On average, participants from both cohorts were absent 2.93 (*SD* 2.42) sessions. Game activities played by participants at Facility 1 included Rummikub® (3 sessions), Yahtzee® (11 sessions), and dominoes (4 sessions). Game activities played by participants at Facility 2 included Yahtzee® (13 sessions) and dominoes (5 sessions).

Control group.

Nine participants (8 females, 1 male) were randomly selected to the control group. One female participant was unable to complete post-testing resulting in eight participants included for data analysis. The control group was comprised of four participants from Facility 1 (3 females, 1 male) and four participants (all females) from Facility 2. The mean age of the control group was 83.8 years (*SD* 7.07). Seven participants (6 females, 1 male) indicated right hand dominance while 1 participant (female) indicated left hand dominance.

Purdue Pegboard Results

Participants in both the experimental and control groups completed the Purdue Pegboard as a pre- and post-test measurement of manual dexterity performance. Means and standard deviations of pre-and post-test values are presented in Table 2.

Table 2. *Purdue Pegboard Subtests Results (M ± SD)*

	Pre-Test		Post-Test	
	Exp	Con	Exp	Con
Right Hand	7.2 ± 3.3	9.0 ± 2.9	8.2 ± 2.8	9.6 ± 3.2
Left Hand	7.3 ± 2.0	9.88 ± 2.0	8.0 ± 2.2	10.4 ± 1.4
Both Hands	5.3 ± 2.3	6.7 ± 2.4	5.9 ± 2.5	6.7 ± 2.9
Combined	19.9 ± 7.2	25.6 ± 6.3	22.2 ± 7.0	26.6 ± 6.8
Assembly	12.8 ± 6.3	16.0 ± 6.0	13.9 ± 6.7	16.6 ± 6.3

A 2 X 2 repeated measures mixed ANOVA was conducted for the purposes of assessing differences between experimental and control groups, assessing changes from pre- to post-test, and assessing group over time interactions for each subtest of the Purdue Pegboard. Data indicated that there was no significant difference between experimental and control groups when measuring right hand function ($F = 1.22, p = 0.29$), both hands function ($F = 0.81, p = 0.38$), combined hand function ($F = 2.40, p = 0.18$), and assembly function ($F = 2.40, p = 0.14$) tasks. However, when examining the left hand function task, the control group demonstrated significantly greater function ($F = 7.30, p = 0.02$) compared to the experimental group.

When assessing the main effect of time (pre- to post-test), findings indicated that there was a significant difference ($p < .01$) between pre- and post-test scores for all subtests of the Purdue Pegboard. A percentage change calculation indicated that both experimental and control groups experienced increases in manual dexterity performance. Data demonstrated that experimental group participants experienced increases in right hand function (21.5%), left hand function (14.4%), both hands function (13.8%), combined hand function (14.3%), and assembly function (11.8%) tasks. The control group also experienced increases, although smaller in magnitude, in right hand function (6.5%), left hand function (6.9%), combined hand function (3.8%), and assembly function (4.3%) tasks; however, the both hands function task was found to have decreased (-0.6%) in the control group.

While both experimental and control groups experienced increases in manual dexterity performance from pre- to post-test, an assessment of group over time interaction indicated that there were no significant interactions when examining right hand function

($F = 0.73$, $p = 0.41$), left hand function ($F = 0.15$, $p = 0.70$), both hands function ($F = 2.0$, $p = 0.17$), combined hands function ($F = 3.77$, $p = 0.18$) and assembly function ($F = 2.0$, $p = 0.18$) tasks. Given the lack of significant differences between the groups and the lack of an interaction effect, the improvements in manual dexterity performance evident between pre- and post-test could not be attributed the game playing intervention.

