



**The Short-term Effects of a Sports Stacking  
Intervention on the Cognitive and Perceptual Motor  
Functioning In Geriatrics**

By

**Kamantha Moodley**

**Supervisor: Dr. Rowena Naidoo**

Submitted in fulfilment for the degree of Master of Sport Science

University of KwaZulu-Natal

School of Health Sciences

Discipline of Biokinetics, Exercise and Leisure Sciences

January 2016

## DECLARATION

I, Ms Kamantha Moodley (Student number: 211558955), declare that:

1. The research reported in this dissertation, except where otherwise indicated, is my original research.
2. This dissertation has not been submitted for any degree or examination at any other university.
3. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
4. This dissertation does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
  - a. Their words have been re-written but the general information attributed to them has been referenced.
  - b. Where the exact words have been used, then their writing has been placed in italics and inside quotation marks, and referenced.
5. This dissertation does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the source detailed in the dissertation and references sections.

Signed:



---

Date:

7 January 2016

---

## ACKNOWLEDGEMENTS

I wish to express my sincere gratitude and appreciation to the following people and institutions:

- To **God** - for his strength, grace and guidance.
- My **parents and sister** - for their sacrifices, endless support, words of wisdom and constant motivation throughout this journey.
- My **aunt, uncle and cousins** – for all the support, pick me ups and motivation you have given me throughout this year.
- My **grandparents** – for the love and for always believing in me.
- My **boyfriend (Sumeshan)** - for all the love, patience, encouragement and support you have given me.
- My **supervisor** - for the inspiration, encouragement and guidance throughout this project. Your mentorship, motivation and belief in me is deeply appreciated.
- My **friends and fellow masters students** in the **Discipline of Biokinetics, Exercise and Leisure Sciences**, namely Travino Kisten, Hayley Velayudam, Varnika Reddy, Ebrahim Meer and Fathima Meer – for their support and help during this study.
- **Residents of The Association for the Aged (TAFTA)**- thank you for participating in the study. Your courage and will to persevere, in spite of your age, will never be forgotten.
- The **University of KwaZulu-Natal** - for affording me the opportunity to undertake this study and for providing an environment conducive for me to attain my goals.

## TABLE OF CONTENTS

DECLARATION.....	ii
ACKNOWLEDGEMENTS .....	iii
TABLE OF CONTENTS .....	iv
LIST OF FIGURES.....	vii
LIST OF APPENDICES.....	viii
LIST OF ABBREVIATIONS.....	ix
ABSTRACT .....	10
CHAPTER ONE .....	12
INTRODUCTION.....	12
1.1. INTRODUCTION.....	12
1.2. PROBLEM STATEMENT .....	15
1.3. AIM.....	16
1.4. OBJECTIVES .....	16
1.5. HYPOTHESES.....	16
1.6. SIGNIFICANCE.....	16
1.7. CONCLUSION .....	17
CHAPTER TWO.....	18
LITERATURE REVIEW.....	18
2. INTRODUCTION .....	18
2.1. INTERVENTIONS TO IMPROVE MOTOR AND COGNITIVE FUNCTIONING 18	
2.2. BALANCE.....	21
2.3. HAND EYE COORDINATION .....	26
2.4. REACTION TIME .....	28
2.5. MEMORY .....	31
2.6. QUALITY OF LIFE .....	35
2.7. SPORTS STACKING HISTORY AND STUDIES .....	37
2.8. CONCLUSION .....	40
CHAPTER THREE.....	41
METHODOLOGY.....	41
3.1 INTRODUCTION.....	41

3.2	RESEARCH DESIGN.....	41
3.3	POPULATION AND SAMPLE SELECTION .....	41
3.4	PROCEDURES AND PROTOCOL.....	42
3.5	INSTRUMENTATION .....	45
3.6	CONCLUSION .....	50
	CHAPTER FOUR.....	51
	MANUSCRIPT .....	51
	ABSTRACT .....	52
	INTRODUCTION.....	52
	METHOD.....	55
	STATISTICAL ANALYSIS .....	59
	RESULTS.....	60
	SPORTS STACKING TIMES .....	62
	DISCUSSION.....	63
	ACKNOWLEDGMENTS.....	66
	DECLARATION OF CONFLICTING INTEREST .....	66
	FUNDING.....	66
	REFERENCES.....	66
	CHAPTER FIVE .....	72
	CONCLUSION AND RECOMMENDATIONS.....	72
5.1.	INTRODUCTION.....	72
5.2.	CONCLUSION .....	72
5.3.	RECOMMENDATIONS .....	73
5.4.	LIMITATIONS OF THE STUDY.....	73
	REFERENCES.....	74
	APPENDICES .....	91
	APPENDIX 1: GATEKEEPER'S PERMISSION LETTER.....	91
	APPENDIX 2: GATEKEEPER'S LETTER.....	92
	APPENDIX 3: ETHICAL APPROVAL LETTER .....	93
	APPENDIX 4: FLYER.....	95
	APPENDIX 5: PARTICIPATION INFORMED CONSENT AND CONSENT FORM..	96
	APPENDIX 6: SPORTS STACKING INTERVENTION.....	100
	APPENDIX 7: SPORTS STACKING RECORDING SHEET .....	102

APPENDIX 8: BODY MASS INDEX RECORDING SHEET .....	103
APPENDIX 9: PLATE TAPPING RECORDING SHEET .....	105
APPENDIX 10: SHORT ORIENTATION MEMORY CONCENTRATION TEST (SOMCT).....	107
APPENDIX 11: SOMCT RECORDING SHEET .....	108
APPENDIX 12: SHARPENED ROMBERG RECORDING SHEET.....	110
APPENDIX 13: REACTION TIME RECORDING SHEET .....	112
APPENDIX 14: LAWTON'S INSTRUMENTAL ACTIVITIES OF DAILY LIVING (IADL) QUESTIONNAIRE .....	114
APPENDIX 15: LAWTON'S IADL RECORDING SHEET .....	115

## LIST OF FIGURES

<b>FIGURES</b>		<b>PAGE NO.</b>
Figure 2.1	Components of balance control	25
Figure 2.2	Different Indirect Memory Tests	32
Figure 2.3	Different Direct Memory Tests	33
Figure 2.4	Speed Stacks cups	38
Figure 3.1	3-3-3 sequence	44
Figure 3.2	3-6-3 sequence	44
Figure 3.3	The Cycle	44
Figure 3.4	BMI Classification Table	46
Figure 3.5	Plate Tapping Board	47
Figure 3.6	Feet together	48
Figure 3.7	Tandem	48
Figure 3.8	Semi-Tandem	48
Figure 3.9	Position Speed Test	49



## LIST OF APPENDICES

<b>APPENDICES</b>		<b>PAGE NO.</b>
Appendix 1	Gatekeeper's permission letter	91
Appendix 2	Gatekeeper's letter	92
Appendix 3	Ethical approval letter	93
Appendix 4	Flyer	95
Appendix 5	Participation informed consent and Consent forms	96
Appendix 6	Sports Stacking Intervention	100
Appendix 7	Sports Stacking Recording Sheet	102
Appendix 8	Body Mass Index (BMI) Recording Sheet	103
Appendix 9	Plate tapping Recording Sheet	105
Appendix 10	Short Orientation Memory Concentration Test (SOMCT)	107
Appendix 11	SOMCT Recording Sheet	108
Appendix 12	Sharpened Romberg Test Recording Sheet	110
Appendix 13	Reaction Time recording Sheet	112
Appendix 14	Lawton's Instrumental Activities of Daily Living (IADL) Questionnaire	114
Appendix 15	Lawton's IADL Questionnaire Recording Sheet	115

## **LIST OF ABBREVIATIONS**

ACTIVE – Advanced Cognitive Training for Independent and Vital Elderly

EEG – Electroencephalogram

fMRI – Functional Magnetic Resonance Imaging

IADL – Instrumental Activities of Daily Living

IQ – Intelligence Quotient

MRI – Magnetic Resonance Imaging

NBC – Network Broadcasting Company

PET – Position Emission Tomography

PFC – Prefrontal Cortex

SOMCT – Short Orientation Memory Concentration Test

WCSA – World Cup Stacking Association

WSSA – World Sports Stacking Association

## ABSTRACT

**Introduction:** Sport stacking has been shown to improve cognitive and motor functioning, such as reaction time and hand eye coordination, through studies conducted on children in grades two and three but limited research exists to suggest these improvements in other populations. Due to the decline in cognitive and motor functioning resulting from aging and the correlation of falls occurred with decreased cognitive functioning, improvements in these aspects may promote an improvement in brain functioning and quality of life in geriatrics.

**Aim:** The aim of this study was to determine the effects of sport stacking on geriatric motor and cognitive functioning.

**Methods:** This quasi-experimental design with a pre- and post-intervention selected a purposive sample of 60 geriatric participants in a retirement home located in the eThekweni region, KwaZulu-Natal. Participants were between 60-90 years old; had no physical disabilities; had no sports stacking experience; had no medical conditions including Alzheimer's or Parkinson's disease or medication for Vertigo, hand eye coordination or memory, had no orthopedic complications, and were sedentary. All participants' Body Mass Index were measured using the Nagata BW-1222 W. Performance on Hand eye coordination was tested by using the plate tapping test, Reaction Time was tested by using the Position Speed Test, Memory was tested by using the SOMCT questionnaire, and Balance was tested by using the Sharpened Romberg Test. The quality of life assessment was measured by using the Lawton's Instrumental Activities of Daily Living Questionnaire. Thirty participants were exposed to an eight week intervention twice a week for 60 minutes while the control group (n=30) continued with activities as per norm. Pre- and post-intervention results were analysed using the statistical programme SPSS Version 19. Means and Standard Deviations, and paired t-test statistics were used to test significant differences pre- and post- intervention.

**Results:** The intervention group showed improvements in their reaction time ( $\bar{x}$  - 4.464)( $\sigma$  3.986) and plate tapping ( $\bar{x}$  2.629)( $\sigma$  2.468) times. However, the control group also had an increase in reaction time ( $\bar{x}$  -1.933)( $\sigma$  4.849) and plate tapping ( $\bar{x}$

1.538)( $\sigma$  3.255) times. The improvements found in the control group were not as significant as what was found in the intervention group. Overall, there were no changes in the balance results pre- and post-intervention. There were no significant results found in their memory, quality of life and hand eye coordination tests. However, the intervention groups' sports stacking times improved over the eight week intervention and this could possibly be due to an improvement in skill level.

**Conclusion:** It was apparent that the sports stacking intervention proved to be beneficial in improving motor functioning in geriatrics.

# CHAPTER ONE

## INTRODUCTION

### 1.1. INTRODUCTION

The history of cup stacking began in the 1980's in southern California (<http://www.worldsportstackingassociation.org>). Initially, cup stacking used paper cups but due to the cups being fragile, it was then changed to plastic cups (Udermann & Murray, 2006). Currently, specially manufactured polymer cups for cup stacking are used (Udermann & Murray, 2006). Cup stacking became publicised in 1990 on the Networks Broadcasting Company's (NBC) The Tonight's Show, when a young boy demonstrated cup stacking to the country (Udermann & Murray, 2006). After the broadcast on The Tonight's Show, a teacher in Colorado began cup stacking classes after school. This became a frequent and popular extra mural activity at this school. After this programme begun, it spread among other schools in the district. Thereafter, local and national competitions attracted thousands of avid cup stackers. Through these educational programmes in the United States of America, cup stacking become internationally recognised in countries like Canada, Japan, Germany, Australia, Singapore, United Kingdom and Scandinavia (Udermann & Murray, 2006).

Cup stacking is defined as an individual or team activity where participants stack and unstack specially designed plastic cups in pre-determined sequences while racing against the clock or an opponent (Udermann & Murray, 2006). Cup stacking is easy to learn and helps to improve hand eye coordination, reaction time and skill development (Godinet, 1986). However, in 2005, cup stacking was recognised for its physical demand and competitiveness and the name "Cup Stacking" changed to "Sports Stacking" by the World Cup Stacking Association (Udermann & Murray, 2006). Sports stacking allows for an enhancement in motor skills such as directionality, laterality, perceptual motor functioning, crossing the midline and hand eye coordination (Fox, 2001). However, these motor skills are affected by the ageing process.

The process of ageing affects the functioning of the nervous system, cardiopulmonary, skeletomuscular and other organ systems additionally, as ageing begins, there is a decrease in brain weight and the rate of blood flow (Tseng, Gau & Lou, 2011). These factors collectively cause memory loss, reduction in learning abilities and a decrease in cognitive functioning (Pang, Chow, Cummings, Leung, Chiu, Lam & Fuh, 2002). However, physical activity is associated with decreased risks of cognitive impairments (Cotman & Berchtold, 2002). A study conducted by Colcombe, Kramer, Erickson, Scalf, McAuley, Cohen & Elavsky (2004) showed that adults who participated in a regular walking protocol had a positive outcome on their cognitive functioning. Furthermore, intervention studies show a positive relationship between fitness and improvements in cognition and brain function (Kramer, Erickson & Colcombe, 2006). It can also promote improvements in psychological well-being such as positive feelings, decreasing stress responses, increasing confidence and improving sleeping patterns (Tseng et al., 2011).

Reaction time is known as “an important index of functional age” (Mathey, 1976). Reaction time and hand eye coordination has shown to decrease with age (Ratcliff, Thapar & McKoon, 2001). Geriatrics have a slower reaction time as their response to a given task in comparison to younger persons, is more careful. Additionally, older persons are more conservative compared to younger individuals (Ratcliff, Thapar, & McKoon, 2001). Age is a major contributor to lower reaction time due to it being affected via the decrease in central processing speed, decrease in passive joint flexibility, being more cautious before responding to certain tasks and the change in neuromuscular properties (Welford, 1977).

Deary & Der (2005) used reaction time to explain the association between Intelligence Quotient (IQ) levels and death. The results of this study found that adjusting reaction time to have an effect on IQ scores and mortality had no significant effect. This suggested that a decline in information processing may have an association with mental abilities and early death.

Furthermore, aging plays a large role in affecting hand function. This is due to lack of independence in daily activities and gait-related problems (Hunter, White & Thompson, 1998). As ageing occurs, hand precision decreases. This is a natural phenomenon in ageing and it results in hand tremours. This requires movements to

be repeated until it is performed correctly. Hand tremours causes a feeling of helplessness due to repetition and also it requires more time when carrying out simple everyday tasks (Sebastjan, Dabrowska, Ignasiak & Zeurek, 2008).

As aging occurs, muscular strength decreases which affects proprioception (Hurley, Rees & Newham, 1998). Lin & Bhattacharyya (2012) showed that one in every five geriatrics experience problems with dizziness or balance. Balance problems arose from unsteadiness, vertigo, trying to walk on uneven surfaces as well as faintness. It was also found that certain prescribed medication could trigger dizziness and balance problems (Lin & Bhattacharyya, 2012). Balance is maintained via sensory and musculoskeletal systems, with a large part been the role of aging on balance. However, geriatrics who have experienced a fall lose confidence in their physical capabilities which results in them being hesitant to participate in physical activity/exercise (Matsumura & Ambrose, 2006). Studies have also focused on how geriatrics react under timed and challenging postural scenarios. It has been shown that there is a decrease in standing and walking in geriatrics, due to the loss of confidence if they have previously fallen (Joshua, D'Souza, Unnikrishnan, Mithra, Kamath, Acharya & Venugopal, 2014; Tucker, Kavanagh, Barrett & Morrison, 2008).

On the other hand, medication such as sedatives and anti-inflammatory drugs are also a major cause of falls due to tiredness and loss of complete muscle function (Cumming, 1998). Sarcopenia is defined as the age-related loss in muscle mass and function (Sayer, Robinson, Patel, Shavlakadze, Cooper & Grounds, 2013) and it results in decreases in physical endurance and flexibility (Cadore, Rodríguez-Mañas, Sinclair & Izquierdo, 2013). These all work together and in turn, there is a decrease in ones balance abilities (Konrad, Girard, & Helfert, 1999).

Additionally, cognitive impairment has been shown to be one of the strongest independent predictors for fall induced fractures (Bergland & Wyller, 2004). It was shown in a study that moderate to high intensity resistance training resulted in health benefits for geriatrics such as decreasing the risk of common chronic diseases and helps improve mental and physical fitness (Cassilhas, Viana, Grassmann, Santos, Tufik & Mello, 2007). Improvements in motor and cognitive functioning may be beneficial to improve brain functioning and quality of life (Fleming, Evans, Weber, & Chutka, 1995).

Another common problem among the geriatric population is the loss or slow decline of memory (Kral, 1962). Memory problems is the most common and difficult hurdle faced (Hertzog & Dixon, 1994). Foerster, Carbone, Schneider, Chen & College (2014) used sports stacking to test long-term memory, although used simultaneously with a verbal task. The results of this study showed that sports stacking did not improve long-term memory.

As a result of the cognitive and motor challenges experienced in geriatrics, the ability to perform simple everyday tasks is increased and in turn one's quality of life is decreased. Stewart & King (1991) proposed two categories for research on quality of life. The first category been functioning and the second, well-being. Functioning refers to dexterity, ability to carry out daily living tasks and cognition. Well-being refers to bodily states, emotional health and overall life satisfaction (Drewnowski & Evans, 2001).

Cahn-Weiner, Boyle, Malloy, Razani, Casas, Wong, & Josephson (2002) examined functioning for determining instrumental activities of daily living (IADL) in community living geriatrics. The results of the study showed that there is a strong relationship between functional independence and executive functioning abilities in older persons (Cahn-Weiner et al., 2002). Executive functioning is defined as the ability to perform goal-directed, complex and self-serving tasks (Royall, Chiodo & Polk, 2000).

Therefore, if functioning and well-being of an individual can be increased, quality of life will be improved.

## **1.2. PROBLEM STATEMENT**

Aging reduces the ability of hand and eye coordination for various manual task demands (Rand & Stelmach, 2011). As aging occurs, muscular strength decreases which affects proprioception (Hurley, Rees, & Newham, 1998). However, an improvement in balance due to exercise can optimise visual, vestibular and somatosensory systems in geriatrics (Hu & Woollacott, 1994). Furthermore, exercise interventions can improve balance (Cadore et al., 2013) and substantial improvements in reaction time can occur due to the regular participation in exercise or physical activity in general (Dustman, Ruhling, Russell, Shearer, Bonekat, Shigeoka & Bradford, 1984; Rudisill & Toole, 1992).



Sport stacking has been beneficial to improve reaction time as well as hand eye coordination in children and adults. However, there are limited studies on the motor and cognitive functioning benefits of sports stacking among geriatrics.

### **1.3. AIM**

The aim of this study was to determine the short-term effects of a sports stacking intervention on the motor and cognitive functioning in geriatrics.

### **1.4. OBJECTIVES**

- To determine the short-term effects of a sports stacking intervention on the motor functioning (hand eye coordination, reaction time, balance and quality of life) pre- and post-intervention in geriatrics.
- To determine the short-term effects of a sports stacking intervention on the cognitive functioning (memory) pre- and post-intervention in geriatrics.

### **1.5. HYPOTHESES**

H<sub>1</sub>: A short-term sports stacking intervention will improve motor functioning in geriatrics.

H<sub>0</sub>: A short-term sports stacking intervention will not improve motor functioning in geriatrics.

H<sub>1</sub>: A short-term sports stacking intervention will improve cognitive functioning in geriatrics.

H<sub>0</sub>: A short-term sports stacking intervention will not improve cognitive functioning in geriatrics.

### **1.6. SIGNIFICANCE**

Due to the limited research in the area of sports stacking specifically in relation to geriatrics, this study will help to fill the gap in the literature as well as to promote sports stacking at a geriatric level. The promotion of sports stacking will be due to it being beneficial to motor and cognitive functioning. The results can be used to

educate healthcare professionals who work with geriatrics at old age and retirement homes.

## **1.7. CONCLUSION**

In general, there are limited studies conducted on sports stacking, specifically with geriatrics. This study attempts to show that sports stacking can improve cognitive and motor functioning in geriatrics. It is anticipated that the results from this study will have an effect on exercise programmes developed for geriatrics.

The layout of this dissertation is as follows:

Chapter Two: Literature Review

Chapter Three: Methodology

Chapter Four: Manuscript

Chapter Five: Conclusion and Recommendations

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2. INTRODUCTION**

The literature review will focus on the various cognitive and motor functioning components such as balance, reaction time, hand eye coordination, quality of life and memory. It will also include previous intervention studies conducted to improve motor and cognitive functioning in the geriatrics. These specific functions are found to be problem areas in geriatrics. The literature will provide a clearly understanding about each of the different areas.

Additionally, literature on cup or sport stacking will be presented. However, the literature is very limited, specifically, the literature on sports stacking among geriatrics.

#### **2.1. INTERVENTIONS TO IMPROVE MOTOR AND COGNITIVE FUNCTIONING**

On average, 30% of geriatrics over the age of 65 years fall every year (Blake, Morgan, Bendall, Dallosso, Ebrahim, Arie & Basse, 1988). A study conducted by Tinetti, Baker, McAvay, Claus, Garrett, Gottschalk, & Horwitz (1994), investigated whether the risk of falling in geriatrics can be reduced by modifying the known risk factors. Men and women aged 70 in the community who had at least one of these risk factors; (1) postural hypertension, (2) used sedatives, (3) used a minimum of four prescription drugs and (4) had an impairment with the strength and range of motion in their arms and legs were recruited (Tinetti et al., 1994). The participants in the intervention group had their medication adjusted, were given behavioural instructions and followed an exercise programme. The control group received health-care treatment as per norm. After a year, the results showed a significant reduction in the risk of falling in the intervention group due to the multi-risk factor intervention. Hence, results indicated that a multi-risk factor intervention can improve functional independence and confidence in geriatrics (Tinetti et al., 1994).

In the past, there has been a great interest on the influence of lifestyle factors which can contribute to cognitive strength in geriatrics. These lifestyle factors are intellectual engagement, exercise and physical activity, nutrition and their social interactions. A study conducted by Colcombe, Kramer, Erickson, Scalf, McAuley, Cohen & Elavsky (2004) showed that adults that participated in a regular walking protocol, had a positive outcome on their cognitive functioning. It was also hypothesised that intervention studies do show a positive relationship between fitness and improvements in cognition and brain function (Colcombe et al., 2004).