Compliance Surveys

Participants in both the experimental and control group completed a weekly compliance survey for the purposes of assessing compliance with the study protocol. Based on the results of the compliance surveys, it was determined that the experimental group and control group participated in game activities beyond those of the study. The most frequently played games by the experimental group included bingo, computer games, penny millionaire, and solitaire while those of the control group included bingo, bridge, gin rummy, and penny millionaire. The experimental group played these activities 3 to 4 days per week, 50 or more minutes per session where as the control group participated 1 to 2 days per week, 40 minutes per session. While both groups did participate in game activities beyond those of the study, participants were compliant with the study protocol, given that these activities were a part of the participants' normal daily activities prior to the study.

Summary

The purpose of this study was to examine the effects of game activities on manual dexterity performance in older adults. There were no statistically significant differences in Purdue Pegboard subtests between experimental and control groups, with the exception that the control group demonstrated significantly greater left hand function both prior to

and upon completion of the six-week intervention. Analysis of changes in manual dexterity scores over time demonstrated that there was a significant difference between pre- and post-test scores for all subtests of the Purdue Pegboard. Analysis using percentage change between pre- and post-test revealed that both experimental and control groups experienced increases (with exception to the both hands task in the control group) in manual dexterity performance. However, while both groups experienced increases in manual dexterity performance from pre- to post-test, no significant interactions were evident. When examining participant compliance, results indicated that control and experimental group participants did play game activities outside those selected for the study during the six-week intervention with the experimental group participating in outside games twice as often as the control group.

Chapter V: Discussion

The primary finding of this study was that participation in game activities did not significantly improve manual dexterity performance in older adults. While game activities did not significantly improve manual dexterity performance in older adults, an important finding revealed that experimental group participants did experience small but greater increases in manual dexterity performance. The following sections of this chapter will discuss the findings of this study, implications for the older adult population, and limitations and areas for future research.

Manual Dexterity Performance

It is commonly accepted that manual dexterity performance decreases in the older adult population. Research conducted by Kornatz et al. (2005) and Ranganathan et al. (2001a) suggests that decreases in manual dexterity performance in older adults are due to a decline in the function of the neuromuscular system. Kornatz et al. hypothesized that the onset of sarcopenia and subsequent incomplete reinnervation of remaining muscle fibers results in greater muscular force fluctuations thus impairing finger and hand steadiness. This hypothesis was in agreement with the findings of Ranganathan et al. (2001a) who found that older adults demonstrated greater force fluctuations when performing pinch steadiness tasks.

Despite the decrease in manual dexterity performance associated with increasing age, the findings of Keogh et al. (2007), Kornatz et al. (2005), and Ranganathan et al. (2001a) indicate that participation in light load resistance (Keogh et al., 2007; Kornatz et al., 2005) and skilled finger movement (Ranganathan et al., 2001a) training can slow or reverse the rate of decline in the neuromuscular system, resulting in increased manual

dexterity performance among older adults. Ranganathan et al. found that participation in skilled finger movement training increased motor neuron excitability and pinch force steadiness. These findings were similar to those found by Kornatz et al. who demonstrated that light load finger resistance training resulted in decreased motor unit discharge rate variability and decreased fluctuations in muscle force. The results of the present study indicated that participation in game activities may not have had an effect similar to that of skilled finger movement and light load finger resistance training at improving manual dexterity performance in older adults. While the current study did not objectively measure force fluctuations in the hand, it may be hypothesized that the game activities did not induce the necessary stimulus in improving hand steadiness thus resulting in no significant change in manual dexterity performance.

Previous research (Kornatz et al., 2005) has demonstrated that individuals who complete approximately 60 finger repetitions in a 30 minute training session experience improvements in manual dexterity performance. In the current study, participants' frequency of manipulations per session was influenced by two primary factors: one, the game played, and two, the number of participants present per session. The game activities selected for the present study, as determined through pilot study data, included gin rummy, Rummikub®, dominoes, solitaire, Yahtzee®, and pinochle. Frequency of manipulation per participant varied according to the game played, with solitaire having the greatest number of manipulations (93 per participant) and dominoes having the least number of manipulations (63 manipulations per participant in two-person game). Yahtzee® (71.5 manipulations per participant in two-person game) was the most frequently chosen game activity during the six-week intervention. Frequency of

manipulation during the game activity was affected by the number of participants present at each session. Participants were absent on average 2.93 sessions during the six-week study; thus, group sizes ranged from two to six participants on a weekly basis. Hence, in the current study game activities may not have consistently included 60 manipulations per session which might have contributed to the lack of significant change in manual dexterity performance that was evident from pre- to post-test.

While there were no significant differences between experimental and control groups when examining right hand function, both hands function, combined hand function, and assembly function tasks, control group participants performed significantly better than the experimental group on the left hand function task at both pre- and post-test. The control and experimental groups each included one female participant (one selected to the control group, one to the experimental group) who indicated left hand dominance. Given that groups were randomly assigned and that both the control and experimental groups each included a participant with left hand dominance, the significant differences between groups may be attributed to interindividual differences in left hand performance.

Participants in the present study demonstrated lower baseline mean Purdue Pegboard scores when compared to the findings of previous research (Desrosiers et al., 1995; Kornatz et al., 2005). A potential explanation for the divergence with previous research can be attributed to different inclusion criteria utilized by the researchers. While the present study was primarily focused on the assisted-living older adult population, both Desrosiers et al. and Kornatz et al. included only healthy, independent-living older adults in their sample population. Falconer et al. (1991) demonstrated that dependent

older adults (e.g. individuals with assisted-living or health care residence status) have significantly decreased manual dexterity performance compared to independent-living older adults. Given that the present study was comprised primarily of individuals with assisted-living residence status, the difference in manual dexterity scores between the studies may be attributed to inclusion criteria that focused on two different populations of older adults.

Despite the non-significant findings of this study, it is important to note that experimental group participants did experience small increases in manual dexterity performance over the six-week intervention period. Hence, while there was no significant improvement, participants also did not experience a decline in manual dexterity performance. It could be hypothesized that game activities may be an effective intervention in slowing the rate of decline in manual dexterity performance in older adults. This finding could have important implications given that maintaining manual dexterity performance in older adults could result in prolonged independence and increased quality of life in this population (Falconer et al., 1991; Incel et al., 2009; Shiffman, 1992).

Compliance Surveys

Compliance surveys were conducted on a weekly basis to assess participant adherence to the study protocol. Both experimental and control group participants indicated that they played additional card and board games not related to the present study throughout the six-week interventional period. Participants in the experimental group most frequently played these games 3 to 4 days per week, 50 minutes per game activity. Given that these activities were a part of the participants' normal daily activities

prior to the initiation of the study, it can be concluded that participants were compliant with the study protocol.

While participants were compliant with the study protocol, survey data demonstrated that experimental group participants played game activities outside those selected for the study twice as frequently as control group participants. It may be that the experimental group experienced greater, although non-significant increases in manual dexterity performance due to their cumulative game playing activity throughout the six-week intervention, rather than just the game activities played as a part of the study. Regardless, the frequency of games played among the participants in this study would seem to support the hypothesis that older adults do enjoy participating in game activities and therefore would be more likely to engage in therapeutic sessions involving game activities (Hoppes et al., 2001; Szturm et al., 2008).

Implications of Findings

The older adult population is rapidly increasing. Current estimates indicate that individuals aged 60 years or older will comprise 1 out of every 5 persons of the global population by 2050 (United Nations Department of Economic and Social Affairs Population Division, 2002). As mentioned, aging is associated with a decline in manual dexterity performance (Desrosiers et al., 1995; Incel et al., 2009; Ranganathan et al., 2001b). Declines in manual dexterity performance in older adults have been linked to a loss of independence due to an inability of these individuals to perform activities of daily living (Falconer et al., 1991; Shiffman, 1992). Previous research has demonstrated that interventions such as skilled finger movement training (Ranganathan et al., 2001a) and light load finger resistance training (Keogh et al., 2007; Kornatz et al., 2005) can improve

manual dexterity performance in the older adult population. Research has also indicated that game activities have improved manual dexterity in individuals with disabilities (Szturm et al., 2008). However, there is a paucity of research as to the effect of game activities on manual dexterity performance in older adults. In fact, based on what the authors of the present study could find, this study is the only study that has examined the effects of game activities on manual dexterity in this population.