A systematic review conducted by Tseng, Gau & Lou (2011) was designed to evaluate how effective exercise is, with regard to improving cognitive functioning in geriatrics. The review included 12 randomised controlled trials. These studies used 60 minute exercise interventions, three times a week for twenty-four weeks. The results of this study showed that an exercise intervention of six weeks, three times a week for 60 minutes improved cognitive functioning in geriatrics (Tseng et al., 2011).

Research has shown that participation in exercise has become a key indicator of improvements in cognitive functioning. A study conducted over five years has shown that physical activity is associated with decreasing the risks of cognitive impairments (Cotman & Berchtold, 2002). Cognitive impairments refers to memory loss, Dementia and Alzheimer's Disease. Exercise is an easy and very popular behaviour that helps activate molecular and cellular responses that support and maintain good brain health (Cotman & Berchtold, 2002). Even though exercise is most beneficial to this specific population, socialising can also play a part when it comes to exercising.

Researchers have studied the decline in cognitive functioning that occurs due to ageing. This affects mental stability and growth of knowledge. A very important indicator of aging is the processing speed. A common approach to improving cognitive functioning is the engagement in social and leisure activities (Park, Gutches, Meade & Stine-Morrow, 2007). A study conducted by Carstensen & Mikels (2005) also showed that a greater interaction in different cognitive, leisure and physical activities improves cognitive functioning.

Chronological age is associated with a great risk of diseases like cognitive impairments, metabolic syndrome and heart disease (Wang, Haskell, Farrell, Lamonte, Blair, Curtin, & Burt, 2010). A study conducted by Fratiglioni, Paillard-Borg

& Winblad (2004) found that social networking, leisure activities and physical activities on a regular basis can decrease the rate of cognitive decrements. Ageing also affects memory and the ability to manipulate information (Bherer, Erickson & Liu-ambrose, 2013). A study conducted by Voelcker-Rehage & Niemann (2013) also showed that coordination and motor exercises can improve cognitive functioning in healthy older individuals.

Gerontology studies have shown that exercise can maintain functioning and psychological well-being in geriatrics (Ruuskanen & Ruoppila, 1995). An improvement in moods, confidence levels and cognitive functioning was seen (Rogers, Meyer & Mortel, 1990). Social interaction plays a big role in improving their psychological well-being because it also increases their self-esteem and confidence around others (Simons, Epstein, McGowan, Kupfer & Robertson, 1985).

Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) is an intervention used to prove that mental abilities can be improved under lab conditions and can show improvements in daily functioning tasks. Primary outcomes in daily functioning tasks were money management, preparation of food, using medication and driving. Secondary outcomes were quality of life, health-service utilisation and mobility. This study took place over four years. The results obtained from ACTIVE can be used as a guide for behavioural medicine in the future (Jobe, Smith, Ball, Tennstedt, Marsiske, Willis & Kleinman, 2010). Motor and cognitive impairments, there could also be a chemical link with these impairments.

Moberg, Ph, Ding, Hitzemann, Smith & Logan (1998) conducted a study to determine whether there is a relationship between brain dopamine and cognitive and motor functioning in healthy persons. Thirty individuals between 24-86 years participated in the study to assess dopamine receptors in the brain. Participants were required to perform tasks that were sensitive to dopamine alterations in patients with neurological diseases. The results showed that there was a decrease in age-related dopamine activity and this is associated with a decline in motor and cognitive functioning. This was found in healthy individuals (Moberg et al., 1998).

## **2.2. BALANCE**

An emphasis is placed on physical, psychological and functional factors when referring to ageing healthily by geriatrics, policy makers and health care professionals (Phelan, Anderson, LaCroix & Larson, 2004). Interventions are initiated to decrease hospital readmissions and risks of falling. These interventions have a common goal of physical activity maintenance, independence and disability limitations (Beswick, Rees, Dieppe, Ayis, Gooberman-Hill, Horwood & Ebrahim, 2008). Modernised health care organisations use geriatric screening and multidimensional assessments to avoid and detect health problems in geriatrics. This screening method is conducted in Italy, France, Germany and Denmark (Leichsenring, 2004). Balance maintenance is key in fall reduction.

Maintaining balance is critically important when carrying out daily tasks without falling (Alexander, 1994). One of the tests used in this study was the Sharpened Romberg Test (eyes opened and eyes closed). This test was a true indicator of the maintenance of balance on a narrow base of support (Franchignoni, Tesio, Martino & Ricupero, 1998). The participants (n=45) were between the age of 55 and 71 years and they were divided into four groups. This study used the Sharpened Romberg Test, One-Legged Stance Test, Functional Reach Test and the Sit to Stand Test. Results showed that the Sharpened Romberg Test – eyes opened was easier than eyes closed. Furthermore, all four tests were reliable, did not create redundant results and were performed in the same domain. However, further research could be conducted to determine which test achieves a distinctive measure of balance (Franchignoni et al., 1998).

Berg, Wood-Dauphinee, Williams, & Maki (1992) assessed the validity of a balance scale. This scale was used to indicate/predict the possible falls in geriatrics. One hundred and thirteen geriatrics participated in this study and were assessed via functional tests and balance regulation over a nine month period. Seventy stroke patients were also tested for balance capabilities over three months. The results illustrated that the balance scores did determine the occurrence of falls.

An environmental factor is anything that can affect living organisms (Humpel, 2002). Environmental factors become less meaningful to falls as individuals age. Weakness, dizziness and loss of balance takes over and becomes more meaningful

to falls and also to the contribution of falls (Heitmann, Gossman, Shaddeau & Jackson, 1989). Black, Wall & Nashner (1983) tested balance and vestibular effects by using the Sharpened Romberg Test. It was found that when participants were requested to close their eyes, balance was lost due to the loss of visual information. This created bodily sways. Hence, the Sharpened Romberg Tests were quick and reliable for clinical use (Black, Wall, & Nashner, 1983).

Tucker, Kavanagh, Barrett & Morrison (2008) focused on how geriatrics react under timed and challenging postural scenarios. It has been shown that there is a decrease in standing and walking in geriatrics. Tucker et al. (2008) examined the age differences in reaction time and the pattern of coordination whilst participating in voluntary sway movements. Eight men (mean age of 24 years) and ten geriatric men (mean age of 75 years) participated in this study. The instrumentation that was used was a force plate using different directions; (1) Anterior-Posterior and (2) Medial-Lateral. The two testing conditions were named Static reaction and Dynamic reaction. Static reaction began from a stationary stance into an Anterior-Posterior or a Medial-Lateral direction via a voluntary sway. Dynamic reactions began by the participants performing a quick switch of voluntary sway into Anterior-Posterior and Medial-Lateral directions. Both these reactions were initiated by auditory signals/cues. The results indicated that geriatrics have a more strict coordinated strategy compared to the young adults. This was due to the geriatrics trying to compensate for the lack of stability (Tucker et al., 2008).

Bisson, Contant, Sveistrup & Lajoie (2007) conducted a study using virtual reality training and biofeedback training to rehabilitate balance in geriatric participants. Two groups of 12 healthy adults aged 65 and over trained twice a week for ten weeks. The virtual reality training group were required to lean sideways when attempting to juggle a virtual ball. The biofeedback group had to maintain their centre of gravity in a square as a red dot was their cue on a screen. Results showed an improvement in balance in both groups. This is a usual study and illustrated feasible results (Bisson et al., 2007). Even though new studies and new technologies have been successful, the actual science behind balance and the aging process is a fundamental piece of information.

Wolf, Barnhart, Kutner, McNeely, Coogler & Xu (1996) used Tai Chi and computerised balance training to determine indicators of frailty and occurrence of regular falls. Two hundred participants aged 70 and above participated in a 15 week intervention. Results showed that Tai Chi did have a positive impact on indices of frailty and also on occurrences of regular falls. Further studies need to be conducted to determine whether Tai Chi can improve health levels in geriatrics (Wolf et al., 1996). Although it was clear that selected interventions do help, the body's role in maintaining balance is vital.

Balance is maintained via sensory and musculoskeletal systems. A large part is the role of aging and balance. Geriatrics who have experienced a fall lose confidence in their physical capabilities, results in them being hesitant to participate in physical activity/exercise (Matsumura & Ambrose, 2006). Due to the normal aging process, there is an impairment in posture while standing, walking and when avoiding obstacles (Tinetti, Williams, & Gill, 2000) . There are minimal causes of impaired balance, i.e. vestibular, sensory, visual, musculoskeletal and neuromuscular, cardiovascular impairments, gait changes and medication. There is a decrease in gains of vestibular reflex and an increase in saccade latencies, i.e. at an individual's age, their vestibular senses become less sensitive and efficient to cues (Nakayama, Helfert, Konrad & Caspary, 1994). It must also be noted that selected health conditions like arthritis and diabetes, which are common diseases in geriatrics can also affect balance (Konrad, Girardi & Helfert, 1999). Visual impairments such as changes in depth perception, sensitivity to glares and dark adaptations can have an overall negative effect on balance (Harwood, 2001).

Furthermore, musculoskeletal and neuromuscular impairments show a reduction in muscular strength and joint flexibility due to the body's inability to respond correctly to balance cues. Cardiovascular impairments show that the aging process has an association with a decrease response to sympathetic activity which results in a decrease in exercise induced heart-rate and contractibility and a decreased cardiac output (Fleg, O'Connor, Gerstenblith, Becker, Clulow, Schulman & Lakatta, 1995). Gait changes appear by slow walking with long stops in between places and the use of two support systems or instruments (Matsumura & Ambrose, 2006). Medication such as sedatives and anti-inflammatory drugs also contribute to a large cause of



falls due to tiredness and loss of complete muscle function (Cumming, 1998). Maintaining and controlling balance can help you determine what causes falls in geriatrics.

Berg (1989) aimed to develop a predictor of appropriate balance for geriatrics. The study consisted of 38 participants between the ages of 60 and 93 years. The reliability of the predictors was measured by physiotherapists who watched recordings of the participants' performances at two different times. It was found that further investigation needs to be conducted to determine appropriate balance for geriatrics (Berg, 1989).

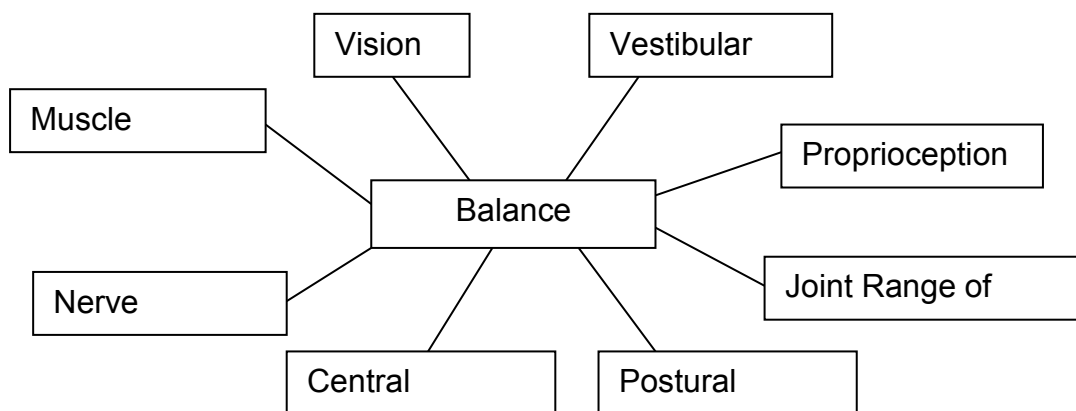
Fifty percent of geriatrics who fall have said that the fear of falling restricts them from carrying out daily activities (Howland, Lachman, Peterson, Cote, Kasten, & Jette, 1998). A study was conducted on 94 geriatrics over the age of 75. These individuals had balance issues and lived in residential care facilities. The experimental group performed 12 individualised balance exercises, while the control group performed 12 sessions of individualised extra attention exercises over four to six weeks (Wolf, Feys, De Weerd Van der Meer, Noom, Aufdemkampe & Noom, 2001). The tests used were the Berg Balance Scale and The Dynamic Gait Index. The results showed that the experimental group improved significantly more than the control group. This showed that a short individualised exercise programme can improve balance in geriatrics who are over 75 years old (Wolf et al., 2001). Another study conducted by Hu & Woollacott (1994) also showed that an improvement in balance due to exercise which can optimise visual, vestibular and somatosensory systems in geriatrics.

A study conducted by Shumway-Cook, Brauer & Woollacott (2000) measured the sensitivity of the Timed Up and Go Test with a single task versus a double task condition. Thirty geriatrics aged 65 to 95 years participated. Fifteen geriatrics without a fall history and 15 geriatrics with two or more falls in their history were recruited to participate in this study. The tasks were Timed Up and Go with subtraction tasks and a Timed Up and Go with holding a cup of water. The results indicated that Timed Up and Go was sensitive for determining geriatrics that are at risk for falling. The double task did not add to the percentage of fall risk in geriatrics (Shumway-Cook et al., 2000).

Beswick et al. (2008) assessed community based interventions in geriatrics. The mean age was 65 years. These participants lived in an old age home. This study consisted of a host of randomised controlled trials. It was found that complex interventions can prove to allow geriatrics to live safe and independent lives.

Falls can become common in older persons due to balance problems, visual impairments and also dementia. Interventions such as group exercises using strength and balance training did decrease the amount of falls in geriatrics and persons who already have a high risk of falling. Tai Chi was also effective in reducing falls in geriatrics. It was also found that certain medications also increase the risk of falling in geriatrics (Handoll, 2010).

In the 1900's, balance was seen as a neurological reflexive function due to Sir Charles Sherrington (Nashner, 1997; Shumway-Cook & Woollacott, 1995). Nowadays, balance is described as a mechanical system due to the influence of mass, gravity and forces. Figure 2.1 shows the factors that can affect balance (Shumway-Cook & Woollacott, 1995).



**Figure 2.1. Components of balance control**(Adapted from Yim-Chiplis & Talbot (2000))

A study was conducted by physical therapists in 2003 to monitor the functional status in geriatrics. The balance capabilities of geriatrics population were measured. Seventy-six geriatrics between the ages of 66-101 years old participated in this test. Gait speed, fast gait speed, Berg Balance, Timed Up and Go, timed sit to stand, six

minute walk and a physical performance test was assessed. At the end of this study these tests proved to show the functional status of geriatrics to be positive (Lusardi, Pellecchia & Schulman, 2003).

Exercise, balance and reaction time programmes can be combined in interventions. Additionally, balance and reaction time can also be combined as a strong component of a programme. Lord & Castell's (1994) study comprised of males and females (n=40) between the ages of 50 and 75 years old. The study consisted of a control (n=20) and intervention group (n=20). Pre- and post-intervention tests were conducted and included strength, reaction time and muscle control/coordination assessments. The intervention group participated in exercises which comprised of four parts; a warm up, cardio respiratory work out (walking), flexibility and muscular strength. The duration of the intervention was for an hour, twice a week for 20 weeks. Post-intervention findings showed that exercise did improve physical exercise in geriatrics, specifically strength and muscle control/coordination.

### **2.3. HAND EYE COORDINATION**

Ageing creates changes in overall coordination. This study measured hand and eye movements in youngsters and geriatrics. Electrooculograms and electromyograms represented hand movements. Movements were recorded and used to determine how well participants performed in aiming (target) tasks. The results showed that the geriatrics had an improvement in reaction time with eye and hand movements. However, the error correcting techniques also increased and this shows that ageing effects are caused by impairments in the sensory process (Warabi, Noda & Kato, 1986).

Pei, Chou, Lin, Hsu & Wong (2008) conducted a study to determine Tai Chi Chaun effects on motor control in geriatrics. The focus was on eye hand coordination. Forty two geriatrics participated in this study. Twenty-two had been exposed to the Tai Chi Chaun for three years and the control group consisted of 20 healthy, physically active geriatrics. For the baseline testing, participants had to stroke three sensors in a specific sequence and all their results were recorded. The experimental group showed significantly better results. There was a reduction in pause time, displacement, number of sub movements and movement times. The experimental

groups eye hand coordination increased due to the Tai Chi Chaun intervention (Pei et al., 2008).

Furthermore, many studies were conducted using different tests to measure hand eye coordination. The Jensen Test was used to measure hand function required to carry out everyday tasks. It was used to test if hand function declines with age. One hundred and twenty one geriatric men and women participated in this study. Participants were divided into three age groups; (1) 60-69 years, (2) 70-79 years and (3) 80-89 years. Results showed a difference, though not significant between males and females in the different age groups. It was found that hand function did decrease with age although males performed slightly better. Overall, there was a positive relationship between age and the amount of time needed to finish the task (Hackel, Wolfe, Bang & Canfield, 1992).

Ruff & Parker (1993) carried out a study using the Finger Tapping and Grooved Pegboard Tests to determine age and gender specific changes in eye hand coordination and motor speed. Three hundred and sixty participants were involved in this study. Participants were grouped by gender and by age (seven to 22 years (three educated groups, i.e. obtained a tertiary qualification and working in a selected profession) and four aged groups (16-70 years)). The results showed that the females were slower in the finger tapping test due to ageing and were also faster on the Grooved Pegboard Test. The final results showed that the educated group performed better and there was a minor effect on ageing (Ruff & Parker, 1993).

Another study used ball juggling to determine structural brain changes in geriatrics. This six month study included 69 geriatrics with a mean age of 60 years. It was observed that the geriatrics were able to learn how to juggle, though slower than adolescents. Magnetic resonance imaging (MRI) scans showed that there was a decrease in grey matter with regards to ageing. However, the results showed that there was an increase in grey matter post-study (Boyke, Driemeyer, Gaser, Büchel & May, 2008).

## 2.4. REACTION TIME

Simple reaction time has been used by doctors and psychologists as experimental tests to test for differences in cognition (Donders, 1868). There are two reasons why reaction time is very important in gerontology. Firstly, there is a growing interest in ageing and the change of processing of information and secondly, due to these changes it can indicate more complex cognitive dysfunction (Madden, 2001).

Reaction time is known as “an important index of functional age” (Mathey, 1976). It was found that in a study by Deary & Der (2005), there were gender differences noted in men and women and this indicated that men were faster than women. The participants were between the age of 58 and 70 years. Reaction time and precise movements work hand in hand.

As ageing occurs, hand precision decreases. This is a natural phenomenon in ageing and it results in hand tremours. This requires movements to be repeated until it is performed correctly. Hand tremours cause a feeling of helplessness due to repetition and it also requires more time when carrying out simple everyday tasks (Sebastjan, Dabrowska, Ignasiak & Zeurek, 2008). A study conducted by Sebastjan et al. (2008) found that women aged 68-71 years, who have a better quality of life and participate in daily physical activities can have increased efficiency in carrying out precise hand movements. It was also noted that there was a decrease in the processing speed which also effects reaction time (Rabbitt, 1986).

Motor and cognitive functions are decreased due to age and processing speed (Rabbitt, 1986). Shumway-Cook, Woollacott, Kerns & Baldwin (1997) stated that kinaesthetic and visual sensory input decreases with age and that increased attention can improve these systems. Older persons are known to maintain their sensory inputs to make up for the age-related changes in auditory, visual and proprioceptive functions (Shumway-Cook & Woollacott, 1995). This can hinder the way they solve problems on a daily basis.

Burton, Strauss, Hultsch & Hunter (2009) conducted an investigation to determine if decreases in reaction time is predictive of the geriatrics ability to problem solve common daily issues. The study was conducted on 304 geriatric individuals' aged between 62 and 92 years. The results of this study showed that reaction time did

account for issues with daily problem solving. It was also found that inconsistencies in reaction time may be associated with functional issues (Burton et al., 2009). Functional issues can affect an individual's occupational behaviour.

Task complexity has a strong relationship with occupational behaviour (Barris, Kielhofner, Levine & Neville, 1985). Barris et al. (1985) defined task complexity as "the number of movement steps required to execute a task". Breaking tasks down into smaller steps has proven to have a huge impact on reaction times (Fischman & Yao, 1994). Kinematics is described as the spatial and temporal aspect of movement (Hamill & Knutzen, 1995). A person's hands first accelerates then decelerates to obtain the correct trajectory when performing tasks (Georgopoulos, 1986). Ma & Trombly (2004) found that motor characteristics are affected by task complexity. Occupational therapists are advised to divide movements into smaller steps when working with geriatric patients. As this is most effective in improving task complexity (Ma & Trombly, 2004). Variability of tasks can determine where the dysfunction lies in cognitive and motor functioning.

Hultsch, Macdonald & Dixon (2002) examined three types of variability; (1) variability between people, (2) variability within people across tests and (3) variability within people across time. The study included 99 young adults and 763 older adults. Four measures were used to test reaction time. Results showed that within-persons variability, there was a positive effect but individual differences were found with their performance in speed, memory and certain abilities. The final result was that variability of tasks is a crucial indicator of ageing and cognitive functioning (Hultsch et al., 2002).

Moreover, individuals who display lower Intelligent Quotient (IQ) scores tend to have a shorter mortality rate. This is measured by psychometric intelligence in childhood, adult life, middle age and older age (Deary, Der & Ford, 2001). Many people can display high IQ scores if they have optimal health behaviours or if they have successful lives such as, good educational qualifications and being a part of a professional society (Deary & Der, 2005). A study conducted by Deary & Der (2005) used reaction time to explain the association between IQ levels and death. Reaction time measures are knowledge free and it does not require educational and social status. The results of this study found that by adjusting reaction time to have an

effect on IQ scores and mortality, had no significant effect. This suggested that a decline in information processing may have an association with mental abilities and early death (Deary & Der, 2005).

Barnett (2003) conducted a study to determine if one year of weekly home exercises could improve balance, reaction time, health and strength in community living geriatrics. One hundred and sixty three participants aged 65 years and older were divided into a control or intervention group. Their health status was measured every six months from baseline. It was found that the intervention group had a improvement in balance and reaction time and demonstrated a decrease in fall risk.

Woollacott & Shumway-Cook (2002) conducted a study using dual tasks to determine age related shifts in balance and stability. It is known that these two factors can cause instability in geriatrics. It was found that when sensory information is decreased, geriatrics require more attentional capacity to maintain balance and stability (Woollacott & Shumway-Cook, 2002).

Reaction time is a major contributor to falls. This study used a home exercise intervention to increase strength and balance and reduce the chances of falls in geriatric women. Two hundred and thirty three women participated in this study. One hundred and sixteen were assigned to the intervention group and the remaining participants were assigned to the control group. The ages ranged from 80 years and older. The exercise programme lasted one year. The results indicated that the women in the intervention group did have a significant decrease in their risks of falls and an improvement in reaction time (Campbell, Robertson, Gardner, Norton, Tilyard & Buchner, 1997).

A fall profile on 325 geriatrics was conducted to determine the rate of falls in the past year. Participants were contacted every week for a year to determine their falls (if they had any). It was found that 55% of these geriatrics suffered minor soft tissue injuries and 6% had fractures and lacerations. The rest of the group suffered no falls. Minor injuries were a result of slow reaction time and motor control (Nevitt, Cummings & Hudes, 1991).

This study investigated the use of aerobic exercise on certain aspects of the brain. It was shown that aerobic exercise has a positive effect on cognitive function and

physical performance. This includes a very large effect on reaction time. It was found that aerobic exercise can benefit physical, motor and cognitive health in individuals (Hillman, Erickson & Kramer, 2008).

Clarkson-Smith & Hartley (1989) investigated the relationship between exercise and cognitive abilities in geriatrics. The participants were 62 geriatrics who exercised and 62 sedentary geriatrics. All participants were tested on memory, reasoning and reaction time. Results showed that the exercise group had an increased memory, reasoning and reaction time scores. Furthermore, it was recommended that additional research needs to be conducted on physical activity and cognition in geriatrics.

## **2.5. MEMORY**

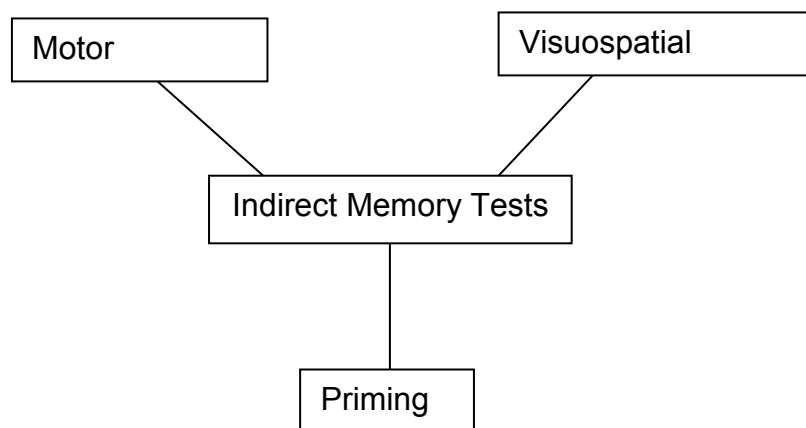
### **Cognitive functioning**

An increase in age has also been shown to impair various forms of memory (Braes, Milisen & Foreman, 2007). A common problem amongst geriatrics is their loss or slow decline of memory (Kral, 1962). This study evaluated two groups of 20 participants in each group. Group one lived independently and group two lived at a geriatric hospital. Even though these individuals had no memory problems or the likes of, they still chose to reside at a hospital. Majority of the participants that were admitted into hospital, were recovering from an illness such as heart disease or a stroke. All participants completed the Rivermead Behavioural Memory Test. This test is used to measure day to day memory. Results showed that participants that resided at the hospital presented with a higher rate of cognitive impairment, however, did not have serious mental issues. It was concluded that if memory loss is detected early it can allow for an intervention to be initiated such as behavioural changes and therapy (Cockburn & Collin, 1988).

The following study evaluated memory in geriatrics in a more informative context. In the geriatric population, memory is the most common and difficult challenge experienced (Hertzog & Dixon, 1994). There are four components to memory and aging in geriatrics, namely; slower processing speed, a decrease in processing resources, age-related inhibitory problems and a reduction in cognitive control. It is



shown that age-related changes in attentional resources can impair older adults' cognitive process. Automatic and controlled memory processing is also a crucial part of memory. Automatic processing needs little attentional requirements and occurs naturally while controlled processing is effortful and does not happen naturally (Hasher & Zacks, 1979). Controlled processing decreases with age. There are two ways of testing memory and they are indirect and direct memory tests. Direct memory tests measure verbal ways to report memory information and are motor learning, visuospatial and priming (Figure 2.2). Indirect memory tests uses changes in behaviour to report memory information namely; Semantic memory, episodic memory, working memory and prospective memory (Figure 2.3) (Kester, Benjamin & Castel, 2002).



**Figure 2.2. Different Indirect memory tests** (Adapted from Kester et al. (2002))

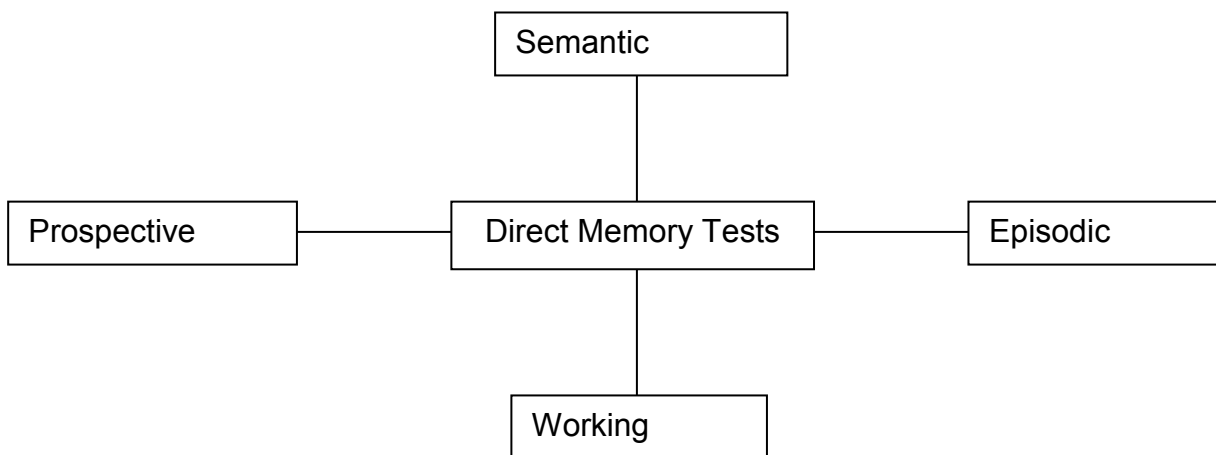
### **Indirect memory tests**

Motor learning in older adults is impaired due to the decrease in the speed of movement, muscle functioning and incompatible response to mapping. A study was conducted to show the motion learning in geriatric participants. Participants were required to hold a hand-held stylus in their hand and in contact with a moving target on a screen. Motor skills were measured by the amount of time they could hold the

stylus on the screen. This result showed that geriatrics learn at a slower rate compared to younger individuals (Ruch, 1934; Wright & Payne, 1985).

Visuospatial information is closely associated with motor learning. Wilkniss, Jones, Korol, Gold & Manning (1997) studied a group of geriatric and young individuals. Participants were requested to memorise a route on a map, then navigate through that route without using the map. Results showed that geriatrics found the task more difficult than the younger individuals.

Priming is performed via a stimulus that brings about the same stimulus from a past experience. Priming has been given preference over motor learning and visuospatial learning. Finding indicated that geriatrics have stronger priming effects (Light & Voie, 1993; Voie & Light, 1994).



**Figure 2.3. Different Direct memory tests** (Adapted from Kester et al. (2002))

Semantic memory tests participant's knowledge, i.e. facts, words and concepts. Geriatrics show very small or even minimal decreases in their vocabulary and knowledge (Giambra & Arenberg, 1995; Perlmutter & Metzger, 1980). Episodic memory is being able to recall or recognise events or tasks that happened in the past (Kester et al., 2002). Working memory is a form of short-term memory such as a brief repetition of words or letters for a short period of time. May, Hasher & Kane (1999) showed that older adults are at an increased risk of a decline in working memory. Prospective memory is when an individual forms an idea to perform a task

in the future and remembers or forgets to perform it (Kester et al., 2002). Cockburn & Smith (1991) showed that there is an age-related problem with prospective memory.

The following study focused on source memory in geriatrics aged 65 years and older. Source memory is defined as an aspect of context that was present when a certain event happened (Johnson, Hashtroudi & Lindsay, 1993). It was found that source memory was affected by ageing due to the possible decrease in frontal lobe performance in geriatrics. Four different experiments were conducted to explore the effect of ageing on source memory. The results stated that defects in source memory was due to a below average function for frontal performance. Thus frontal functioning is very important in terms of memory (Glisky, Rubin & Davidson, 2001).

Cognitive defects are found during the ageing process. However, some geriatrics still perform at the same level as young adults. This is due to counter-acting the age related changes and recognising brain function. A study by Cabeza, Anderson, Locantore & McIntosh (2002) used the Position Emission Tomography (PET) and the Functional Magnetic Resonance Imaging (fMRI) to determine prefrontal cortex (PFC) functioning in younger adults and geriatrics. Participants were seven young adults with an age range from 20-35 years, eight high functioning geriatrics with an age range from 64-78 years and eight low functioning geriatrics with an age range from 63-74 years. These scans detected that young adults and high functioning geriatrics recruit the same PFC region but the low functioning geriatrics do not use it efficiently. This is where the high functioning geriatrics counteract this effect by reorganising brain performances.

Charles, Mather & Carstensen (2005) focused on emotional attentional and memory in relation to ageing. It was shown that geriatrics show more emotional memory distortions for past experiences than young adults. This positive effect is due to their focus being on their emotional regulation and to destroy negative information. This resulted in an improved emotional regulation as a result of their cognitive abilities and motivation (Charles et al., 2005)

Charles, Mather & Carstensen (2003) also conducted two studies to determine age differences in recall and memory recognition. In the first study, the participants were from a wide age group, were shown images on a screen and then were distracted.

Participants were then asked to recall what they had seen. The amount of images seen decreased as the age increased. In the second study, there was a large age difference in recognition and recall. These findings were consistent for both studies (Charles et al., 2003).

A study conducted by Cutler & Grams (1988) found that memory complaints are common among older persons. Memory self-efficiency is defined as “an individual’s belief in his or her memory abilities, strengths and weaknesses” (Ponds & Jolles, 2006). This has a strong link to how people use their memory from day to day. Ponds & Jolles (2006) showed that memory complaints in healthy geriatrics is not related to a decline in memory. Some advice on memory, would be that memory training should restore the older adults control over memory skills by changing their expectations and perceptions of memory (Ponds & Jolles, 2006).

A good indicator of memory that is quick, easy and reliable to use is the Short Orientation Memory Concentration Test (SOMCT). Katzman, Brown, Fuld, Peck, Schechter & Schimmel (1983) designed the SOMCT in 1983. It was described as a reliable tool to detect pathological changes in older adult’s brains. This test has a high face validity (Davous, Lamour, Debrand & Rondot, 1987). A study conducted by Davous et al. (1987) found that the SOMCT was very sensitive in detecting mild cognitive impairments in geriatrics. This test can also be used to test for true dementia and pseudo-dementia of depression (Davous et al., 1987).

## **2.6. QUALITY OF LIFE**

Physical activity is a very common and beneficial public health intervention used to maintain or better the quality of life in geriatrics (Drewnowski & Evans, 2001). Quality of life is defined as “a conscious cognitive judgment of satisfaction with one’s life” (Pavot & Diener, 1993). A study conducted by Stewart & King (1991) proposed two categories for research on quality of life. The categories are functioning and well-being. Functioning refers to dexterity, ability to carry out daily living tasks and cognition. Well-being refers to bodily states, emotional health and overall life satisfaction (Drewnowski & Evans, 2001). Peppers (1976) found that experiencing enjoyment in activities can have a direct link to life satisfaction. Another important aspect is executive functional testing.

Studies in the past shows that performance in executive functioning tests is an extremely reliable predictor of independent living in older persons (Cahn-Weiner, Boyle, Malloy, Razani, Casas, Wong & Josephson, 2002). Cahn-Weiner et al. (2002) examined functioning for determining instrumental activities of daily living (IADL) in community living geriatrics. Two assessments were used, namely; the neuropsychological and IADL assessments. The IADL assessment measured their functional abilities such as dressing, medication administrative and financial management. The results from this study showed that there is a strong relationship between functional independence and executive functioning abilities in older persons (Cahn-Weiner et al., 2002). Performing these assessments can also help determine dysfunctions in geriatrics.

The ageing population creates a demand for functional disability and supervisory assessments (Bell-McGinty, Podell, Franzen, Baird & Williams, 2002). Being able to identify the risk of functional disabilities can help implement early interventions to reduce this risk. Executive functioning is defined as the ability to perform goal-directed, complex and self-serving tasks (Royall, Chiodo & Polk, 2000). Executive functioning does have a significant effect on IADL's among geriatrics. Bell-McGinty et al. (2002) found that executive tests are a strong indicator of functional status.

There is a decrease in speed processes in older adults. A study conducted by Owsley, Sloane, McGwin & Ball (2002) on the time required to finish IADL tasks in everyday tasks. Visual-processing speed, inductive reasoning and memory was used to determine if there is an independent association between the time required to complete IADL tasks. The results proved that memory and reasoning were related to completing IADL tasks, however, processing speed was the only component independently associated with IADL scores. Instrumental activities of daily living are very useful and effective in evaluating cognitive interventions and an increase in processing speeds (Owsley et al., 2002).

The use of structured assessments can be helpful for the screening of problems that are undetected in geriatrics. These IADL assessments can provide valid information about conditions or limitations in patients that are not frequently assessed in clinical practices. Clinicians should use these instrumental assessments as very good and

useful information from these assessments are determined (Applegate, Blass & Franklin Williams, 1990).

Chronic conditions causes a serious and fast decline in older adults especially during hospitalisation as patients are movement restricted and this contributes to the rapid decline in performing crucial tasks for independent living. The Lawton's IADL tests a person's competencies such as doing the laundry, taking phone calls and handling their financial matters. This assessment is most commonly used to test for early detection of functional dysfunctions (Graf, 2008).

## **2.7. SPORTS STACKING HISTORY AND STUDIES**

### **History**

The history of cup stacking began in the 1980's in southern California (["http://www.worldsportstackingassociation.org"](http://www.worldsportstackingassociation.org)). Initially, cup stacking used paper cups but due to the cups being fragile, it was then changed to plastic cups (Udermann & Murray, 2006). Having been recognised for its physical demand and competitiveness, in 2005, the name Cup Stacking changed to Sports Stacking by the World Cup Stacking Association (WCSA) (Udermann & Murray, 2006). The WCSA's mission was to promote standardisation and advancement for cup stacking. The WCSA then changed its name to the World Sports Stacking Association (WSSA)



**Figure 2.4. Speed Stacks Cups**

Sourced from ([http://image.dhgate.com/albu\\_474862882\\_00-1.0x0/12pcs-speed-stacks-deluxe-set-with-mat-bag.jpg](http://image.dhgate.com/albu_474862882_00-1.0x0/12pcs-speed-stacks-deluxe-set-with-mat-bag.jpg))

The designs of sports stacking cups are unique in many different ways (Figure 2.4). The cups are specially designed to decrease the chances of the cups sticking together. This will help the stacker to stack the cups faster and more efficiently. There are several ribs inside the cups and it is there to help separate the cups while they are being stacked together. The outside of the cup is slightly textured to assist the stacker with a better grip. The inside of the cup is very smooth and this allows the cups to slide on top of each other. There are four holes underneath the cup which assists with ventilation and preventing the sticking of the cups (<http://www.speedstacks.com>).

## **Studies**

Aside from sports stacking been a competitive sports code, studies have shown that sports stacking has been beneficial to improve reaction time as well as hand eye coordination (Udermann, Murray, Mayer & Sagendorf, 2004).

Udermann et al. (2004) stated that being involved in cup stacking can show an improvement in quickness and hand eye coordination. Sixty-nine children were recruited from Grade two and four. Children were divided into a control and intervention group. The intervention group performed cup stacking for 20–30 minutes a day, four times a week for three weeks. The control group received normal

physical education lessons. Results showed that cup stacking can significantly improve quickness and reaction time in children.

A study was conducted to determine which practice sequence of cup stacking works better. The two types were massed practice and distributed practice sequences (Gibbons, Hendrick & Bauer, 2007). The results from this study showed that distribute practice was more advantageous in enhancing performance and increasing the learning of cup stacking (Gibbons et al., 2007). Furthermore, a study conducted by Lee & Genovese (1989) stated that for optimal performance in motor skills, researchers need to determine whether massed or distribution practices were more beneficial. Baddeley & Longman (1978) proved that shorter and more frequent practice sessions can enhance performance and improve times in timed tasks.

There are claims that cup stacking allows the use of both sides of the body and the brain. This helps develop the skill of cup stacking. The aim of this study was to use an Electroencephalogram to measure the electrical activity of both hemispheres of the brain while performing cup stacking. The participants were 18 students from the Texas Technical University. Each participant had an introductory session, a practice session and a testing session. The results proved the claim that there is activation on both sides of the brain during cup stacking (Hart & Bixby, 2005).

A recent study conducted by Krog (2015) on the effects of a sports stacking intervention on enhancing learning performance in a Grade one academic programme. The intervention was conducted for eight and 16 weeks on 54 Grade one scholars. The intervention consisted of 20 minutes of sports stacking every day. The results indicated that the eight weeks measure impacted on the actual sports stacking but the 18 weeks measure effected time and sports stacking.

Sports stacking allows for an enhancement in motor skills such as directionality, laterality, perceptual motor functioning, crossing the midline and hand eye coordination (Fox, 2001). Krog (2010) defines laterality as “an internal awareness of the two sides of the body, namely left and right, as well as the two sides are different”. This is very important with regard to reading capabilities, as reading requires laterality. When it comes to reading, crossing the midline allows the visual are in the brain to overlap (Maguire, 2001). Sports stacking uses left and right movements as well as crossing the midline (Krog, 2015).



Overall, there are limited studies using cup or sports stacking as a means to assess improvements in hand eye coordination. Moreover, a limited number of studies have been published on children with even fewer on geriatrics.

## **2.8. CONCLUSION**

Taking into consideration the aim of the study which was to determine the short-term effects of a sports stacking intervention on the motor and cognitive functioning in geriatrics, the literature presented strengthens the need for such a study.

No data on the effects or relationship between sports stacking and geriatrics was found. This is a gap in the literature. However, there were numerous studies on interventions that improved selected components of motor and cognitive functioning in geriatrics. In particular, Hu and Woolacott (1994) stated that an improvement in balance due to exercise can optimise visual, vestibular and somatosensory systems in geriatrics and Colcombe et al. (2004) also showed that adults who participated in a regular walking protocol, had a positive outcome on their cognitive functioning.

Furthermore, the pre-and post-tests measures in this study were based on valid and reliable motor and cognitive tests presented in the literature. The Short Orientation Memory Concentration Test (Davous et al., 1987) and the Sharpened Romberg Test (Franchignoni et al. 1998; Black et al. 1983). Additionally, the duration of the intervention was similar to that of an intervention study carried out by Bisson et al. (2007). Lastly, Tseng et al. (2011) and Carstensen and Mikels (2005) used exercise to increase motor and cognitive functioning.

In conclusion, based on the literature presented, the methodology for this study was designed. The following chapter will present the methods and procedures.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 INTRODUCTION**

This chapter will explain the method that was used to carry out this study, as well as the research design and the sample population. Furthermore, all instruments used in this study will also explained in detail in this chapter.

#### **3.2 RESEARCH DESIGN**

This study was a quasi-experimental design with a pre- and post-intervention assessment. A quasi-experimental design refers to when the tester tries to follow the settings of the real-world while still trying to control the dangers that may affect the internal validity (Thomas, Nelson, & Silverman, 2011).

#### **3.3 POPULATION AND SAMPLE SELECTION**

The population was geriatrics residing in a retirement home in KwaZulu-Natal. A purposive sample (n=60) was recruited from a local retirement home in the Ethekwini region. Participants were randomly assigned to either the intervention (n=30) or control (n=30) group.

The sample adhered to the following inclusion/exclusion criteria:

##### **Inclusion criteria**

- Aged between 60 – 90 years old
- No physical disabilities
- No prior exposure to sports stacking
- No medical conditions or on medication that may affect balance, hand-eye coordination or memory like Vertigo, Alzheimer's and Parkinson's disease
- No orthopedic complications
- Sedentary (Not in a routine physical activity programme)

##### **Exclusion criteria**

- Not between the ages of 60 – 90 years old

- Physical disabilities
- Prior exposure to sports stacking
- Medical conditions or on medication that may affect balance, hand-eye coordination or memory like Vertigo, Alzheimer's and Parkinson's disease
- Orthopedic complications
- Not sedentary (Involved in a routine physical activity programme)

### **3.4 PROCEDURES AND PROTOCOL**

#### **Procedures**

A Gatekeeper's permission letter requesting permission to conduct this study was sent to The Association for the Aged (TAFTA) (Appendix One) via email. Gatekeeper's permission was received from the manager of TAFTA (Mary Asher Service Centre) (Appendix Two). Subsequent ethical clearance was granted from the Biomedical Research Ethics Committee (BFC 186/15) at the University of KwaZulu-Natal (Appendix Three).

#### **Protocol**

##### **Step 1**

A call for participants was sent out via flyers (Appendix Four) and was posted at the selected retirement home.

##### **Step 2**

Participants who adhered to the inclusion criteria were required to read the Participant Information Letter and complete the consent form (Appendix Five), of which they received a copy.

##### **Step 3**

Participants were randomly divided into the intervention and control groups. The randomisation process used was the manual randomisation. Participants' study numbers were placed into a hat and drawn out, and assigned to either group.

#### Step 4

Pre-intervention: Baseline measures of all participants were determined. Body Mass Index (BMI), hand-eye-coordination, reaction time, memory, psychometric tests and balance were assessed three days prior to the intervention. The baseline measures were approximately an hour per participant over two days. All the results were recorded accordingly.

#### Step 5

The Intervention (8 weeks): On week one and two, participants were familiarised regarding the background of sports stacking. They wore comfortable clothes and flat comfortable shoes. The techniques were demonstrated to the participants to familiarise them with the movements required. The sports stacking intervention (Appendix Six) was conducted at the retirement home.