While the primary finding of this study indicated that game activities did not significantly improve manual dexterity performance in older adults, the data revealed that participants did experience small, although non-significant, improvements in their manual dexterity performance. Thus, although the primary finding of this study would seem to imply that game activities are not an effective tool in increasing manual dexterity performance, the small improvements evident in experimental group participants suggest that game activities may be useful in slowing the rate of decline in manual dexterity performance that is often present in the older adult population. While this study did not find any significant improvement in manual dexterity performance as a result of a six-week game playing intervention, there were several limitations that if addressed in future research, may indicate that game activities can significantly improve manual dexterity performance.

Limitations and Areas for Further Research

This study was conducted within a six-week intervention period, due both to maintenance of participant interest and for manageability. It is possible that researchers would see greater improvements in manual dexterity performance with an increase in the duration of the intervention period. Future research may also find greater improvements

in manual dexterity performance by increasing the number of manipulations that participants perform during the game activity sessions. The non-significant findings were also likely due to the small sample size utilized in the study. A power analysis revealed that a sample size of 18 participants would be needed to attain a power of 80%; however, due to difficulty obtaining participants from additional retirement communities and participant attrition during the study, the sample size used for data analysis was reduced to 17 participants. Further research should include larger sample sizes so that results are reflective of the greater population of older adults. Finally, this study primarily included females, and individuals who were right-hand dominant. To be able to generalize to a greater population, future studies should include greater numbers of male participants and participants who are left-hand dominant.

Summary

The purpose of this study was to examine the effects of game activities on manual dexterity performance in older adults. The present study found that a six-week period of game activities did not significantly improve manual dexterity performance. However, experimental group participants did demonstrate slight, although non-significant, improvements in manual dexterity performance which suggests that game activities may be an effective intervention in slowing the rate of decline in manual dexterity that is often present in the older adult population. Given that this study was limited both in scope and size, future studies with altered parameters may find that game activities significantly improve manual dexterity performance in older adults.

References

- Beckman, A.G.K., Parker, M.G., & Thorslund, M. (2005). Can elderly people take their medicine? *Patient Education and Counseling*, *59*, 186-191.
- Binder, E.F., Schechtman, K.B., Ehsani, A.A., Steger-May, K., Brown, M., Sinacore, D.R., ...Hollooszy, J.O. (2002). Effects of exercise training on frailty in community-dwelling older adults: Results of a randomized, controlled trial. *Journal of the American Geriatrics Society*, *50*, 1921-1928.
- Buffington, C. W., MacMurdo, S. D., & Ryan, C. M. (2006). Body position affects manual dexterity. *Anesthesia & Analgesia*, *102*, 1879-1883.
- Buchman, A.S., Wilson, R.S., Bienias, J.L., Bennett, D.A. (2005). Gender differences in upper extremity motor performance of older persons. *Geriatrics and Gerontology International*, *5*, 59-65. doi:10.1111/j.1447-0594.2005.00266.x
- Carmeli, E., Patish, H., & Coleman, R. (2003). The aging hand. *The Journals of Gerontology*, *58A*(2), 146-152.
- Chan, T. (2000). An investigation of finger and manual dexterity. *Perceptual and Motor Skills*, *90*, 537-542.
- De Serres, S.J., & Fang, N.Z. (2004). The accuracy of perception of a pinch grip force in older adults. *Canadian Journal of Physiology and Pharmacology*, *82*, 693-701. doi:10.1139/Y04-085
- Desrosiers, J., Hebert, R., Bravo, G., & Dutil, E. (1995). The Purdue Pegboard Test: normative data for people aged 60 and over. *Disability and Rehabilitation*, *17*(5), 217-224.

- Desrosiers, J., Hebert, R., Bravo, G., & Dutil, E. (1996). Hand sensibility in healthy older people. *Journal of the American Geriatrics Society, 44*, 974-978.
- Desrosiers, J., Hebert, R., Bravo, G., & Rochette, A. (1999). Age-related changes in upper extremity performance of elderly people: A longitudinal study. *Experimental Gerontology, 34*(3), 393-405.
- Dickinson, C., & Shim, M. (2007). The influence of manual dexterity on reading speed with hand-held magnifier. *Investigative Ophthalmology & Visual Science, 48*, 4368-4374.
- DSS Research. (2010). *Researcher's Toolkit*. Retrieved from www.dssresearch.com/toolkit/sscalc/size.asp
- Falconer, J., Hughes, S. L., Naughton, B. J., Singer, R., Chang, R. W., & Sinacore, J. M. (1991). Self report and performance-based hand function tests as correlates of dependency in the elderly. *Journal of the American Geriatrics Society, 39*, 695-699.
- Fraser, S. A., Li, K. Z. H., & Penhune, V. B. (2009). A comparison of motor skill learning and retention in younger and older adults. *Experimental Brain Research, 195*, 419-427. doi:10.1007/s00221-009-1806-5
- Hardin, M. (2002). Assessment of hand function and fine motor coordination in the geriatric population. *Topics in Geriatric Rehabilitation, 18*(2), 18-27.
- Hoppes, S., Hally, C., & Sewell, L. (2000). An interest inventory of games for older adults. *Physical & Occupational Therapy in Geriatrics, 18*(2), 71-83. doi:10.1300/J148v18n02_05

- Hoppes, S., Wilcox, T., & Graham, G. (2001). Meaning of play for older adults. *Physical and Occupational Therapy in Geriatrics, 18*(3), 57-68.
doi:10.1300/J148v18n03_04
- Incel, N.A., Sezgin, M., As, I., Cimen, O.B., & Sahin, G. (2009). The geriatric hand: Correlation of hand-muscle function and activity restriction in elderly. *International Journal of Rehabilitation Research, 32*, 213-218.
doi:10.1097/MRR.0b013e3283298226
- Keogh, J.W., Morrison, S., & Barrett, R. (2007). Strength training improves the tri-digit finger-pinch force control of older adults. *Archives of Physical Medicine & Rehabilitation, 88*, 1055-1063.
- Kilbreath, S.L., & Heard, R.C. (2005). Frequency of hand use in healthy older persons. *Australian Journal of Physiotherapy, 51*, 119-122.
- Kornatz, K.W., Christou, E.A., & Enoka, R.M. (2005). Practice reduces motor unit discharge variability in a hand muscle and improves manual dexterity in old adults. *Journal of Applied Physiology, 98*, 2072-2080.
doi:10.1152/jappphysiol.01149.2004
- National Library of Medicine. (2010). *MedlinePlus: Assisted Living*. Retrieved from <http://www.nlm.nih.gov/medlineplus/assistedliving.html>
- Neistadt, M.E., McAuley, D., Zecha, D., & Shannon, R. (1993). An analysis of a board game as a treatment activity. *American Journal of Occupational Therapy, 47*(2), 154-160.
- Olafsdottir, H.B., Zatsiorsky, V.M., & Latash, M.L. (2008). The effects of strength training on finger strength and hand dexterity in healthy elderly individuals.

Journal of Applied Physiology, 105, 1166-1178.

doi:10.1152/jappphysiol.00054.2008

Onishi, J., Masuda, Y., Suzuki, Y., Gotoh, T., Kawamura, T., & Iguchi, A. (2006). The pleasurable recreational activities among community-dwelling older adults.

Archives of Gerontology and Geriatrics, 43, 147-155.