It consisted of two 60-minute sessions a week for eight weeks. The sessions were conducted as a 25-minute session with a short break and another 25-minute session. Studies have stated that there is a reduction in attention efficiency in the geriatric population (Commodari & Guarnera, 2008), hence intermittent training is recommended.

The intervention consisted of a multistage progression from basic to advanced techniques of cup stacking, as well as progression from slow to fast speeds of performing the techniques. Participants were required to learn three different sports stacking sequences which were the 3-3-3 (Figure 3.1), 3-6-3 (Figure 3.2) and the Cycle (Figure 3.3). The techniques were designed to use both hands and thus both sides of the brain. It stimulates neural pathways due to the cross-body action of the arms. The sequences that the participants were taught consisted of a memory component. The intervention also included physical activity such as relays. Relays consisted of working in teams and or pairs which required a socialisation aspect as well as ensuring interactive activities among participants.



Figure 3.1: 3-3-3 sequence



Figure 3.2: 3-6-3 sequence

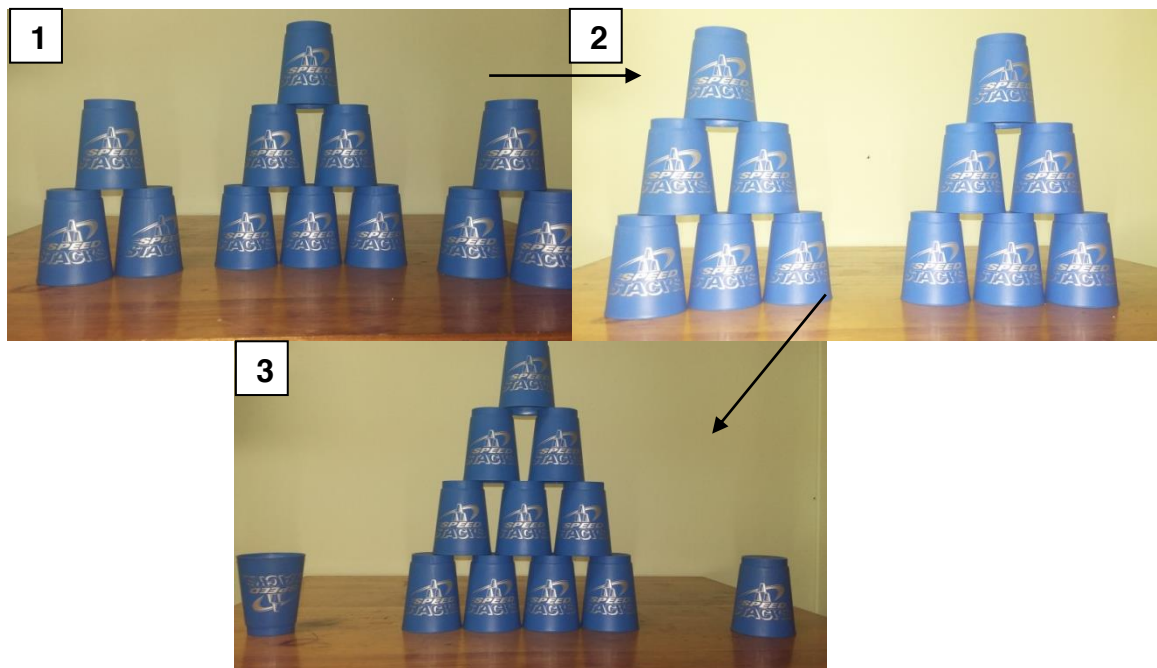


Figure 3.3: The Cycle

Participants were encouraged to improve their times at each session. Times from each session were recorded (Appendix Seven).

The non-sport stacking participants (control group) remained sedentary. Participants were not allowed to participate in the sport stacking lessons, and were requested to abstain from any physical activity programmes. However, once the intervention time-period was completed, the control group was exposed to the intervention.

Post-intervention: All participants were re-assessed on baseline measures.

### **3.5 INSTRUMENTATION**

#### **Body Mass Index (BMI) – (American College of Sports Medicine, 2013)**

Height was measured by using the 'Nagata BW-1122H'. The participants were told to take off their shoes, stand with their feet together and hands at their side. Their bodies were in contact with the wall. Their weight was also measured by using the 'Nagata BW-1122H'. The scale was calibrated before testing. The participants were asked to stand on the scale without shoes on and to remove all unnecessary clothing. Body Mass Index was measured using height and weight measurements. Body Mass Index was calculated using the following formulae:

$$\frac{Weight}{(Height)^2}$$

Body mass index results were determined by the following classification (American College of Sports Medicine, 2013) :

Classification	BMI (Kg/M <sup>2</sup> )	Sub-Classification	BMI (kg/m <sup>2</sup> )
Underweight	< 18.50		
Normal Range	18.5 - 24.99		
Overweight	≥ 25.00- 29.99		
Obese	≥ 30.00	Obese Class I	30.00 - 34.99
		Obese Class II	35.00 - 39.99
		Obese Class II	≥ 40.00

**Figure 3.4: BMI Classification table**

All results were recorded accordingly (Appendix Eight).

**Hand eye coordination – (Oja & Tuxworth, 1995)**

Hand eye coordination was measured using the plate-tapping test. This test was used to assess the speed and the coordination of limb movement. It utilised a table with adjustable height, a plate-tapping board (two green disks at least 20cm in diameter and a rectangular piece of 30 x 20cm) (Figure 3.5) and a stopwatch. The table height was adjusted to a comfortable height for each participant. Participants placed their non-preferred hand on the rectangle. The participants then moved their preferred hand back and forth between the green disks over the hand in the middle as quickly as possible while an examiner timed them with a stopwatch. This action

was repeated for 25 full cycles (50 taps). The recorded times were electronically saved on a computer for data analysis. All results were recorded accordingly (Appendix Nine).



**Figure 3.5: Plate-Tapping Board**

### **Memory – (Lezak, 1995)**

The participants were tested on their memory by answering the short orientation-memory-concentration test (SOMCT) (Appendix Ten). The test used a negative scoring scale. Each question had a maximum number of errors allowed, for example the question, “what year is it now?” Had a maximum error score of 1, multiplied by its weight which is 4, equalling in a score of 4 if the error is made. If no errors were made the score remained as 0. The score that they got for each question was added together to result in a total error score out of 28, with the higher score being bad and a lower score of 0-6 being of normal limits. The tests were then collected and stored physically in a file and electronically on a computer for data analysis. All results were recorded accordingly (Appendix Eleven).

### **Balance – (Briggs, Gossman, & Birch, 1989)**

The participants were tested on balance using the Sharpened Romberg test. This test was used to measure the level of balance and proprioception of an individual. The test was performed in a heel-to-toe standing position with the dominant foot behind the non-dominant foot. The timer began when the participant assumed the proper position and indicated that they were ready. If the participant moved their feet from the position, opened their eyes on the closed-eyes trial, or reached the maximum test time of 60 seconds, then the timer stopped. The participants had three trials to reach the maximum time of 60 seconds. The longest balance time of the



three trials were taken as their score. The participants stood in three different positions, i.e. feet together, semi-tandem, and tandem. Each position was held for 10seconds, with eyes open and then another 10seconds with their eyes closed. The participants who successfully completed two out of three tests were scored as “balanced”. All results were recorded accordingly (Appendix Twelve).



**Figure 3.6: Feet together**



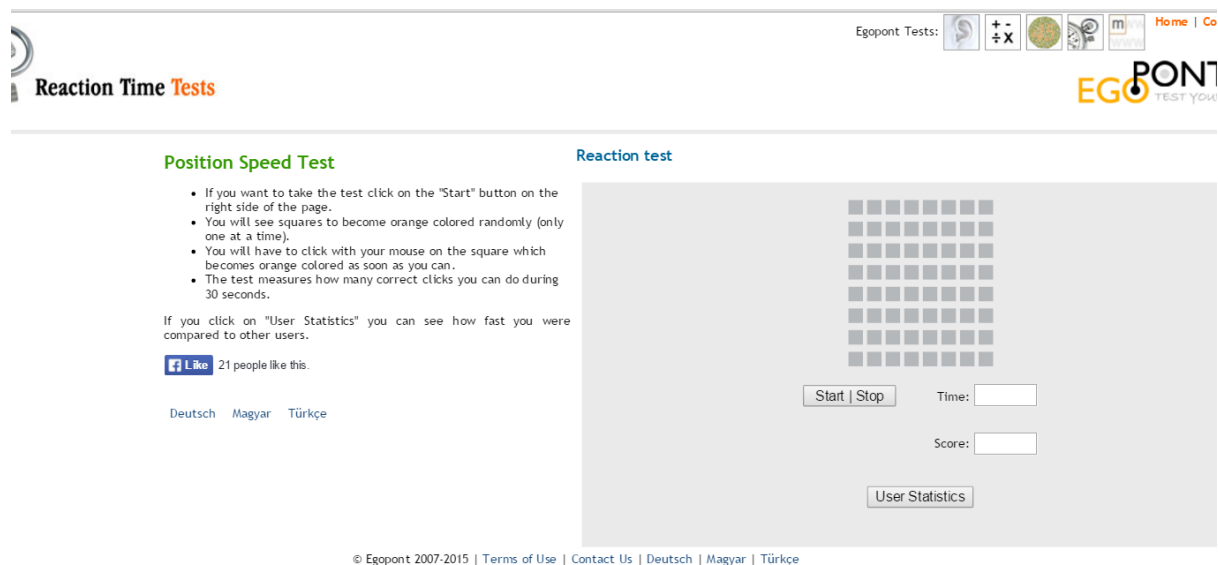
**Figure 3.7: Tandem**



**Figure 3.8: Semi-tandem**

## Reaction Time – (“www.egopont.com/reaction\_positionspeed\_test.php)

The participants were tested using an online Position Speed Test. It was a computer based test that was used to assess simple reaction time. Participants were required to respond as quickly as possible to an orange square that appeared on a grid table on the screen. Once they clicked on the orange square it randomly moved to another block on the grid. The participants had 30 seconds to “click on” as many orange squares as possible to determine their level of reaction time. The participants had two attempts at the test and the best score was recorded. All results were recorded accordingly (Appendix Thirteen).



**Figure 3.9: Position Speed Test**

## Lawton’s Activity of Daily Living Questionnaire - (Graf, 2008)

The Lawton Active Daily Living Questionnaire (Appendix Fourteen) was a functional assessment of their independence. It focused on testing basic capabilities. The questionnaire measured functioning at the present time and attempted to determine improvements or decreases in functioning. It measured the use of a telephone, shopping, food preparation, housekeeping, laundry, mode of transport, responsibility of medication, and their ability to handle personal finances. The scoring was as follows; one (1) point is given when able to perform the tasks and zero (0) points were given when unable to perform the task. The higher the score, the more capabilities and the lower the score, the greater need for dependence on another person. The final score was out of eight (8) (Appendix Fifteen).

### **3.6 CONCLUSION**

This chapter provided a description of the methods that were used in order to achieve the study objectives. The protocol was strictly adhered to. The following chapter will present the manuscript which will be submitted to an accredited peer-reviewed journal for publication.

## **CHAPTER FOUR**

### **MANUSCRIPT**

#### **The Short-term Effects of a Sports Stacking Intervention on the Cognitive and Perceptual Motor Functioning In Geriatrics**

Authors: Moodley, K and Naidoo, R

Discipline of Biokinetics, Exercise and Leisure Sciences, University of KwaZulu-Natal, College of Health Sciences, South Africa

#### **Corresponding Author**

Rowena Naidoo

University of KwaZulu-Natal  
Discipline of Biokinetics, Exercise and Leisure Sciences

Private Bag X54001  
Durban, 4000  
South Africa

Tel: +27 31 260 8235  
Fax: +27 31 260 7903  
Cell: +27 83 777 2813  
email: [naidoor3@ukzn.ac.za](mailto:naidoor3@ukzn.ac.za)

## **ABSTRACT**

The aim of this study was to determine the effects of sport stacking on geriatric motor and cognitive functioning. Sport stacking has been beneficial to improve reaction time as well as hand eye coordination in children and adults (Udermann, Murray, Mayer & Sagendorf, 2004). However, there are limited studies on the motor and cognitive functioning benefits of sports stacking among geriatrics. This quasi-experimental study design with a pre and post intervention was conducted at a local retirement home. A purposive sample of 60 geriatric male and female participants were recruited to participate in this study. Participants were randomly divided into an intervention group (n=30) and a control group (n=30). All participants completed pre- and post-test motor and cognitive measures. The motor functioning tests included, hand eye coordination, reaction time, balance and quality of life tests. The cognitive function test included memory capabilities. The intervention group completed an eight week sports stacking intervention while the control group remained sedentary and continued with daily activities as per norm. Post-tests results showed that the intervention group had a significant improvement in reaction time, sports stacking times and plate tapping scores. However, there were no significant results with memory, quality of life and hand eye coordination tests.

## **INTRODUCTION**

Sports stacking is defined as an individual or team activity where participants stack and unstack specially designed plastic cups in pre-determined sequences while racing against the clock or an opponent (Udermann & Murray, 2006). Sports stacking is easy to learn and helps to improve hand eye coordination, reaction time and skill development (Godinet, 1986). Sports stacking allows for an enhancement in motor skills such as directionality, laterality, perceptual motor functioning, crossing the midline and hand eye coordination (Fox, 2001). However, all these motor skills are affected by the ageing process.

The process of ageing effects the functioning of the nervous system, cardiopulmonary, skeletomuscular and other organ systems additionally, as ageing begins, there is a decreases in brain weight and the rate of blood flow (Tseng, Gau & Lou, 2011). These factors collectively cause memory loss, reduction in learning abilities and a decrease in cognitive functioning (Pang, Chow, Cummings, Leung,

Chiu, Lam & Fuh, 2002). Physical activity is associated with decreased risks of cognitive impairments (Cotman & Berchtold, 2002). A study conducted by Colcombe, Kramer, Erickson, Scalf, McAuley, Cohen & Elavsky (2004) showed that adults who participated in a regular walking protocol had a positive outcome on their cognitive functioning. Furthermore, intervention studies show a positive relationship between fitness and improvements in cognition and brain function (Kramer, Erickson & Colcombe, 2006). Physical activity also promotes improvements in psychological well-being such as positive feelings, decreasing stress responses, increasing confidence and improving sleeping patterns (Tseng et al., 2011).

Reaction time is known as “an important index of functional age” (Mathey, 1976). Reaction time and hand eye coordination has shown to decrease with age (Ratcliff, Thapar & McKoon, 2001). Geriatrics have a slower reaction time as their response to a given task in comparison to younger persons, is more careful. Additionally, older persons are more conservative compared to younger individuals (Ratcliff et al., 2001). Age is a major contributor to lower reaction time due to it being affected via the decrease in central processing speed, decrease in passive joint flexibility, being more cautious before responding to certain tasks and the change in neuromuscular properties (Welford, 1977).

As ageing occurs, hand precision decreases. This is a natural phenomenon in ageing and it results in hand tremours. This requires movements to be repeated until performed correctly. Hand tremours cause a feeling of helplessness due to repetition and also requires more time when carrying out simple everyday tasks (Sebastjan, Dabrowska, Ignasiak & Zeurek, 2008). It has been shown that there is a decrease in standing and walking in geriatrics, due to the loss of confidence if they have previously fallen (Joshua, D’Souza, Unnikrishnan, Mithra, Kamath, Acharya & Venugopal, 2014; Tucker, Kavanagh, Barrett & Morrison, 2008).

Geriatrics may also find it difficult to perform simple everyday tasks. Cahn-Weiner, Boyle, Malloy, Razani, Casas, Wong, & Josephson (2002) examined the functioning for determining instrumental activities of daily living (IADL) in community living geriatrics. The results of the study showed that there is a strong relationship between functional independence and executive abilities in older persons (Cahn-Weiner et al.,

2002). Executive functioning is defined as the ability to perform goal-directed, complex and self-serving tasks (Royall, Chiodo & Polk, 2000).

Ageing results in muscular strength decreases which affects proprioception (Hurley, Rees & Newham, 1998). Lin & Bhattacharyya (2012) showed that one in every five geriatrics experience problems with dizziness or balance. Balance problems arose from unsteadiness, vertigo, trying to walk on uneven surfaces as well as faintness. It was also found that certain prescribed medication could trigger dizziness and balance problems (Lin & Bhattacharyya, 2012). Balance is maintained via sensory and musculoskeletal systems and this is affected by the ageing process. Geriatrics who have experienced a fall lose confidence in their physical capabilities which results in them being hesitant to participate in physical activity/exercise (Matsumura & Ambrose, 2006). Hu & Woollacott (1994) also showed that an improvement in balance due to exercise can optimise visual, vestibular and somatosensory systems in geriatrics.

Medication such as sedatives and anti-inflammatory drugs is also a major cause of falls due to tiredness and loss of complete muscle function (Cumming, 1998). Sarcopenia is defined as the age-related loss in muscle mass and function (Sayer, Robinson, Patel, Shavlakadze, Cooper & Grounds, 2013) and it results in decreases in physical endurance and flexibility (Cadore, Rodríguez-Mañas, Sinclair & Izquierdo, 2013). These all work together and in turn, there is a decrease in one's balance abilities (Konrad, Girard, & Helfert, 1999).

Cognitive impairment has been shown to be one of the strongest independent predictors for fall induced fractures (Bergland & Wyller, 2004). Moderate to high intensity resistance training results in health benefits for geriatrics such as decreasing the risk of common chronic diseases and helps improve mental and physical fitness (Cassilhas, Viana, Grassmann, Santos, Tufik & Mello, 2007). Improvements in motor and cognitive functioning may be beneficial to improve brain functioning and quality of life (Fleming, Evans, Weber, & Chutka, 1995).

Furthermore, a common problem amongst the geriatric population is their loss or slow decline of memory (Kral, 1962). Memory problems is the most common and difficult hurdle faced (Hertzog & Dixon, 1994).

Foerster, Carbone, Schneider, Chen & College (2014) used sports stacking to test long-term memory but it was used simultaneously with a verbal task. Results showed that sports stacking did not improve long term memory. Additionally, substantial improvements in reaction time can occur due to the regular participation in exercise or physical activity in general (Dustman, Ruhling, Russell, Shearer, Bonekat, Shigeoka & Bradford, 1984; Rudisill & Toole, 1992).

Sport stacking has been beneficial to improve reaction time as well as hand eye coordination in children and adults. However, there are limited studies on the motor and cognitive functioning benefits of sports stacking among geriatrics. Hence, the aim of this study was to determine the short-term effects of a sports stacking intervention on the motor functioning (hand eye coordination, reaction time and quality of life and cognitive functioning (memory and balance) in geriatrics.

## **METHOD**

### *Design*

This study was a quasi-experimental design with a pre- and post-intervention assessment. Permission to conduct this study was granted from The Association for the Aged in KwaZulu-Natal and ethical clearance from the University's Biomedical Research Ethics Committee (BFC 186/15) was also granted.

### *Participants*

A purposive sample (n=60) of geriatrics aged between 60-90 years were recruited from a local retirement home in KwaZulu-Natal. Participants were randomly assigned to either the intervention (n=30) or control (n=30) group. The sample adhered to the following inclusion criteria; had no physical disabilities; had no sports stacking experience; had no medical conditions including Alzheimer's or Parkinson's disease; no medication for Vertigo, hand eye coordination or memory; had no orthopedic complications; and were sedentary. A call for participants was posted via flyers at the retirement home. Participants that adhered to the inclusion criteria completed consent forms and were then randomly assigned into either the intervention or control group.



## *Tests*

Pre- and post-tests measures included Body Mass Index (BMI) (American College of Sports Medicine, 2008); motor and cognitive functioning tests. Motor functioning tests for hand eye coordination (Plate Tapping Test) (Oja & Tuxworth, 1995), reaction time (Position Speed Test); quality of life (Lawton's Instrumental Activities Daily Living Questionnaire) (Graf, 2008); and balance (Sharpened Romberg Test) (Briggs, Gossman, & Birch, 1989) were measured. The cognitive functioning test for memory utilised the Short Orientation Memory Concentration Test (SOMCT) (Lezak, 1995). All measures were assessed three days prior to the start of the intervention. Sports stacking times were also recorded as these were measured during the intervention.

## *The intervention*

The eight-week sports stacking intervention (Appendix 6) consisted of two 60-minute sessions. The sessions were conducted as a 25-minute session with a short ten minute break and another 25-minute session. There is a reduction in attention efficiency in the geriatric population (Commodari & Guarnera, 2008), hence intermittent training programme. The intervention consisted of a multistage progression from basic to advanced techniques of cup stacking, as well as progression from slow to fast speeds of performing the techniques.

Participants were required to learn three different sports stacking sequences which were the 3-3-3 (Figure 1), 3-6-3 (Figure 2) and the Cycle (Figure 3). The techniques were designed to use both hands and thus both sides of the brain (Madigan & Delaney, 2009). It stimulates neural pathways due to the cross-body action of the arms. The crossing of the midline and using both hands activates both sides of the brain which results in developing new connections in the brain. This connection initiates brain growth (Fox, 2001). Physical activity such as walking/jogging relays were included. All sports stacking times were recorded.



Figure 1: 3-3-3 sequence



Figure 2: 3-6-3 sequence

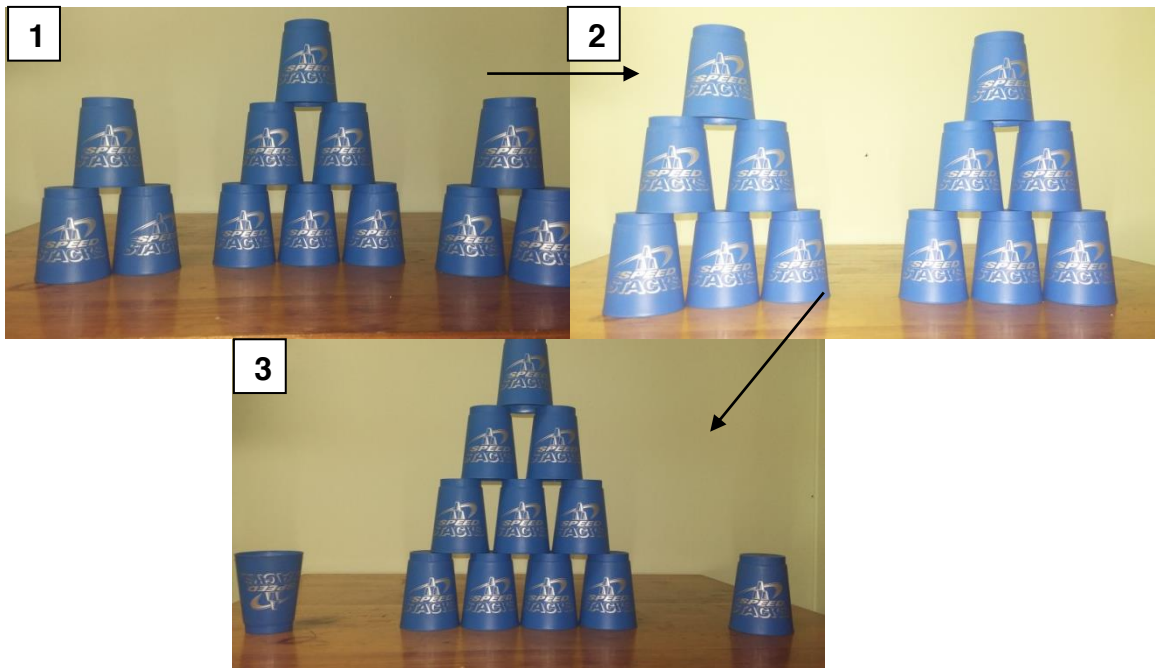


Figure 3: The Cycle

The control group remained sedentary and continued with their daily schedules as per norm.

### *Instrumentation*

Body mass index was assessed according to the American College of Sports Medicine guidelines (American College of Sports Medicine, 2008). Height was measured by using the 'Nagata BW-1122H'. The participants were requested to remove their shoes, stand with their feet together and hands at their side. Their bodies were in contact with the wall. Their weight was also measured by using the 'Nagata BW-1122H'. The scale was calibrated before testing.

The plate tapping test (Oja & Tuxworth, 1995) assessed the speed and the coordination of limb movement. It utilised a table with adjustable height and a plate tapping board (two green disks at least 20cm in diameter and a rectangular piece of 30 cm x 20cm). The table height was adjusted to a comfortable height for each participant. Participants placed their non-preferred hand on the rectangle. The participants then moved their preferred hand back and forth between the green disks over the hand in the middle as quickly as possible. This timed action was repeated for 25 full cycles (50 taps).

The position speed test was an online computer based test that assessed simple reaction time. Participants were required to respond as quickly as possible to an orange square that appeared on a grid table on the screen. Once they clicked on the orange square it randomly moved to another block on the grid. The participants had 30 seconds to click as many orange squares as possible to determine their level of reaction time. The participants had two attempts at the test and the best score was recorded ("[http://www.egoport.com/reaction\\_positionspeed\\_test.php](http://www.egoport.com/reaction_positionspeed_test.php)").

Balance and proprioception was assessed using the Sharpened Romberg test (Briggs et al., 1989). This timed test was performed in a heel-to-toe standing position with the dominant foot behind the non-dominant foot. If the participant moved their feet from this position, opened their eyes when instructed that is should be closed or reached the maximum test time of 60 seconds, then the timer stopped. The participants had three trials to reach the maximum time of 60 seconds. The longest balance time of the three trials were taken as their score. The participants stood in

three different positions, i.e. feet together, semi-tandem, and tandem. Each position was held for ten seconds, with eyes open and then another ten seconds with their eyes closed. The participants who successfully completed two out of three tests were scored as “balanced”.

The Lawton’s Instrumental Activities of Daily Living Questionnaire (Graf, 2008) was a functional assessment of their independence. The questionnaire measured functioning at the present time and attempted to determine improvements or decreases in functioning. It measured the use of a telephone, shopping, food preparation, housekeeping, laundry, mode of transport, responsibility of medication, and their ability to handle personal finances. The scoring was as follows; one (1) point is given when able to perform the tasks and zero (0) points were given when unable to perform the task. The higher the score, the more capabilities and the lower the score, the greater need for dependence on another person. The final score was out of eight.

The SOMCT (Lezak, 1995) assessed memory. The test used a negative scoring scale. Each question had a maximum number of errors allowed, for example the question, “what year is it now?” Had a maximum error score of 1, multiplied by its weight which is 4, equalling in a score of 4 if the error is made. If no errors were made the score remained as 0. The score for each question was added together to result in a total error score out of 28, with the higher score being below normal and a lower score of 0-6 being of normal limits.

All measures were approximately an hour per participant and were conducted over two days.

## **STATISTICAL ANALYSIS**

The data collected in this study was subjected to various statistical procedures. All the data was analysed by a computerised statistical program known as SPSS Version 19. Descriptive (means and standard deviations) and inferential (paired t-tests) statistics were used to test significant differences pre- and post- intervention. The changes in the mean and standard deviations were compared to the pre and post test scores for the intervention and control groups. Sports stacking scores were

also analysed to determine whether the participant's times decreased (improved) during the intervention. Statistical significance was set at  $p < 0.005$ .

## RESULTS

Pre-intervention included a 100% compliance of 60 participants. However, due to adverse events (death) of two participants, data presented will represent 58 participants (intervention group  $n=28$ ; control group  $n=30$ ).

### *Participants*

Ages ranged from 60 to 89 years with a mean age of 72.97 for the sample. The mean age in the intervention group was 73.14 ( $\pm 7.73$ ) years old and 72.80 ( $\pm 7.31$ ) years in the control group.

A total of 12 males and 48 females participated in the study. The intervention group comprised of five males and 23 females while the control group comprised of seven males and 23 females.

The mean BMI pre-intervention was  $28.98 \text{ kg/m}^2$  and post-intervention was  $29.00 \text{ kg/m}^2$ .

### *Motor Functioning Components*

Table 1: Motor functioning results for the control and intervention group

COMPONENTS	CONTROL MEAN ( $\pm$ STANDARD DEVIATION)			INTERVENTION MEAN ( $\pm$ STANDARD DEVIATION)		
	PRE	POST	p-value	PRE	POST	p-value
Plate Tapping Test (seconds)	29.14 ( $\pm 10.03$ )	27.60 ( $\pm 11.46$ )	0.015*	22.32 ( $\pm 3.34$ )	19.70 ( $\pm 2.88$ )	0.000*
Simple Reaction Time Test (seconds)	15.30 ( $\pm 9.61$ )	17.23 ( $\pm 8.29$ )	0.037*	16.36 ( $\pm 6.86$ )	20.82 ( $\pm 7.04$ )	0.000*
Lawton's Instrumental Activities of Daily Living Questionnaire (n)	7.60 ( $\pm 0.77$ )	7.77 ( $\pm 0.57$ )	0.134	7.71 ( $\pm 0.74$ )	7.89 ( $\pm 0.32$ )	0.134

\*  $p < 0.005$

Table 1 depicts the pre- and post-test results for the control and intervention groups. It is evident that there was a significant difference in the Plate Tapping Test and Simple Reaction Time Test scores. The intervention group had a significant difference in the 'Plate tapping measure' ( $t(27)=5.636, p<0.0005$ ) and the 'Reaction Time measure' ( $t(27)=5.927, p<0.0005$ ). The control group had a significant difference in the 'Plate tapping measure' ( $t(29)=2.588, p<0.015$ ) and the 'Reaction Time measure' ( $t(29)=2.184, p<0.0037$ ). Although both groups presented with significant changes post-intervention in the plate tapping scores, the intervention group's level of improvement was higher (2.6 seconds) compared to the control group's (1.5 seconds) time. Similarly, the intervention group presented with a higher level of improvement in the mean reaction time measurement (4.4 seconds) than the control group (1.9 seconds).

For the balance measure, a non-parametric sign test was applied to the pairs of measures to determine if there were significant differences pre- and post-intervention. The Sharpened Romberg test's pre- and post-intervention mean scores were not significant, although an improvement in scores was noted post-test.

### *Cognitive Functioning Components*

Table 2: Cognitive functioning results for the control and intervention group

COMPONENT	CONTROL MEAN (± STANDARD DEVIATION)			INTERVENTION MEAN (± STANDARD DEVIATION)		
	PRE	POST	p-value	PRE	POST	p-value
Short Orientation Memory Concentration Test	3.93 (±4.04)	3.00 (±3.17)	0.109	3.50 (±4.18)	2.50 (±2.67)	0.204

Table 2 depicts the pre- and post-test results for the control and intervention group. There were no significant differences between the control and intervention group pre- and post-intervention for memory.

## SPORTS STACKING TIMES

The intervention group only performed the sport stacking activities. Results indicated improvements in sports stacking times. Average times clearly decreased over time (Figures 4, 5 and 6).

### 3-3-3

There was a significant effect of time on stacking 3-3-3,  $F(7,42) = 19.187, p < 0.0005$ .

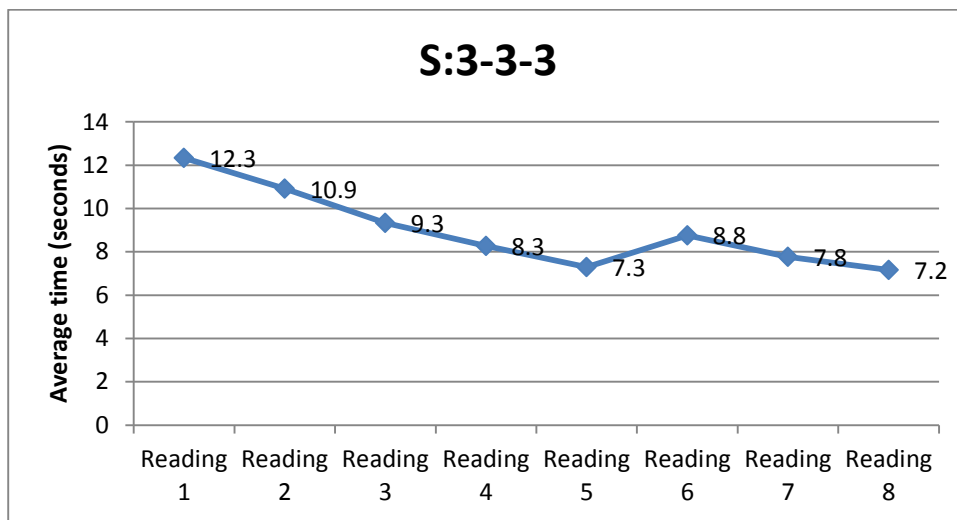


Figure 4: 3-3-3 average sports stacking times

### 3-6-3

There was a significant effect of time on stacking 3-6-3,  $F(1,43) = 6.082, p < 0.029$ .

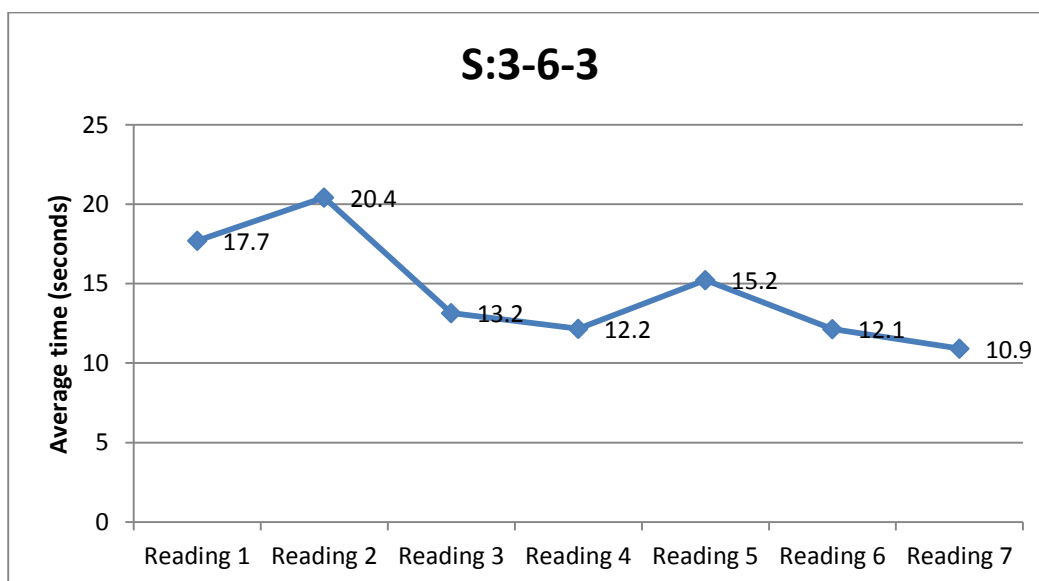


Figure 5: 3-6-3 average sports stacking times

*The Cycle*

There was a significant effect of time on stacking the cycle,  $F(2.14) = 19.945$ ,  $p < 0.0005$ ).

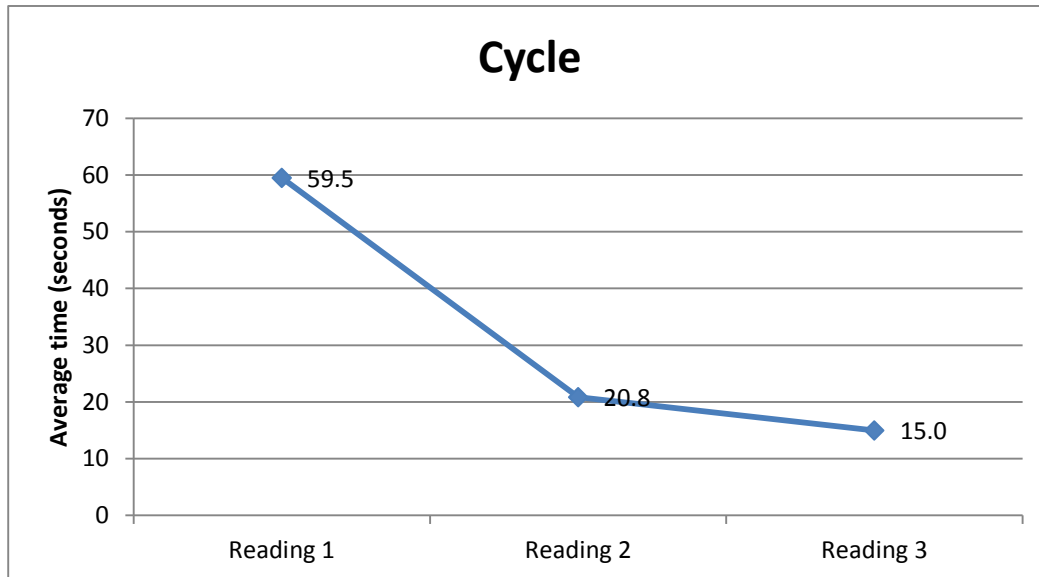


Figure 6: The cycle average sports stacking times

**DISCUSSION**

Sports stacking focuses on motor skills, i.e. hand eye coordination, directionality, laterality, crossing the midline and motor functioning (Fox, 2001; Udermann et al., 2004). Apart from sports stacking as a competitive sports code, studies have shown that sports' stacking has been beneficial to improve reaction time as well as hand-and-eye coordination (Udermann et al., 2004). Krog (2015) implemented a sports stacking intervention and the results indicated that eight weeks post-tests showed improvements on the skill of sports stacking. However, the 16 weeks post-tests showed improvements in sports stacking times as well as the skill of sports stacking. The increased duration of the intervention demonstrated improved motor functioning (hand eye coordination).

Similarly, results from the current study showed that there was a positive effect on participants hand eye coordination and reaction time in the intervention and control



group (Table 1). Even though there was a significant difference in both groups, the intervention group had a larger level of improvement than the control group. The skill of sport stacking was also improved as the intervention groups sports stacking times significantly improved over time. This was achieved due to the participants practising the sequences and remembering the techniques. Similarly, Udermann et al. (2004) conducted a study that also demonstrated that cup stacking can significantly improve quickness and reaction time, however, this was among children. To the best of the authors knowledge, there are no current sport stacking intervention studies conducted on geriatrics.

Khemthong, Pejarasangharn, Uptampohtiwat & Khanya (2012) conducted a study on the effects of musical training on reaction time in elderly individuals showed that there was almost a 19% increase in visual unwarned-reaction time. However, the intervention of sports stacking improved reaction time in the intervention group more so than the intervention of musical training, indicating that the sports stacking intervention can positively increase geriatrics reaction speed time. Similarly, in the current study there was a significant difference between groups in the Simple Reaction Time Test. The control group had a positive increase in reaction time whilst the intervention group had a larger positive increase in reaction time.

Ageing also effects brain functioning in relation to memory and the ability to remember tasks. The present study did not show an improvement in memory. However, on the contrary, studies have shown to improve memory functioning in geriatrics, specifically when memory loss is detected early, as it can allow for an intervention to be implemented (Cockburn & Collin, 1988). Colcombe et al. (2004) also showed that adults who participated in a regular walking protocol, had a positive outcome on their cognitive functioning. It was also hypothesised that intervention studies show a positive relationship between fitness and improvements in cognition and brain function (Colcombe et al., 2006). Wolf, Feys, De Weerd Van der Meer, Noom, Aufdemkampe & Noom (2001) recruited geriatric participants residing in residential care facilities and presented with balance problems. A four to six week intervention of 12 individualised balance exercises showed significant post-intervention. A short-term, individualised exercise programme can improve balance in geriatrics over the age of 75 (Wolf et al., 2001).

Physical activity is a very common and beneficial public health intervention used to maintain or better the quality of life in geriatrics (Drewnowski & Evans, 2001). The quality of life assessment used in the current study did not show a significant difference post-intervention. This could also be due to the small and possible biasness demonstrated by the participants. Biasness refers to them not answering the questionnaire truthfully. This was not evident in the current study. However, studies (Drewnowski & Evans, 2001; Owsley et al., 2002) conducted have shown improvements in quality of life abilities in geriatrics. Similarly, a study conducted by Cahn-Weiner et al. (2002) examined functioning for determining instrumental activities of daily living (IADL) in community living geriatrics. Two assessments were used, namely the neuropsychological and IADL assessments. The IADL assessment measured functional abilities such as dressing-up, medication administration and financial management. Results showed that there is a strong relationship between functional independence and executive functioning abilities in older persons (Cahn-Weiner et al., 2002).

Overall, the results from this study shows that a short-term sports stacking can be beneficial for the geriatric population. Significant effects on motor functioning such as hand eye coordination and reaction time was demonstrated post-intervention. It is apparent that studies relating to sports stacking is very limited. Additional research needs to be conducted on the cognitive effects of sports stacking on as well as its short- and long-term effects on the geriatric population.

In conclusion, it was apparent that the sports stacking intervention proved to be beneficial in improving hand eye coordination and reaction time (motor functioning) among geriatrics. This particular sports stacking intervention could be beneficial if implemented at retirement/old age homes as it could create improvements in motor functioning and possible cognitive functioning. A long-term sports stacking intervention may also be more beneficial resulting in improvements in both motor and cognitive functioning.

Finally, there were major limitations to this study. Firstly, the small sample size. The small sample size impacted the significance of selected results. Secondly, the study participants were geriatrics from a retirement/old age home and not community living geriatrics. Furthermore, a limited number of males participated in this study which

resulted in majority of the participants being females (83%). Lastly, additional cognitive functioning tests should have been included like the Rivermead Behavioural Memory Test and the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) to increase the validity of testing this component.

## **ACKNOWLEDGMENTS**

The authors would like to acknowledge and thank the participants at the old age home who willingly participated in this study.

## **DECLARATION OF CONFLICTING INTEREST**

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

## **FUNDING**

This study was funded by the College of Health Sciences, University of KwaZulu-Natal.

## **REFERENCES**

- American College of Sports Medicine (Ed.). (2013). *ACSM's health-related physical fitness assessment manual*. Lippincott Williams & Wilkins.
- Applegate, W., Blass, J., & Franklin Williams, T. (1990). Instruments for the functional assessment of older patients. *N Engl J Med*, *322*(17), 1207–1214.
- Bergland, A., & Wyller, T. B. (2004). Risk factors for serious fall related injury in elderly women living at home. *Injury prevention*, *10*(5), 308-313.
- Briggs, R. C., Gossman, M. R., Birch, R., Drews, J. E., & Shaddeau, S. A. (1989). Balance performance among noninstitutionalized elderly women. *Physical Therapy*, *69*(9), 748-756.

- Cadore, E. L., Rodríguez-Mañas, L., Sinclair, A., & Izquierdo, M. (2013). Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. *Rejuvenation Research*, *16*(2), 105–114. <http://doi.org/10.1089/rej.2012.1397>
- Cahn-Weiner, D., Boyle, P., Malloy, P. F., Razani, J., Casas, R., Wong, J. T., & Josephson, K. (2002). Tests of executive function predict instrumental activities of daily living in community-dwelling older individuals. *Applied Neuropsychology*, *9*(3), 187–191. <http://doi.org/10.1207/S15324826AN0903>
- Cassilhas, R. C., Viana, V. R., Grassmann, V., Santos, R. T., Santos, R. F., Tufik, S., & Mello, M. T. (2007). The impact of resistance exercise on the cognitive function of the elderly. *Medicine and Science in Sports and Exercise*, *39*(19), 1401–1407. <http://doi.org/10.1249/mss.0b013e318060111f>
- Cockburn, J., & Collin, C. (1988). Measuring everyday memory in elderly people: a preliminary study. *Age and Ageing*, *17*, 265–269.
- Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., & Elavsky, S. (2004). Cardiovascular fitness, cortical plasticity, and aging. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(9), 3316–3321. <http://doi.org/10.1073/pnas.0400266101>
- Commodari, E., & Guarnera, M. (2008). Attention and aging. *Aging clinical and experimental research*, *20*(6), 578–584.
- Cotman, C. W., & Berchtold, N. C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences*, *25*(6), 295–301. [http://doi.org/10.1016/S0166-2236\(02\)02143-4](http://doi.org/10.1016/S0166-2236(02)02143-4)
- Cumming, R. G. (1998). Epidemiology of medication-related falls and fractures in the elderly. *Drugs & Aging*, *12*(1), 43–53. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9467686>
- Drewnowski, A., & Evans, W. J. (2001). Nutrition, physical activity, and quality of life in older adults: Summary. *The Journals of Gerontology, Series B: Psychological*

*Sciences and Social Sciences*, 56(suppl 2), 89–94.  
[http://doi.org/10.1093/gerona/56.suppl\\_2.89](http://doi.org/10.1093/gerona/56.suppl_2.89)

Dustman, R. E., Ruhling, R. O., Russell, E. M., Shearer, D. E., Bonekat, H. W., Shigeoka, J. W., & Bradford, D. C. (1984). Aerobic exercise training and improved neuropsychological function of older individuals. *Neurobiology of aging*, 5(1), 35-42.