Padilha, D.M.P., Hugo, F.N., Hilgert, J.B., & Dal Moro, R.G. (2007). Hand function and oral hygiene in older institutionalized Brazilians. *Journal of the American Geriatrics Society*, 55, 1333-1338.

Journal of the American Geriatrics Society, 55, 1333-1338.

Ranganathan, V.K., Siemionow, V., Sahgal, V., Liu, J.Z., & Yue, G.H. (2001a). Skilled finger movement exercise improves hand function. *Journal of Gerontology: Medical Sciences*, 56A, M518-M522.

Journal of Gerontology: Medical Sciences, 56A, M518-M522.

Ranganathan, V.K., Siemionow, V., Sahgal, V., & Yue, G.H. (2001b). Effects of aging on hand function. *Journal of the American Geriatrics Society*, 49, 1478-1484.

doi:10.1046/j.1532-5415.2001.4911240.x

Seidler, R. D. (2007). Older adults can learn to learn new motor skills. *Behavioural Brain Research*, 183, 118-122.

Behavioural Brain Research, 183, 118-122.

Shiffman, L. M. (1992). Effects of aging on adult hand function. *American Journal of Occupational Therapy*, 46, 785-792.

American Journal of Occupational Therapy, 46, 785-792.

Stuck, A.E., Walthert, J.M., Nikolaus, T., Bula, C.J., Hohmann, C., & Beck, J.C. (1999).

Risk factors for functional status decline in community-living elderly people: A systematic literature review. *Social Science & Medicine*, 48, 445-469.

- Szturm, T., Peters, J.F., Otto, C., Kapadia, N., & Desai, A. (2008). Task-specific rehabilitation of finger-hand function using interactive computer gaming. *Archives of Physical Medicine and Rehabilitation, 89*, 2213-2217.
- Tiffin, J., & Asher, E. J. (1948). The Purdue Pegboard: Norms and studies of reliability and validity. *Journal of Applied Psychology, 32*, 234-247.
- Tremblay, F., Wong, K., Sanderson, R., & Cote, L. (2003). Tactile spatial acuity in elderly persons: assessment with grating domes and relationship with manual dexterity. *Somatosensory & Motor Research, 20*(2), 127-132.
doi:10.1080/0899022031000105154
- United Nations Department of Economic and Social Affairs Population Division. (2002). World population ageing: 1950-2050. Retrieved from <http://www.un.org/esa/population/publications/worldageing19502050/>
- Voelcker-Rehage, C., & Willimczik, K. (2006). Motor plasticity in a juggling task in older adults—a developmental study. *Age and Ageing, 35*, 422-427.
doi:10.1093/ageing/afl025
- Wiener, J. M., Hanley, R. J., Clark, R., & Van Nostrand, J. F. (1990). Measuring the activities of daily living: Comparisons across national surveys. *U.S. Department of Health and Human Services Office of the Assistant Secretary for Planning and Evaluation Office of Disability, Aging, and Long-Term Care Policy*, 1-18.
- World Health Organization. (2010). *Definition of an older or elderly person*. Retrieved from <http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html>

Appendix A

Control Group Weekly Compliance Survey

1) Did you play any card or board games this week? (Please circle)

YES	NO
-----	----

IF YOU ANSWERED YES, PLEASE COMPLETE QUESTIONS 2-4.

2) How many times did you play card or board games this week? (Please circle)

1 to 2 times	3 to 4 times	5 or more times
--------------	--------------	-----------------

3) What was the average amount of time you played each game? (Please circle)

10 minutes	20 minutes	30 minutes	40 minutes	50 or more minutes
------------	------------	------------	------------	--------------------

4) What games did you play this week? (Please circle)

If your game is not listed, please write it in the blank space provided.

Bingo	Bridge	Checkers
Concentration	Dominoes	Poker
Rummy	Scrabble	Solitaire
Old Maid	Yahtzee	

Appendix B

Experimental Group Weekly Compliance Survey

- 1) Did you play card or board games this week when you were not playing games as a part of this study? (Please circle)

YES	NO
-----	----

IF YOU ANSWERED YES, PLEASE COMPLETE QUESTIONS 2-4.