Fleming, K., Evans, J., Weber, D., & Chutka, D. (1995). Practical functional assessment of elderly persons: a primary-care approach. *Mayo Clinic Proceedings*. Retrieved from <http://www.sciencedirect.com/science/article/pii/S0025619611639499>

Foerster, R. M., Carbone, E., Schneider, W. X., Chen, S., & College, A. E. (2014). Long-term memory-based control of attention in multi-step tasks requires working memory: evidence from domain-specific interference, 5(May), 1–8.  
<http://doi.org/10.3389/fpsyg.2014.00408>

Fox, B. (2001). Speed Stacks. Instructor Catalogue. *Speed Stacks Inc.*

Godinet, W. (1986). Cup stacking game apparatus.

Graf, C. (2008). The Lawton instrumental activities of daily living scale. *The American Journal of Nursing*, 108(23), 52–62; quiz 62–63.  
<http://doi.org/10.1097/01.NAJ.0000314810.46029.74>

Hertzog, C., & Dixon, R. (1994). Metacognitive development in adulthood and old age. Retrieved from <http://psycnet.apa.org/psycinfo/1994-97967-011>

Hu, M. H., & Woollacott, M. H. (1994). Multisensory training of standing balance in older adults: I. Postural stability and one-leg stance balance. *Journal of Gerontology*, 49(2), M52–61. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/8126353>

- Hurley, M. V., Rees, J., & Newham, D. J. (1998). Quadriceps function, proprioceptive acuity and functional performance in healthy young, middle-aged and elderly subjects. *Age and ageing*, 27(1), 55-62.
- Joshua, A. M., D'Souza, V., Unnikrishnan, B., Mithra, P., Kamath, A., Acharya, V., & Venugopal, A. (2014). Effectiveness of progressive resistance strength training versus traditional balance exercise in improving balance among the elderly - a randomised controlled trial. *Journal of Clinical and Diagnostic Research : JCDR*, 8(3), 98–102. <http://doi.org/10.7860/JCDR/2014/8217.4119>
- Khemthong, S. Pejarasangharn, U. Uptampohtiwat, T., & Khanya, A. (2012). Effect of Musical Training on Reaction Time: A randomized control trial in Thai Elderly Individuals. *Music and Medicine.*, 4(16), 16 – 21.
- Konrad, H. R., Girardi, M., & Helfert, R. (1999). Balance and aging. *The Laryngoscope*, 109(9), 1454–60. <http://doi.org/10.1097/00005537-199909000-00019>
- Kral, V. A. (1962). Senescent forgetfulness: benign and malignant. *Canadian Medical Association Journal*, 86(6), 257.
- Kramer, A. F., Erickson, K. I., & Colcombe, S. J. (2006). Neural Changes Associated with Training Exercise , cognition , and the aging brain, 1237–1242. <http://doi.org/10.1152/jappphysiol.000500.2006>.
- Krog, S. (2015). Speed Stacking : An appropriate tool to enhance academic learning in the foundation phase, 21(December), 1424–1440.
- Lezak, M. (1995). Observational Methods, Rating Scales, and Inventories. *Neuropsychological Assessment*, 18, 736 – 747.
- Lin, H. W., & Bhattacharyya, N. (2012). Balance disorders in the elderly: epidemiology and functional impact. *The Laryngoscope*, 122(8), 1858-1861.
- Madigan, T., & Delaney, T. (2009). *Sports: Why people love them!* University Press of America.

- Mathey, F. (1976). Psychomotor performance and reaction speed in old age. *Contributions to Human Development, 3*, 36–50.
- Matsumura, B. A., & Ambrose, A. F. (2006). Balance in the Elderly. *Clinics in Geriatric Medicine, 22*, 395–412. <http://doi.org/10.1016/j.cger.2005.12.007>
- Oja, P., & Tuxworth, B. (1995). The Eurofit test battery for Adults. Eurofit for Adults: Assessment of Health-Related Fitness, *6*, 75 – 76.
- Owsley, C., Sloane, M., McGwin, G., & Ball, K. (2002). Timed instrumental activities of daily living tasks: relationship to cognitive function and everyday performance assessments in older adults. *Gerontology, 48*(4), 254–65. <http://doi.org/58360>
- Pang, F. C., Chow, T. W., Cummings, J. L., Leung, V. P. Y., Chiu, H. F. K., Lam, L. C. W., & Fuh, J. L. (2002). Effect of neuropsychiatric symptoms of Alzheimer's disease on Chinese and American caregivers. *International Journal of Geriatric Psychiatry, 17*(1), 29–34. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11802227>
- Position Speed Test. (n.d). Retrieved from [www.egopont.com/reaction\\_positionspeed\\_test.php](http://www.egopont.com/reaction_positionspeed_test.php).
- Ratcliff, R., Thapar, A., & McKoon, G. (2001). The effects of aging on reaction time in a signal detection task. *Psychology and aging, 16*(2), 323.
- Royall, D. R., Chiodo, L. K., & Polk, M. J. (2000). Correlates of disability among elderly retirees with “subclinical” cognitive impairment. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 55*(9), M541–6. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10995053>
- Rudisill, M., & Toole, T. (1992). The effects of a physical activity program on reaction time and movement time for the older adult. *Journal of Human Movement Studies, 22*, 205 – 212.

- Sayer, A., Robinson, S., Patel, H., Shavlakadze, T., Cooper, C., & Grounds, M. (2013). New Horizons in the Pathogenesis, Diagnosis and Management of Sarcopenia. *Age and Ageing*, *42*(2), 145 – 150.
- Sebastjan, A., Dabrowska, G., Ignasiak, Z., & Zeurek, G. (2008). Evaluation of precise motor skills of a hand in elderly women representing different levels of physical activity. [Polish, English]\nOcena motoryki precyzyjnej reki starszych kobiet o roznym poziomie aktywnosci ruchowej. *Fizjoterapia*, *16*(1), 41–45. <http://doi.org/10.2478/v10109-009-0004-0>
- Tseng, C. N., Gau, B. S., & Lou, M. F. (2011). The effectiveness of exercise on improving cognitive function in older people: a systematic review. *The Journal of Nursing Research : JNR*, *19*(2), 119–31. <http://doi.org/10.1097/JNR.0b013e3182198837>
- Tucker, M. G., Kavanagh, J. J., Barrett, R. S., & Morrison, S. (2008). Age-related differences in postural reaction time and coordination during voluntary sway movements. *Human Movement Science*, *27*, 728–737. <http://doi.org/10.1016/j.humov.2008.03.002>
- Udermann, B. E., & Murray, S. R. (2006). Cup Stacking : Does It Deserve a Place in Physical Education Curricula.
- Udermann, B. E., Murray, S. R., Mayer, J. M., & Sagendorf, K. (2004). Influence of cup stacking on hand-eye coordination and reaction time of second-grade students. *Perceptual and Motor Skills*, *98*, 409–414.
- Welford, A. (1977). *Motor Performance: Handbook of the Psychology of Aging*. New York.
- Wolf, B., Feys, H., De Weerd, van der Meer, J., Noom, M., Aufdemkampe, G., & Noom, M. (2001). Effect of a physical therapeutic intervention for balance problems in the elderly: a single-blind, randomized, controlled multicentre trial. *Clinical Rehabilitation*, *15*(01), 624–636. <http://doi.org/10.1191/0269215501cr456oa>



## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATIONS**

#### **5.1. INTRODUCTION**

This final chapter draws conclusions taking into consideration the study's objectives. The first objective was to determine the short-term effects of a sports stacking intervention on the motor functioning (hand eye coordination, reaction time, balance and quality of life) pre- and post-intervention in geriatrics. The second objective was to determine the short-term effects of a sports stacking intervention on the cognitive functioning (memory) pre- and post-intervention in geriatrics.

Additionally, recommendations and limitations of the study will be presented.

#### **5.2. CONCLUSION**

The study suggested that an eight-week sports stacking intervention could provide short-term motor functioning benefits for the geriatric population. Significant effects on motor functioning such as hand eye coordination and reaction time was demonstrated post-intervention. However, the balance and quality of life component did not show statistically significant improvements post-intervention. Thus, the hypothesis, a short-term sports stacking intervention will improve motor functioning in geriatrics, was accepted.

Furthermore, this study showed that there was no improvement with cognitive functioning, specifically on memory post-intervention. Thus, the null hypothesis, a short-term sports stacking intervention will not improve cognitive functioning in geriatrics was also accepted.

Positively, there was an improvement in the intervention groups' sports stacking times as the intervention progressed. This could be due to improved skilled level of the participants and possible memory of stacking sequences.

In summary, this study highlighted that an eight-week sports stacking intervention could be beneficial if implemented at retirement/old age homes as it could create improvements in motor functioning and possible cognitive functioning.

### **5.3. RECOMMENDATIONS**

A larger sample size is recommended for future studies. Due to the relatively small sample size, generalisations could not be made.

Studies relating to sports stacking are very limited. Additional research needs to be conducted on both the cognitive and motor effects of sports stacking among geriatrics.

A long-term sports stacking intervention may also be more beneficial resulting in improvements in both motor and cognitive functioning.

### **5.4. LIMITATIONS OF THE STUDY**

Firstly, the small sample size. The small sample size impacted the significance of selected results. Secondly, the study participants were geriatrics from a retirement/old age home and not community living geriatrics. Furthermore, a limited number of males participated in this study which resulted in majority of the participants being females (83%). Lastly, additional cognitive functioning tests should have been included like the Rivermead Behavioural Memory Test and the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) to increase the validity of testing this component.

## REFERENCES

- Alexander, N. B. (1994). Postural Control in Older Adults. *Journal of the American Geriatrics Society*, 42(1), 93–108. <http://doi.org/10.1111/j.1532-5415.1994.tb06081.x>
- American College of Sports Medicine (Ed.). (2013). *ACSM's health-related physical fitness assessment manual*. Lippincott Williams & Wilkins.
- Applegate, W., Blass, J., & Franklin Williams, T. (1990). Instruments for the functional assessment of older patients. *N Engl J Med*, 322(17), 1207–1214.
- Baddeley, A., & Longman, D. (1978). The Influence of Length and Frequency of Training Sessions on the Rate of Learning to Type. *Ergonomics*, 21(8), 627–635. Retrieved from <https://www.gwern.net/docs/spacedrepetition/1978-baddeley.pdf>
- Barris, R., Kielhofner, G., Levine, R., & Neville, A. (1985). Occupation as interaction with the environment. In *A model of Human occupation: Theory and Application* (pp. 42–62).
- Bell-McGinty, S., Podell, K., Franzen, M., Baird, A. D., & Williams, M. J. (2002). Standard measures of executive function in predicting instrumental activities of daily living in older adults. *International Journal of Geriatric Psychiatry*, 17(9), 828–834. <http://doi.org/10.1002/gps.646>
- Berg, K. (1989). Measuring balance in the elderly: preliminary development of an instrument. *Physiotherapy Canada*, 41(6), 304–311. <http://doi.org/10.3138/ptc.41.6.304>
- Berg, K. O., Wood-Dauphinee, S. L., Williams, J. I., & Maki, B. (1992). Measuring balance in the elderly: validation of an instrument. *Canadian Journal of Public Health = Revue Canadienne de Santé Publique*, 83 Suppl 2, S7–11. Retrieved from <http://europepmc.org/abstract/med/1468055>

- Bergland, A., & Wyller, T. B. (2004). Risk factors for serious fall related injury in elderly women living at home. *Injury prevention, 10*(5), 308-313.
- Beswick, A. D., Rees, K., Dieppe, P., Ayis, S., Gooberman-Hill, R., Horwood, J., & Ebrahim, S. (2008). Complex interventions to improve physical function and maintain independent living in elderly people: a systematic review and meta-analysis. *Lancet (London, England), 371*(9614), 725–35. [http://doi.org/10.1016/S0140-6736\(08\)60342-6](http://doi.org/10.1016/S0140-6736(08)60342-6)
- Bherer, L., Erickson, K. I., & Liu-ambrose, T. (2013). A Review of the Effects of Physical Activity and Exercise on Cognitive and Brain Functions in Older Adults, 2013.
- Bisson, E., Contant, B., Sveistrup, H., & Lajoie, Y. (2007). Functional balance and dual-task reaction times in older adults are improved by virtual reality and biofeedback training. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society, 10*(1), 16–23. <http://doi.org/10.1089/cpb.2006.9997>
- Black, F., Wall, C., & Nashner, L. (1983). Effects of visual and support surface orientation references upon postural control in vestibular deficient subjects. *Acta Otolaryngol (Stockh), 95*, 199–210.
- Blake, A. J., Morgan, K., Bendall, M. J., Dallosso, H., Ebrahim, S. B., Arie, T. H., & Bassey, E. J. (1988). Falls by elderly people at home: prevalence and associated factors. *Age and Ageing, 17*(6), 365–72. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3266440>
- Boyke, J., Driemeyer, J., Gaser, C., Büchel, C., & May, A. (2008). Training-induced brain structure changes in the elderly. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 28*(28), 7031–5. <http://doi.org/10.1523/JNEUROSCI.0742-08.2008>
- Braes, T., Milisen, K., & Foreman, M. (2007). Assessing Cognitive Functioning. *Evidence-Based Geriatric Nursing Protocols for Best Practice, 4*, 41 –56.

- Briggs, R. C., Gossman, M. R., Birch, R., Drews, J. E., & Shaddeau, S. A. (1989). Balance performance among noninstitutionalized elderly women. *Physical Therapy, 69*(9), 748-756.
- Burton, C. L., Strauss, E., Hultsch, D. F., & Hunter, M. A. (2009). The relationship between everyday problem solving and inconsistency in reaction time in older adults. *Neuropsychology, Development, and Cognition. Section B, Aging, Neuropsychology and Cognition*. <http://doi.org/10.1080/13825580903167283>
- Cabeza, R., Anderson, N. D., Locantore, J. K., & McIntosh, A. R. (2002). Aging Gracefully: Compensatory Brain Activity in High-Performing Older Adults. *NeuroImage, 17*(3), 1394–1402. <http://doi.org/10.1006/nimg.2002.1280>
- Cadore, E. L., Rodríguez-Mañas, L., Sinclair, A., & Izquierdo, M. (2013). Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. *Rejuvenation Research, 16*(2), 105–14. <http://doi.org/10.1089/rej.2012.1397>
- Cahn-Weiner, D., Boyle, P., Malloy, P. F., Razani, J., Casas, R., Wong, J. T., & Josephson, K. (2002). Tests of executive function predict instrumental activities of daily living in community-dwelling older individuals. *Applied Neuropsychology, 9*(3), 187–191. <http://doi.org/10.1207/S15324826AN0903>
- Campbell, A. J., Robertson, M. C., Gardner, M. M., Norton, R. N., Tilyard, M. W., & Buchner, D. M. (1997). Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. *BMJ, 315*(7115), 1065–1069. <http://doi.org/10.1136/bmj.315.7115.1065>
- Carstensen, L. L., & Mikels, J. A. (2005). At the Intersection of Emotion and Cognition. Aging and the Positivity Effect. *Current Directions in Psychological Science, 14*(3), 117–121. <http://doi.org/10.1111/j.0963-7214.2005.00348.x>
- Cassilhas, R. C., Viana, V. R., Grassmann, V., Santos, R. T., Santos, R. F., Tufik, S., & Mello, M. T. (2007). The impact of resistance exercise on the cognitive function of the elderly. *Medicine and Science in Sports and Exercise, 39*(19), 1401–1407. <http://doi.org/10.1249/mss.0b013e318060111f>

- Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General*, *132*(2), 310–324. <http://doi.org/10.1037/0096-3445.132.2.310>
- Charles, S. T., Mather, M., & Carstensen, L. L. (2005). Aging and emotional memory: The forgettable nature of negative images for older adults.
- Clarkson-Smith, L., & Hartley, A. A. (1989). Relationships between physical exercise and cognitive abilities in older adults.
- Cockburn, J., & Collin, C. (1988). Measuring everyday memory in elderly people: a preliminary study. *Age and Ageing*, *17*, 265–269.
- Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., & Elavsky, S. (2004). Cardiovascular fitness, cortical plasticity, and aging. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(9), 3316–21. <http://doi.org/10.1073/pnas.0400266101>
- Commodari, E., & Guarnera, M. (2008). Attention and aging. *Aging clinical and experimental research*, *20*(6), 578-584.
- Cotman, C. W., & Berchtold, N. C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences*, *25*(6), 295–301. [http://doi.org/10.1016/S0166-2236\(02\)02143-4](http://doi.org/10.1016/S0166-2236(02)02143-4)
- Cumming, R. G. (1998). Epidemiology of medication-related falls and fractures in the elderly. *Drugs & Aging*, *12*(1), 43–53. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9467686>
- Cutler, S. J., & Grams, A. E. (1988). Correlates of self-reported everyday memory problems. *Journal of Gerontology*, *43*(3), S82–90. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3361099>
- Davous, P., Lamour, Y., Debrand, E., & Rondot, P. (1987). A comparative evaluation of the short orientation memory concentration test of cognitive impairment.

*Journal of Neurology, Neurosurgery, and Psychiatry*, 50(10), 1312–7.  
<http://doi.org/10.1136/jnnp.50.10.1312>

Deary, I., & Der, G. (2005). Reaction time, age and cognitive ability: Logitudinal findings from age 16 to 63 years in representative population samples. *Aging, Neuropsychology, and Cognition*, 12(2), 187–215.  
<http://doi.org/10.1080/13825580590969235>

Deary, I., Der, G., & Ford, G. (2001, February 9). Reaction time and intelligence differences: a population based cohort study. *Intelligence*.  
[http://doi.org/10.1016/S0160-2896\(01\)00062-9](http://doi.org/10.1016/S0160-2896(01)00062-9)  
<[http://dx.doi.org/10.1016/S0160-2896\(01\)00062-9](http://dx.doi.org/10.1016/S0160-2896(01)00062-9)>

Deary, I. J., & Der, G. (2005). Reaction time explains IQ's association with death. *Psychological Science*, 16(1), 64–69. <http://doi.org/10.1111/j.0956-7976.2005.00781.x>

Donders, F. (1868). The speed of mental processes. *Archives of Anatomy, Physiology and Scientific Medicine*, 657–681.

Drewnowski, A., & Evans, W. J. (2001). Nutrition, physical activity, and quality of life in older adults: Summary. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 56(suppl 2), 89–94.  
[http://doi.org/10.1093/gerona/56.suppl\\_2.89](http://doi.org/10.1093/gerona/56.suppl_2.89)

Dustman, R. E., Ruhling, R. O., Russell, E. M., Shearer, D. E., Bonekat, H. W., Shigeoka, J. W., & Bradford, D. C. (1984). Aerobic exercise training and improved neuropsychological function of older individuals. *Neurobiology of aging*, 5(1), 35-42.

Fischman, M. G., & Yao, W. X. (1994). Evidence limiting the subtended-angle hypothesis of response-programming delays. *Perceptual and Motor Skills*, 78(3 Pt 1). Retrieved from [http://utsa.influent.utsystem.edu/en/publications/evidence-limiting-the-subtendedangle-hypothesis-of-responseprogramming-delays\(65bbe3de-e47c-4ab2-8bec-29a491df7662\).html](http://utsa.influent.utsystem.edu/en/publications/evidence-limiting-the-subtendedangle-hypothesis-of-responseprogramming-delays(65bbe3de-e47c-4ab2-8bec-29a491df7662).html)

- Fleg, J. L., O'Connor, F., Gerstenblith, G., Becker, L. C., Clulow, J., Schulman, S. P., & Lakatta, E. G. (1995). Impact of age on the cardiovascular response to dynamic upright exercise in healthy men and women. *Journal of Applied Physiology (Bethesda, Md. : 1985)*, *78*, 890–900.
- Fleming, K., Evans, J., Weber, D., & Chutka, D. (1995). Practical functional assessment of elderly persons: a primary-care approach. *Mayo Clinic Proceedings*. Retrieved from <http://www.sciencedirect.com/science/article/pii/S0025619611639499>
- Foerster, R. M., Carbone, E., Schneider, W. X., Chen, S., & College, A. E. (2014). Long-term memory-based control of attention in multi-step tasks requires working memory: evidence from domain-specific interference, *5*(May), 1–8. <http://doi.org/10.3389/fpsyg.2014.00408>
- Fox, B. (2001). Speed Stacks. Instructor Catalogue. *Speed Stacks Inc.*
- Franchignoni, F., Tesio, L., Martino, M. T., & Ricupero, C. (1998). Reliability of four simple, quantitative tests of balance and mobility in healthy elderly females. *Aging Clinical and Experimental Research*, *10*(1), 26–31. <http://doi.org/10.1007/BF03339630>
- Fratiglioni, L., Paillard-Borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. *The Lancet. Neurology*, *3*(6), 343–53. [http://doi.org/10.1016/S1474-4422\(04\)00767-7](http://doi.org/10.1016/S1474-4422(04)00767-7)
- Georgopoulos, A. P. (1986). On reaching. *Annual Review of Neuroscience*, *9*, 147–70. <http://doi.org/10.1146/annurev.ne.09.030186.001051>
- Giambra, L. M., Arenberg, D., Zonderman, A. B., Kawas, C., & Costa Jr, P. T. (1995). Adult life span changes in immediate visual memory and verbal intelligence. *Psychology and aging*, *10*(1), 123.
- Gibbons, E., Hendrick, J. L., & Bauer, J. (2007). Distribution of practice on cup stacking performance. *AAHPERD National Convention and Exposition*, (2005), 2007.



- Glisky, E. L., Rubin, S. R., & Davidson, P. S. R. (2001). Source memory in older adults: An encoding or retrieval problem? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(5), 1131–1146.  
<http://doi.org/10.1037//0278-7393.27.5.1131>
- Godinet, W. (1986). Cup stacking game apparatus.
- Graf, C. (2008). The Lawton instrumental activities of daily living scale. *The American Journal of Nursing*, 108(4), 52–62; quiz 62–63.  
<http://doi.org/10.1097/01.NAJ.0000314810.46029.74>
- Hackel, M. E., Wolfe, G., Bang, S. M., & Canfield, J. S. (1992). Changes in hand function in the aging adult as determined by the Jebsen Test of Hand Function. *Physical Therapy*, 72, 373–377.
- Hamill, J., & Knutzen, K. (1995). *Biomechanical basis of Human Movement*.
- Handoll, H. (2010). Prevention of falls and fall related injuries in older people in nursing homes and hospitals. *Injury Prevention*, 16(2), 137–138.  
<http://doi.org/10.1136/ip.2010.026625>
- Hart, M. A., & Bixby, W. R. (2005). Brain activation patterns during participation in cup stacking (Motor Behavior). *AAHPERD National Convention and Exposition*, 2(2001), 2005.
- Harwood, R. H. (2001). Visual problems and falls. *Age and Ageing*, 30, 13–18.  
<http://doi.org/10.1093/ageing/30.1.13>
- Hasher, L., & Zacks, R. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General*. Retrieved from <http://psycnet.apa.org/psycinfo/1981-00461-001>
- Heitmann, D. K., Gossman, M. R., Shaddeau, S., & Jackson, J. R. (1989). Balance performance and step width in noninstitutionalized, elderly, female fallers and nonfallers. *Physical Therapy*, 69(11), 923–931.

- Hertzog, C., & Dixon, R. (1994). Metacognitive development in adulthood and old age. Retrieved from <http://psycnet.apa.org/psycinfo/1994-97967-011>
- Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: exercise effects on brain and cognition. *Nature Reviews. Neuroscience*, *9*(1), 58–65. <http://doi.org/10.1038/nrn2298>
- Howland, J., Lachman, M. E., Peterson, E. W., Cote, J., Kasten, L., & Jette, A. (1998). Covariates of fear of falling and associated activity curtailment. *The Gerontologist*, *38*(5), 549–55. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9803643>
- Hu, M. H., & Woollacott, M. H. (1994). Multisensory training of standing balance in older adults: I. Postural stability and one-leg stance balance. *Journal of Gerontology*, *49*(2), M52–61. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/8126353>
- Hultsch, D. F., Macdonald, S. W. S., & Dixon, R. A. (2002). Variability in Reaction Time Performance of Younger and Older Adults. *Journal of Geontology*, *57B*(2), 101–115.
- Humpel, N. (2002). Environmental factors associated with adults' participation in physical activity A review. *American Journal of Preventive Medicine*, *22*(3), 188–199. [http://doi.org/10.1016/S0749-3797\(01\)00426-3](http://doi.org/10.1016/S0749-3797(01)00426-3)
- Hunter, S., White, M., & Thompson, M. (1998). Techniques to evaluate elderly human muscle function: a physiological basis. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *53*(3), B204-B216.
- Hurley, M. V., Rees, J., & Newham, D. J. (1998). Quadriceps function, proprioceptive acuity and functional performance in healthy young, middle-aged and elderly subjects. *Age and ageing*, *27*(1), 55-62.
- Jobe, J. B., Smith, D. M., Ball, K., Tennstedt, S. L., Marsiske, M., Willis, S. L., & Kleinman, K. (2010). ACTIVE: A Cognitive Intervention Trial to Promote Independence in Older Adults, *22*(4), 1–24.

- Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*. <http://doi.org/10.1037/0033-2909.114.1.3>
- Joshua, A. M., D'Souza, V., Unnikrishnan, B., Mithra, P., Kamath, A., Acharya, V., & Venugopal, A. (2014). Effectiveness of progressive resistance strength training versus traditional balance exercise in improving balance among the elderly - a randomised controlled trial. *Journal of Clinical and Diagnostic Research : JCDR*, 8(3), 98–102. <http://doi.org/10.7860/JCDR/2014/8217.4119>
- Katzman, R., Brown, T., Fuld, P., Peck, A., Schechter, R., & Schimmel, H. (1983). Validation of a short Orientation-Memory-Concentration Test of cognitive impairment. *The American Journal of Psychiatry*, 140(6), 734–9. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/6846631>
- Kester, J. D., Benjamin, A. S., & Castel, A. D. (2002). Memory in Elderly People. *Handbook of Memory Disorders*, 543–568.
- Khemthong, S. Pejarasangharn, U. Uptampohtiwat, T., & Khanya, A. (2012). Effect of Musical Training on Reaction Time: A randomized control trial in Thai Elderly Individuals. *Music and Medicine.*, 4(16), 16 – 21.
- Konrad, H. R., Girardi, M., & Helfert, R. (1999). Balance and aging. *The Laryngoscope*, 109(9), 1454–60. <http://doi.org/10.1097/00005537-199909000-00019>
- Kral, V. A. (1962). Senescent forgetfulness: benign and malignant. *Canadian Medical Association Journal*, 86(6), 257.
- Kramer, A. F., Erickson, K. I., & Colcombe, S. J. (2006). Neural Changes Associated with Training Exercise , cognition , and the aging brain, 1237–1242. <http://doi.org/10.1152/jappphysiol.000500.2006>.
- Krog, S. (2010). *Movement programmes as a means to learning readiness South Africa. M Ed Specialisation in Guidance and Counselling*. University of South Africa, Pretoria.

- Krog, S. (2015). Speed Stacking : An appropriate tool to enhance academic learning in the foundation phase, *21*(December), 1424–1440.
- La Voie, D., & Light, L. L. (1994). Adult age differences in repetition priming: A meta-analysis. *Psychology and aging, 9*(4), 539
- Lee, T., & Genovese, E. (1989). Distribution of Practise in motor skills acquisition: different effects for discrete and continuous tasks. *Research Quarterly for Exercise and Sport, 60*(1), 59–65.
- Leichsenring, K. (2004). Developing integrated health and social care services for older persons in Europe. *International Journal of Integrated Care, 4*, e10. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1393267&tool=pmcentrez&rendertype=abstract>
- Lezak, M. (1995). Observational Methods, Rating Scales, and Inventories. *Neuropsychological Assessment, 18*, 736 – 747.
- Light, L., & Voie, D. L. (1993). Direct and indirect measures of memory in old age. Retrieved from <http://psycnet.apa.org/psycinfo/1993-98315-009>
- Lin, H. W., & Bhattacharyya, N. (2012). Balance disorders in the elderly: epidemiology and functional impact. *The Laryngoscope, 122*(8), 1858-1861.
- Lord, S., & Castell, S. (1994). Effects of exercise on balance, strength and reaction time. *Journal of Australian Physiotherapy, 40*(2).
- Lusardi, M. M., Pellecchia, G. L., & Schulman, M. (2003). Functional Performance in Community Living Older Adults. *Journal of Geriatric Physical Therapy, 26*, 14–22. <http://doi.org/10.1519/00139143-200312000-00003>
- Ma, H. I., & Trombly, C. A. (2004). Effects of task complexity on reaction time and movement kinematics in elderly people. *American Journal of Occupational Therapy, 58*(2), 150–158. <http://doi.org/10.5014/ajot.58.2.150>

- Madden, D. (2001). Speed and timing of behavioural processes. *Handbook of the Psychology of Ageing*, 5, 288–312.
- Madigan, T., & Delaney, T. (2009). *Sports: Why people love them!* University Press of America.
- Maguire, T. (2001). Brain Gym. Retrieved November 21, 2015, from <http://www.braingym.com>
- Mathey, F. (1976). Psychomotor performance and reaction speed in old age. *Contributions to Human Development*, 3, 36–50.
- Matsumura, B. A., & Ambrose, A. F. (2006). Balance in the Elderly. *Clinics in Geriatric Medicine*, 22, 395–412. <http://doi.org/10.1016/j.cger.2005.12.007>
- May, C. P., Hasher, L., & Kane, M. J. (1999). The role of interference in memory span. *Memory & cognition*, 27(5), 759-767.
- Moberg, P. J., Ph, D., Ding, Y., Hitzemann, R., Smith, G., & Logan, J. (1998). Association between declines in Brain Dopamine Activity with age and Cognitive and Motor Impairment in Healthy Individuals, (6).
- Nakayama, M., Helfert, R. H., Konrad, H. R., & Caspary, D. M. (1994). Scanning electron microscopic evaluation of age-related changes in the rat vestibular epithelium. *Otolaryngology--Head and Neck Surgery: Official Journal of American Academy of Otolaryngology-Head and Neck Surgery*, 111(6), 799–806. Retrieved from <http://europepmc.org/abstract/med/7991262>
- Nashner, L. M. (1997). Physiology of balance, with special reference to the healthy elderly. *Gait disorders of aging: falls and therapeutic strategies*, 37-53.
- Nevitt, M. C., Cummings, S. R., & Hudes, E. S. (1991). Risk Factors for Injurious Falls: a Prospective Study. *Journal of Gerontology*, 46(5), M164–M170. <http://doi.org/10.1093/geronj/46.5.M164>
- Oja, P., & Tuxworth, B. (1995). The Eurofit test battery for Adults. Eurofit for Adults: Assessment of Health-Related Fitness, 6, 75 – 76.

- Owsley, C., Sloane, M., McGwin, G., & Ball, K. (2002). Timed instrumental activities of daily living tasks: relationship to cognitive function and everyday performance assessments in older adults. *Gerontology*, *48*(4), 254–65. <http://doi.org/58360>
- Pang, F. C., Chow, T. W., Cummings, J. L., Leung, V. P. Y., Chiu, H. F. K., Lam, L. C. W., & Fuh, J. L. (2002). Effect of neuropsychiatric symptoms of Alzheimer's disease on Chinese and American caregivers. *International Journal of Geriatric Psychiatry*, *17*(1), 29–34. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11802227>
- Park, D. C., Gutches, A. H., Meade, M. L., & Stine-Morrow, E. L. (2007). Improving cognitive function in older adults: Nontraditional approaches. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, *62*(SPEC. ISSUE 1), 45–52. [http://doi.org/10.1093/geronb/62.special\\_issue\\_1.45](http://doi.org/10.1093/geronb/62.special_issue_1.45)
- Pavot, W., & Diener, E. (1993). Review of the Satisfaction With Life Scale. *Psychological Assessment*, *5*, 164–172.
- Pei, Y. C., Chou, S. W., Lin, P. S., Lin, Y. C., Hsu, T. H. C., & Wong, A. M. K. (2008). Eye-hand coordination of elderly people who practice Tai Chi Chuan. *Journal of the Formosan Medical Association = Taiwan Yi Zhi*, *107*(2), 103–10. [http://doi.org/10.1016/S0929-6646\(08\)60123-0](http://doi.org/10.1016/S0929-6646(08)60123-0)
- Pepper, L. (1976). Patterns of Leisure and adjustment to retirement. *Gerontologist*, *(16)*, 441–446.
- Perlmutter, M., Metzger, R., Miller, K., & Nezworski, T. (1980). Memory of historical events. *Experimental Aging Research*, *6*(1), 47-60.
- Phelan, E. A., Anderson, L. A., LaCroix, A. Z., & Larson, E. B. (2004). Older adults' views of "successful aging"--how do they compare with researchers' definitions? *Journal of the American Geriatrics Society*, *52*(2), 211–6. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/14728629>

- Ponds, R. W. H. M., & Jolles, J. (2006). Memory complaints in elderly people: The role of memory abilities, metamemory, depression and personality. *Educational Gerontology, 22*(4), 341–357. <http://doi.org/10.1080/0360127960220404>
- Position Speed Test. (n.d). Retrieved from [www.egoport.com/reaction\\_positionspeed\\_test.php](http://www.egoport.com/reaction_positionspeed_test.php).
- Rabbitt, P. (1986). Models and paradigms in the study of stress effects. In *In Energetics and Human Information Processing* (pp. 155–174). Martinus Nijoff Publishers.
- Rand, M. K., & Stelmach, G. E. (2011). Effects of hand termination and accuracy requirements on eye–hand coordination in older adults. *Behavioural brain research, 219*(1), 39-46.
- Ratcliff, R., Thapar, A., & McKoon, G. (2001). The effects of aging on reaction time in a signal detection task. *Psychology and aging, 16*(2), 323.
- Rogers, R. L., Meyer, J. S., & Mortel, K. F. (1990). After reaching retirement age physical activity sustains cerebral perfusion and cognition. *Journal of the American Geriatrics Society, 38*(2), 123–8. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/2299115>
- Royall, D. R., Chiodo, L. K., & Polk, M. J. (2000). Correlates of disability among elderly retirees with “subclinical” cognitive impairment. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 55*(9), M541–6. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10995053>
- Ruch, F. L. (1934). The differentiative effects of age upon human learning. *The Journal of General Psychology, 11*(2), 261-286.
- Rudisill, M., & Toole, T. (1992). The effects of a physical activity program on reaction time and movement time for the older adult. *Journal of Human Movement Studies, 22*, 205 – 212.

- Ruff, R. M., & Parker, S. B. (1993). Gender- And Age-Specific Changes In Motor Speed And Eye-Hand Coordination In Adults: Normative Values For The Finger Tapping And Grooved Pegboard Tests. *Perceptual And Motor Skills*, 76(3c), 1219–1230. [Http://Doi.Org/10.2466/Pms.1993.76.3c.1219](http://doi.org/10.2466/Pms.1993.76.3c.1219)
- Ruuskanen, J. M., & Ruoppila, I. (1995). Physical Activity and Psychological Well-being among People Aged 65 to 84 Years. *Age and Ageing*, 24(4), 292–296. <http://doi.org/10.1093/ageing/24.4.292>
- Sayer, A., Robinson, S., Patel, H., Shavlakadze, T., Cooper, C., & Grounds, M. (2013). New Horizons in the Pathogenesis, Diagnosis and Management of Sarcopenia. *Age and Ageing*, 42(2), 145 – 150.
- Sebastjan, A., Dabrowska, G., Ignasiak, Z., & Zeurek, G. (2008). Evaluation of precise motor skills of a hand in elderly women representing different levels of physical activity. [Polish, English]\nOcena motoryki precyzyjnej reki starszych kobiet o roznym poziomie aktywnosci ruchowej. *Fizjoterapia*, 16(1), 41–45. <http://doi.org/10.2478/v10109-009-0004-0>
- Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the Probability for Falls in Community-Dwelling Older Adults Using the Timed Up & Go Test. *Physical Therapy*, 80(9), 896–903. Retrieved from <http://ptjournal.apta.org/content/80/9/896.short>
- Shumway-Cook, A., & Woollacott, M. (1995). Motor control: theory and practical applications. Retrieved from [https://scholar.google.co.za/scholar?q=motor+control+%3Atheory+and+practical+application&btnG=&hl=en&as\\_sdt=0%2C5#1](https://scholar.google.co.za/scholar?q=motor+control+%3Atheory+and+practical+application&btnG=&hl=en&as_sdt=0%2C5#1)
- Shumway-Cook, A., Woollacott, M., Kerns, K. A., & Baldwin, M. (1997). The Effects of Two Types of Cognitive Tasks on Postural Stability in Older Adults With and Without a History of Falls. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 52A(4), M232–M240. <http://doi.org/10.1093/gerona/52A.4.M232>



- Simons, A. D., Epstein, L. H., McGowan, C. R., Kupfer, D. J., & Robertson, R. J. (1985). Exercise as a treatment for depression: An update. *Clinical Psychology Review*, 5(6), 553–568. [http://doi.org/10.1016/0272-7358\(85\)90034-0](http://doi.org/10.1016/0272-7358(85)90034-0)
- Speed Stacks. (n.d). Retrieved from “<http://www.speedstacks.com>”.
- Stewart, A., & King, A. (1991). Evaluating the efficacy of Physical Activity for influencing quality-of-life outcomes in older adults. *Ann Behav Med*, 13, 108–116.
- Thomas, J., Nelson, J., & Silverman, S. (2011). *Research Methods in Physical Activity* (6th ed.). Human Kinetics.
- Tinetti, M. E., Baker, D. I., McAvay, G., Claus, E. B., Garrett, P., Gottschalk, M., & Horwitz, R. I. (1994). A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *New England Journal of Medicine*, 331(13), 821. <http://doi.org/10.1056/NEJM199409293311301>
- Tinetti, M., Williams, C., & Gill, T. (2000). Dizziness among older adults: a possible geriatric syndrome. *Annals of Internal Medicine*. Retrieved from <http://annals.org/article.aspx?articleid=713287>
- Tseng, C. N., Gau, B. S., & Lou, M. F. (2011). The effectiveness of exercise on improving cognitive function in older people: a systematic review. *The Journal of Nursing Research : JNR*, 19(2), 119–31. <http://doi.org/10.1097/JNR.0b013e3182198837>
- Tucker, M. G., Kavanagh, J. J., Barrett, R. S., & Morrison, S. (2008). Age-related differences in postural reaction time and coordination during voluntary sway movements. *Human Movement Science*, 27, 728–737. <http://doi.org/10.1016/j.humov.2008.03.002>
- Udermann, B. E., & Murray, S. R. (2006). Cup Stacking : Does It Deserve a Place in Physical Education Curricula.

- Udermann, B. E., Murray, S. R., Mayer, J. M., & Sagendorf, K. (2004). Influence of cup stacking on hand-eye coordination and reaction time of second-grade students. *Perceptual and Motor Skills*, *98*, 409–414.
- Voelcker-Rehage, C., & Niemann, C. (2013). Structural and functional brain changes related to different types of physical activity across the life span. *Neuroscience and Biobehavioral Reviews*, *37*(9 Pt B), 2268–95. <http://doi.org/10.1016/j.neubiorev.2013.01.028>
- Wang, C. Y., Haskell, W. L., Farrell, S. W., Lamonte, M. J., Blair, S. N., Curtin, L. R., & Burt, V. L. (2010). Cardiorespiratory fitness levels among US adults 20-49 years of age: findings from the 1999-2004 National Health and Nutrition Examination Survey. *American Journal of Epidemiology*, *171*(4), 426–35. <http://doi.org/10.1093/aje/kwp412>
- Warabi, T., Noda, H., & Kato, T. (1986). Effect of aging on sensorimotor functions of eye and hand movements. *Experimental Neurology*, *92*(3), 686–697. [http://doi.org/10.1016/0014-4886\(86\)90309-2](http://doi.org/10.1016/0014-4886(86)90309-2)
- Welford, A. (1977). *Motor Performance: Handbook of the Psychology of Aging*. New York.
- Wilkniss, S. M., Jones, M. G., Korol, D. L., Gold, P. E., & Manning, C. A. (1997). Age-related differences in an ecologically based study of route learning. *Psychology and aging*, *12*(2), 372.
- Wolf, B., Feys, H., De Weerd, van der Meer, J., Noom, M., Aufdemkampe, G., & Noom, M. (2001). Effect of a physical therapeutic intervention for balance problems in the elderly: a single-blind, randomized, controlled multicentre trial. *Clinical Rehabilitation*, *15*(01), 624–636. <http://doi.org/10.1191/0269215501cr456oa>
- Wolf, S. L., Barnhart, H. X., Kutner, N. G., McNeely, E., Coogler, C., & Xu, T. (1996). Reducing Frailty and Falls in Older Persons: An Investigation of Tai Chi and Computerized Balance Training. *Journal of the American Geriatrics Society*, *44*(5), 489–497. <http://doi.org/10.1111/j.1532-5415.1996.tb01432.x>

Woollacott, M., & Shumway-Cook, A. (2002). Attention and the control of posture and gait: a review of an emerging area of research. *Gait & Posture*, *16*(1), 1–14. [http://doi.org/10.1016/S0966-6362\(01\)00156-4](http://doi.org/10.1016/S0966-6362(01)00156-4)

World Sports Stacking Association. (n.d). Retrieved from <http://www.worldsportstackingassociation.org>.

Wright, B. M., & Payne, R. B. (1985). Effects of aging on sex differences in psychomotor reminiscence and tracking proficiency. *Journal of Gerontology*, *40*(2), 179-184.

Yim-Chiplis, P. K., & Talbot, L. A. (2000). Defining and measuring balance in adults. *Biological Research for Nursing*, *1*, 321–331. <http://doi.org/10.1177/109980040000100408>

## **APPENDICES**

### **APPENDIX 1: GATEKEEPER'S PERMISSION LETTER**

To whom it may concern

I as a Sports Science student at the University of Kwa-Zulu Natal I am involved in a research project for my Masters degree. This study will require geriatric participants who will be performing sport stacking training for eight (8) weeks. Sport stacking is an international sport that involves speed and dexterity by performing a number of different sequences of stacking cups up and down against either an opponent or for the fastest time possible.

We request permission to conduct our study in this (Name\_\_\_\_\_ ) home involving its residents and facilities. We only intend on recruiting 70 participants for our research study. We will take all the necessary precautions to ensure the safety and confidentiality of the residents who agree to be participants. Participants will be required to attend two (2) training sessions per week on a Tuesday and Thursday for eight (8) weeks. The training sessions will each last one hour. The sessions will be held in a room within the home that can accommodate many wide tables that the participants require to practice on and one that has adequate lighting. The benefits that we hope to find is an improvement in balance, hand eye coordination, memory and reaction time.

Kind Regards,

*Dr. Rowena Naidoo (Supervisor) – 083 777 2813*

*Kamantha Moodley – 083 482 7696*

*Discipline of Biokinetics, Exercise and Leisure Sciences*

*University of Kwa-Zulu Natal*

*University Telephone Number - 031 26073940*

*School Research Office:Ms. P Nene – 2608280*

## APPENDIX 2: GATEKEEPER'S LETTER



THE ASSOCIATION FOR THE AGED - NPO 002 093

80 Samora Machel Street, Durban, 4001 P.O. Box 2983, Durban, 4000

Tel: 031 33 23 721 Fax: 031 33 78 787 Email: [www.tafta.org.za](http://www.tafta.org.za)

ATT: Kamantha Moodley/Dr Rowena Naidoo

University of KwaZulu-Natal  
University Road  
Sports Science Dept  
Q block

Dear Dr Rowena Naidoo

### RE: GATEKEEPERS LETTER

On behalf of the Association for the Aged (TAFTA), I am writing to formally indicate our awareness of the research proposed by **Kamantha Moodley**, a student at University of KwaZulu-Natal to conduct her study on 'The short-term effects of Sports stacking intervention on the Cognitive and Perceptual Motor functioning in Geriatrics'.

I am responsible for the TAFTA Service Centres and I give Kamantha Moodley permission to conduct her research at TAFTA Ray Hulett Service Centre and Mary Asher Service Centre twice a week.