- 2) How many times did you play these additional card and/or board games this week? (Please circle)

1 to 2 times	3 to 4 times	5 or more times
--------------	--------------	-----------------

- 3) What was the average amount of time you played each game? (Please circle)

10 minutes	20 minutes	30 minutes	40 minutes	50 or more minutes
------------	------------	------------	------------	--------------------

- 4) What additional games did you play this week? (Please circle)
If your game is not listed, please write it in the blank space provided.

Bingo	Bridge	Checkers
Concentration	Dominoes	Poker
Rummy	Scrabble	Solitaire
Old Maid	Yahtzee	

Appendix C
Consent Form
Pilot Study

Principal Investigator: Jael Hagerott, Graduate Student, Physical Education, Health, and Recreation Department, (509) 251-3649

Responsible Project Investigator: Dr. Garth Babcock, Associate Professor and ATEP Clinical Coordinator, Physical Education, Health, and Recreation Department, (509) 359-2427

This study is being conducted In Partial Fulfillment of the Requirements for the Degree Master of Science.

Purpose and Benefits

The purpose of this study is to find out what types of card and board games you are most interested in playing. This study will allow the investigator to select card and board game activities that are of most interest to older adults.

Procedures

If you decide to participate in this study, you will be asked to fill out a game interest inventory. You will be given a list of games and will place a check mark in the column that most accurately represents your interest in each game activity (e.g. 'very interested'; 'somewhat interested'; 'not interested'). After filling out the form, you will play the five games that were of most interest to everybody in the study. You will play one game per day for a five day period. Each game activity should take no more than 35 minutes to complete.

Risk, Stress or Discomfort

There are minimal risks with this study. It is possible that you may experience sore muscles or joints if you are not used to playing card or board games.

Other Information

Your participation will be confidential during this study; that is, the investigator will be able to associate the data with participants. You will not be offered any form of inducement (e.g. money, free services) to participate in this study. You are free to withdraw from this study at any time without penalty.

Signature of Principal Investigator

Date

The study described above has been explained to me, and I voluntarily consent to participate in this research study. I have had an opportunity to ask questions. I understand that by signing this form I am not waiving my legal rights. I understand that I will receive a signed copy of this form.

Signature of Subject

Date

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact Ruth Galm, Human Protective Administrator @ (509) 359-6567 or rgalm@ewu.edu.

Appendix D

Game Inventory

Instructions

We would like to know what card and board game activities you are most interested in playing. Please place a check mark in the column that reflects your interest for each respective game activity. If there are other card and board games that you are interested in playing but that are not listed in this chart, please write them in the space provided under *Other games*. You will also need to write the number of times you play each game activity every week.

	I'm very interested	I'm somewhat interested	I'm not Interested	# of times I play this game in a week
Backgammon				
Bridge				
Checkers				
Chinese checkers				
Chess				
Concentration				
Connect Four				
Cribbage				
Dominoes				
Pinochle				
Poker				
Scrabble				
Skip-bo				
Solitaire				
Sorry				
Spades				
Triominoes				
Rummy				
Uno				
Yahtzee				
<i>Other Games:</i>				

Appendix E

Example Facility Letter of Agreement

To Whom It May Concern,

Riverview Retirement Community has been presented with all necessary information regarding the proposed research study. After careful review of the study methods and procedures, Riverview Retirement Community has given consent to Ms. Jael Hagerott to address residents within our facility for means of potentially volunteering in the proposed research study. Upon completion of the recruitment process, Riverview Retirement Community has given consent to Ms. Hagerott to perform the specified study procedures within the designated activities room at the facility. We understand that if at any time, circumstances necessitate a change in procedures, Ms. Hagerott will fully inform us as to the nature of the changes. Riverview Retirement Community further understands that it is free to withdraw at any time during the course of the study without penalty or repercussion.

Signature of Facility Representative

Date

Signature of Investigator

Date

Questions? Please contact:

Jael Hagerott (phone: 509-251-3649; email: jael.hagerott@eagles.ewu.edu) or

Dr. Garth Babcock (phone: 509-359-2427; email: gbabcock@ewu.edu).

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact Ruth Galm, Human Protective Administrator @ (509) 359-6567 or rgalm@ewu.edu.

Volunteers Needed!

Do you enjoy playing games? I am a graduate student at Eastern Washington University and am looking at how game activities affect the ability of older adults to use their hands.

To be a part of this study, you must...

- Be an independent or assisted-living resident
- 65 years of age or older
- Physically able to complete card and board games
- Not already playing card or board games 2x/week or more

If you think that you meet the criteria to be in this study, and are interested in participating, join us for an informational meeting on...

**(Day), (Month, Date) in the (Location)
at (Time)**

Questions?

Contact: Jael Hagerott

(509) 251-3649 or jael.hagerott@eagles.ewu.edu

Appendix G
Experimental Study Consent Form
Effects of game activities on manual dexterity performance in older adults.

Principal Investigator: Jael Hagerott, Graduate Student, Physical Education, Health, and Recreation Department, (509) 251-3649

Responsible Project Investigator: Dr. Garth Babcock, Associate Professor and ATEP Clinical Coordinator, Physical Education, Health, and Recreation Department, (509) 359-2427

This study is being conducted In Partial Fulfillment of the Requirements for the Degree Master of Science.

Purpose and Benefits

This purpose of this study is to find out if playing card and board games can improve your ability to manipulate objects with your hands (such as fastening buttons or tying your shoelaces). This study is being conducted as research has shown that older adults experience more difficulty performing manipulative tasks with their hands, and therefore, may benefit from an activity such as card and board games.

Procedures

If you decide to participate in this study, you will be picked by chance to be in one of two groups, a game-playing group or a control group. If you are selected to the game playing group, you will be playing card and board games 20-30 minutes/day, 3 days/week, for a total of 6 weeks. If you are selected to the control group, you will be asked to continue with your normal daily activities during the 6 week period. Regardless of your group selection, you will be performing the Purdue Peg Board, a test that will measure how fast you can pick up and place small objects with your hands. You will perform this test three times during this study as a pre-, mid-, and post- assessment of your hand function. Additionally, you will be asked to fill out a weekly survey during the 6 week period to assess your compliance with the study protocol.

Risk, Stress or Discomfort

There are minimal risks with this study. It is possible that you may experience sore muscles or joints if you are not used to playing card or board games.

Other Information

Your participation will be confidential during this study; that is, the investigator will be able to associate your name with your data from the Purdue Peg Board. You will not be offered any form of inducement (e.g. money, free services) to participate in this study. You are free to withdraw from this study at any time without penalty.

Signature of Principal Investigator

Date

The study described above has been explained to me, and I voluntarily consent to participate in this research study. I have had an opportunity to ask questions. I understand that by signing this form I am not waiving my legal rights. I understand that I will receive a signed copy of this form.

Signature of Subject

Date

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact Ruth Galm, Human Protective Administrator @ (509) 359-6567 or rgalm@ewu.edu.

VITA

Name: Jael J. Hagerott

Education:

Master of Science, Physical Education, Eastern Washington University, 2012.

Bachelor of Arts, Whitworth University, 2007.

Honors and Awards:

Summa Cum Laude, Whitworth University, 2007.

United States Soccer Federation National 'C' License, 2012.

Professional Experience:

Head Coach, Women's Soccer. Whitworth University, Spokane, Washington, 2011-present.

Director of Coaching—Recreation. Inland Empire Youth Soccer Association, Spokane, Washington, 2010-2011.

Assistant Coach, Women's Soccer. Whitworth University, Spokane, Washington, 2008-2011.

Premier Youth Soccer Coach. Spokane Shadow Youth Soccer Club, Spokane, Washington 2007-2009.