If you have any questions or concerns, please feel free to contact my office at 031 3323721

Yours Sincerely

Abel Naicker



**Senior Manager: Service Centres**

Tel: 031 33 23 721 Fax: 0867 489 046

Email: [abeln@tafta.org.za](mailto:abeln@tafta.org.za) Cell: 082 8088 607

## APPENDIX 3: ETHICAL APPROVAL LETTER



19 August 2015

Ms K Moodley (211558955)  
Biokinetics, Exercise and Leisure Sciences  
School of Health Sciences  
[kamantha\\_moodley@yahoo.com](mailto:kamantha_moodley@yahoo.com)

Dear Ms Moodley

**Protocol:** The effects of a sport stacking intervention on the cognitive and perceptual motor functioning in geriatrics. **Degree:** MSc  
**BREC reference number:** BFC186/15

The Biomedical Research Ethics Committee (BREC) has considered the abovementioned application.

The study was provisionally approved by sub-committee of BREC pending appropriate responses to queries raised. Your responses received on 14 July 2015 to BREC letter dated 08 July 2015 have been noted by the Biomedical Research Ethics Committee at a meeting held on 11 August 2015. The conditions have now been met and the study is given full ethics approval and may begin as from 19 August 2015.

This approval is valid for one year from **19 August 2015**. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at <http://research.ukzn.ac.za/BiomedicalResearchEthics.aspx>.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

Page 2/...

Biomedical Research Ethics Committee  
Professor J Tsoka-Gwegweni (Chair)  
Westville Campus, Govan Mbeki Building  
Postal Address: Private Bag X54001, Durban 4000

Telephone: +27 (0) 31 260 2488 Facsimile: +27 (0) 31 260 4600 Email: [brec@ukzn.ac.za](mailto:brec@ukzn.ac.za)  
Website: <http://research.ukzn.ac.za/BiomedicalResearchEthics.aspx>



Pinetown Campus   Edgewood   Howard College   Medical School   Pietermaritzburg   Westville

The following Committee members were present at the meeting that took place on 11 August 2015:

Prof J Tsoka-Gwegweni	Chair
Dr C Aldous	Genetics
Prof R Bhimma	Paediatrics & Child Health
Rev. S D Chiti	External - Lay member
Prof A Coutsooudis	Paediatrics & Child Health
Dr R Govender	Family Medicine
Dr T Hardcastle	Surgery
Dr R Harrichandpersad	Neurosurgery
Mr H Humphries	Research Psychology and Public Health
Dr Z Khumalo	KZN Health (External) General Medicine
Dr M Khan	Obstetrics and Gynaecology
Prof TE Maciba	General Surgery
Dr G Nair	HIV Medicine
Prof Y Rambiritch	Pharmacology (Deputy Chair)
Prof C Rout	Anaesthetics
Dr D Singh	Critical Care
Prof D Wassenaar	Psychology (Deputy Chair)

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely



**PROFESSOR J TSOKA-GWEGWENI**  
Chair: Biomedical Research Ethics Committee

## APPENDIX 4: FLYER



Sports stacking/Speed stacking is a new and fun sport for both young and old. This study aims to find the benefits of sports stacking for both young and old. It keeps you active and stimulates your mind. So if you want to be a part of this research study and if you are:

- Aged between 60 – 90 years old
- No physical disabilities
- Never done sports stacking before
- Not on any medication for Vertigo, Alzheimer's and Parkinson's disease or similar condition
- No orthopedic complications
- Not in a routine physical activity program

Please volunteer to join us for sports stacking/speed stacking classes every Monday and Wednesday.

HOPE TO SEE YOU THERE!!!

For further information contact either:

Dr. Rowena Naidoo (Supervisor) – 083 777 2813 | Kamantha Moodley – 083 482 7696



## **APPENDIX 5: PARTICIPATION INFORMED CONSENT AND CONSENT FORM**

### Information Sheet and Consent to Participate in Research

Date: 23 March 2015

Dear Sir/Madam

My name is Kamantha Moodley from the University of KwaZulu-Natal. I am a Masters student at the Department of Biokinetics, Exercise and Leisure Sciences. As part of my degree, I am required to complete a research project. The title of my research project is: The short-term effects of a Sports Stacking Intervention on the Cognitive and Perceptual Motor Functioning in Geriatrics

You are being invited to consider participating in a study that involves research on cognitive and motor function in geriatrics using cup stacking. The aim of my research is to monitor the effects of a sports stacking intervention on motor functioning (Hand eye coordination and reaction time) and cognitive function (memory and balance) pre- and post-intervention.

The study is expected to enroll 60 participants, 30 in the control (non-sport stacking) group and 30 in the intervention (sport stacking) group. This study will take place at the home.

Should you decide to participate in the study, baseline measures will be taken for all participants. Height and weight measurements, hand eye coordination, reaction time, memory, and balance will be assessed three days prior to the intervention (Pre-intervention). The intervention will consist of two 60-minute sessions a week for an eight week period. The sessions will be conducted as a 25-minute session with a short break and another 25-minute session.

The intervention will consist of basic to advanced techniques of cup stacking, as well as progression from slow to fast speeds of performing the techniques. The techniques are designed to use both hands and thus both sides of the brain. The intervention will also incorporate a physical exercise component by including relays which require back and forth running/fast walking. Times from each session will be recorded.

The non-sport stacking participants (control group) will be required to remain sedentary. Participants will not be allowed to participate in the sport stacking lessons, and must not start any physical activity programme as this will affect the results.

At the end of the intervention, all participants will be re-assessed on baseline measures. Once the intervention time-period is complete, the control group will be exposed to the intervention.

All participants must complete the full eight-week intervention in order to be considered part of the research study.

We hope that by participating in the study, participants will benefit through an increase in hand eye coordination, reaction time, memory and balance.

There are minimal risks in this study, except maybe participants may feel tired or slight muscle soreness when performing selected activities. However, the researcher will ensure that a proper warm-up and cool-down is performed by participants and that participants perform the activities at their own pace. The residential nurse and doctor will be available if necessary.

Participation in this research is voluntary and that in the event of refusal/withdrawal of participation the participants will not be penalized or loss of treatment or other benefit to which they are normally entitled.

There will be no compensation for participating in this study.

The data collected will be securely stored in such a way that only the researcher will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the university's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed by a fire.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (approval number BFC186/15).

In the event of any problems or concerns/questions you may contact the researcher at [kamantha\\_moodley@yahoo.com](mailto:kamantha_moodley@yahoo.com)/0784328799 or my supervisor, Dr Rowena Naidoo, [naidoor3@ukzn.ac.za](mailto:naidoor3@ukzn.ac.za) /0312608235 or the UKZN Biomedical Research Ethics Committee:

## **BIOMEDICAL RESEARCH ETHICS ADMINISTRATION**

Research Office, Westville Campus

Govan Mbeki Building

Private Bag X 54001

Durban

4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769 - Fax: 27 31 2604609

Email: [BREC@ukzn.ac.za](mailto:BREC@ukzn.ac.za)

---

**CONSENT**

I \_\_\_\_\_ have been informed about the study entitled “The short term effects of a Sports Stacking Intervention on the Cognitive and Perceptual Motor Function in Geriatrics” by Kamantha Moodley.

I understand the purpose and procedures of the study. I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any treatment or care that I would usually be entitled to.

I have been informed that there is no compensation for participating in this study.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at [kamantha\\_moodley@yahoo.com/0784328799](mailto:kamantha_moodley@yahoo.com/0784328799) or supervisor, Dr Rowena Naidoo at [naidoor3@ukzn.ac.za](mailto:naidoor3@ukzn.ac.za) /0312608235.

If you have any questions or concerns about your rights as a study participant, or if you are concerned about an aspect of the study, then you may contact:

**BIOMEDICAL RESEARCH ETHICS ADMINISTRATION Research Office, Westville Campus**

Govan Mbeki Building

Private Bag X 54001  
Durban  
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604769 - Fax: 27 31 2604609

Email: [BREC@ukzn.ac.za](mailto:BREC@ukzn.ac.za)

\_\_\_\_\_  
**Signature of Participant**

\_\_\_\_\_  
**Date**

\_\_\_\_\_  
**Signature of Witness**

\_\_\_\_\_  
**Date**

## **APPENDIX 6: SPORTS STACKING INTERVENTION**

### **Week 1**

- Introduce participants to Sports Stacking.
- Show them the 3 stack sequence first.
- Once the participants feel comfortable with the 3 stack, we will introduce them to the 3-3-3 stack
- After mastering the 3-3-3 stack, we will get them involved in relays utilizing the 3-3-3 stacking technique.
- The 1<sup>st</sup> relay being where the participants will group (numbers depending on how many we get in the group) and stand in one line. Person number one will sit on a chair and when the clock starts they will up stack, come back to the start of the line and tag their partner. Person number two will sit on the chair after person number one gets up and so on. The next participant will then down stack (This will continue depending on the number of participants).
- The 2<sup>nd</sup> relay that we will do is where one participant up stacks and down stacks comes back and tags their partner and their partner does the same. The 1<sup>st</sup> team that has all their members complete it wins.
- These two relays will help speed up their up stacking and down stacking skills.

### **Week 2 and 3**

- Introduce participants to the 6 stack sequence.
- Once the participants are comfortable with that, we will then show them the 3-6-3 stack.
- After they have done this we will involve them in the relays mentioned above but this time using the 3-6-3 stacking technique.

### **Week 4 and 5**

- Recap what was done in the 1<sup>st</sup>3 weeks.
- Then we will introduce the participants to the 6-6 stacking from the 3-6-3 stacking.

- For the relays, we will change it this week. Participants will be split into teams and will be focusing on the changeover from the 3-6-3 stacking to the 6-6 stacking.
- For the 1<sup>st</sup> relay, the 1<sup>st</sup> participant will have to up stack and down stack the 3-6-3 and 6-6 technique and will then have to tag their partner but this will be done with their eyes closed when they start stacking. They will all be sitting on chair and will have to stand up and go to their stacks which will be across the room. When they return their partner will already be sitting on the chair, they must tag them and sit down again.
- The 2<sup>nd</sup> relay is where the participants will have to up stack and down stack the 3-6-3 and 6-6 technique but will be done while standing on one foot, they will then run back on 2 feet and tag their partner who will do the same. When their 2<sup>nd</sup> turn comes around, the participant will then have to stand on the opposite foot.
- These two relays will help get the participants familiarized with the process of stacking as well as help them with their balance.

#### Week 6 and 7

- This week we will introduce the participants to the 1-10-1 technique from the 6-6 technique.
- This last step will constitute a cycle in stacking.
- We will then spend time helping the participants with the full cycle.
- Both relays done on day 3 will be done on this day using the cycle.

#### Week 8

- On each of these days, in the 1<sup>st</sup> 15 minutes we will allow the participants to practice the full cycle on their own.

Once they have become familiar with the cycle, we will use all the relays as mentioned above on each of these days using the full cycle technique.



## APPENDIX 8: BODY MASS INDEX RECORDING SHEET

<u>Sports stacking intervention</u>							
		<u>PRETEST</u>			<u>POSTTEST</u>		
<u>No.</u>	<u>Names</u>	<u>Height</u>	<u>Weight</u>	<u>BMI</u>	<u>Height</u>	<u>Weight</u>	<u>BMI</u>
<u>1</u>							
<u>2</u>							
<u>3</u>							
<u>4</u>							
<u>5</u>							
<u>6</u>							
<u>7</u>							
<u>8</u>							
<u>9</u>							
<u>10</u>							
<u>11</u>							
<u>12</u>							
<u>13</u>							
<u>14</u>							
<u>15</u>							
<u>16</u>							
<u>17</u>							
<u>18</u>							
<u>19</u>							
<u>20</u>							
<u>21</u>							
<u>22</u>							
<u>23</u>							
<u>24</u>							
<u>25</u>							
<u>26</u>							
<u>27</u>							
<u>28</u>							
<u>29</u>							
<u>30</u>							



<u>31</u>							
<u>32</u>							
<u>33</u>							
<u>34</u>							
<u>35</u>							
<u>36</u>							
<u>37</u>							
<u>38</u>							
<u>39</u>							
<u>40</u>							
<u>41</u>							
<u>42</u>							
<u>43</u>							
<u>44</u>							
<u>45</u>							
<u>46</u>							
<u>47</u>							
<u>48</u>							
<u>49</u>							
<u>50</u>							
<u>51</u>							
<u>52</u>							
<u>53</u>							
<u>54</u>							
<u>55</u>							
<u>56</u>							
<u>57</u>							
<u>58</u>							
<u>59</u>							
<u>60</u>							

## APPENDIX 9: PLATE TAPPING RECORDING SHEET

<u>Sports Stacking Intervention (Plate tapping)</u>			
	<u>Name</u>	<u>Pretest</u>	<u>Posttest</u>
<u>No.</u>		<u>(seconds)</u>	<u>(seconds)</u>
<u>1</u>			
<u>2</u>			
<u>3</u>			
<u>4</u>			
<u>5</u>			
<u>6</u>			
<u>7</u>			
<u>8</u>			
<u>9</u>			
<u>10</u>			
<u>11</u>			
<u>12</u>			
<u>13</u>			
<u>14</u>			
<u>15</u>			
<u>16</u>			
<u>17</u>			
<u>18</u>			
<u>19</u>			
<u>20</u>			
<u>21</u>			
<u>22</u>			
<u>23</u>			
<u>24</u>			
<u>25</u>			
<u>26</u>			
<u>27</u>			
<u>28</u>			
<u>29</u>			
<u>30</u>			

<u>31</u>			
<u>32</u>			
<u>33</u>			
<u>34</u>			
<u>35</u>			
<u>36</u>			
<u>37</u>			
<u>38</u>			
<u>39</u>			
<u>40</u>			
<u>41</u>			
<u>42</u>			
<u>43</u>			
<u>44</u>			
<u>45</u>			
<u>46</u>			
<u>47</u>			
<u>48</u>			
<u>49</u>			
<u>50</u>			
<u>51</u>			
<u>52</u>			
<u>53</u>			
<u>54</u>			
<u>55</u>			
<u>56</u>			
<u>57</u>			
<u>58</u>			
<u>59</u>			
<u>60</u>			

# APPENDIX 10: SHORT ORIENTATION MEMORY CONCENTRATION TEST (SOMCT)

## SHORT ORIENTATION-MEMORY-CONCENTRATION TEST

Patient Name: \_\_\_\_\_

Rater Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Instruction

Score 1 error for each incorrect response, to maximum for each item.

No.	Question	Maximum error	Score	x	Weight	=
1.	What year is it now?	1	_____	x	4	= _____
2.	What month is it now?	1	_____	x	3	= _____
	Repeat this phrase John Brown, 42 Market Street, Chicago or (UK): John Brown, 42 West Street, Gateshead					
3.	About what time is it? (within one hour)	1	_____	x	3	= _____
4.	Count backwards 20 to 1	2	_____	x	2	= _____
5.	Say the months in reverse order	2	_____	x	2	= _____
6.	Repeat the phrase just given	5	_____	x	2	= _____
<i>Total error score</i>						= _____/28

### Reference

Katzman R, Brown T, Fuld P, Peck A, Schechter R, Schimmel H. "Validation of a short Orientation-Memory-Concentration Test of cognitive impairment."  
*Am J Psychiatry*. 1983;140:734-739.

### Comment

A well-studied test, which is (so far) little used. It has been validated against neuropathology, and was derived from the longer Blessed scale. Reliability not formally tested. The score correlated highly ( $r = 0.92$ ) with the full scale and it was almost as sensitive as the longer test. Any error score of 0-6 is within normal limits.

Scoring is difficult as originally devised and as shown, and it is more easily understood if scored positively, subtracting from maximum (for item) for each error. This gives a 0-28 score with a higher being better, scores over 20 being 'normal', as shown below.

## APPENDIX 11: SOMCT RECORDING SHEET

<u>Sports Stacking Intervention (SOMCT)</u>				
	<u>Name</u>	<u>Pretest</u>	<u>Posttest</u>	<u>Improved</u>
<u>No.</u>		<u>Scores</u>	<u>Scores</u>	
<u>1</u>				
<u>2</u>				
<u>3</u>				
<u>4</u>				
<u>5</u>				
<u>6</u>				
<u>7</u>				
<u>8</u>				
<u>9</u>				
<u>10</u>				
<u>11</u>				
<u>12</u>				
<u>13</u>				
<u>14</u>				
<u>15</u>				
<u>16</u>				
<u>17</u>				
<u>18</u>				
<u>19</u>				
<u>20</u>				
<u>21</u>				
<u>22</u>				
<u>23</u>				
<u>24</u>				
<u>25</u>				
<u>26</u>				
<u>27</u>				
<u>28</u>				
<u>29</u>				
<u>30</u>				

<u>31</u>				
<u>32</u>				
<u>33</u>				
<u>34</u>				
<u>35</u>				
<u>36</u>				
<u>37</u>				
<u>38</u>				
<u>39</u>				
<u>40</u>				
<u>41</u>				
<u>42</u>				
<u>43</u>				
<u>44</u>				
<u>45</u>				
<u>46</u>				
<u>47</u>				
<u>48</u>				
<u>49</u>				
<u>50</u>				
<u>51</u>				
<u>52</u>				
<u>53</u>				
<u>54</u>				
<u>55</u>				
<u>56</u>				
<u>57</u>				
<u>58</u>				
<u>59</u>				
<u>60</u>				

## APPENDIX 12: SHARPENED ROMBERG RECORDING SHEET

<u>Sports Stacking Intervention (Sharpened Romberg)</u>								
		<u>Pretest</u>			<u>Posttest</u>			
<u>No</u>	<u>Names</u>	<u>Feet together</u>	<u>Semi Tandem</u>	<u>Tandem</u>	<u>Feet together</u>	<u>Semi Tandem</u>	<u>Tandem</u>	<u>Balanced</u>
<u>1</u>								
<u>2</u>								
<u>3</u>								
<u>4</u>								
<u>5</u>								
<u>6</u>								
<u>7</u>								
<u>8</u>								
<u>9</u>								
<u>10</u>								
<u>11</u>								
<u>12</u>								
<u>13</u>								
<u>14</u>								
<u>15</u>								
<u>16</u>								
<u>17</u>								
<u>18</u>								
<u>19</u>								
<u>20</u>								
<u>21</u>								
<u>22</u>								
<u>23</u>								
<u>24</u>								
<u>25</u>								
<u>26</u>								
<u>27</u>								
<u>28</u>								
<u>29</u>								
<u>30</u>								
<u>31</u>								

<u>32</u>								
<u>33</u>								
<u>34</u>								
<u>35</u>								
<u>36</u>								
<u>37</u>								
<u>38</u>								
<u>39</u>								
<u>40</u>								
<u>41</u>								
<u>42</u>								
<u>43</u>								
<u>44</u>								
<u>45</u>								
<u>46</u>								
<u>47</u>								
<u>48</u>								
<u>49</u>								
<u>50</u>								
<u>51</u>								
<u>52</u>								
<u>53</u>								
<u>54</u>								
<u>55</u>								
<u>56</u>								
<u>57</u>								
<u>58</u>								
<u>59</u>								
<u>60</u>								



## APPENDIX 13: REACTION TIME RECORDING SHEET

<u>Sports Stacking Intervention (Reaction time)</u>				
	<u>Name</u>	<u>Pretest Scores</u>	<u>Posttest Scores</u>	<u>Improved</u>
<u>No.</u>				
<u>1</u>				
<u>2</u>				
<u>3</u>				
<u>4</u>				
<u>5</u>				
<u>6</u>				
<u>7</u>				
<u>8</u>				
<u>9</u>				
<u>10</u>				
<u>11</u>				
<u>12</u>				
<u>13</u>				
<u>14</u>				
<u>15</u>				
<u>16</u>				
<u>17</u>				
<u>18</u>				
<u>19</u>				
<u>20</u>				
<u>21</u>				
<u>22</u>				
<u>23</u>				
<u>24</u>				
<u>25</u>				
<u>26</u>				
<u>27</u>				
<u>28</u>				
<u>29</u>				
<u>30</u>				

<u>31</u>				
<u>32</u>				
<u>33</u>				
<u>34</u>				
<u>35</u>				
<u>36</u>				
<u>37</u>				
<u>38</u>				
<u>39</u>				
<u>40</u>				
<u>41</u>				
<u>42</u>				
<u>43</u>				
<u>44</u>				
<u>45</u>				
<u>46</u>				
<u>47</u>				
<u>48</u>				
<u>49</u>				
<u>50</u>				
<u>51</u>				
<u>52</u>				
<u>53</u>				
<u>54</u>				
<u>55</u>				
<u>56</u>				
<u>57</u>				
<u>58</u>				
<u>59</u>				
<u>60</u>				

# APPENDIX 14: LAWTON'S INSTRUMENTAL ACTIVITIES OF DAILY LIVING (IADL) QUESTIONNAIRE

## The Lawton Instrumental Activities of Daily Living Scale

### A. Ability to Use Telephone

1. Operates telephone on own initiative; looks up and dials numbers..... 1
2. Dials a few well-known numbers..... 1
3. Answers telephone, but does not dial..... 1
4. Does not use telephone at all..... 0

### B. Shopping

1. Takes care of all shopping needs independently..... 1
2. Shops independently for small purchases..... 0
3. Needs to be accompanied on any shopping trip..... 0
4. Completely unable to shop..... 0

### C. Food Preparation

1. Plans, prepares, and serves adequate meals independently..... 1
2. Prepares adequate meals if supplied with ingredients..... 0
3. Heats and serves prepared meals or prepares meals but does not maintain adequate diet..... 0
4. Needs to have meals prepared and served..... 0

### D. Housekeeping

1. Maintains house alone with occasion assistance (heavy work)..... 1
2. Performs light daily tasks such as dishwashing, bed making..... 1
3. Performs light daily tasks, but cannot maintain acceptable level of cleanliness..... 1
4. Needs help with all home maintenance tasks..... 1
5. Does not participate in any housekeeping tasks..... 0

### E. Laundry

1. Does personal laundry completely..... 1
2. Launders small items, rinses socks, stockings, etc..... 1
3. All laundry must be done by others..... 0

### F. Mode of Transportation

1. Travels independently on public transportation or drives own car..... 1
2. Arranges own travel via taxi, but does not otherwise use public transportation..... 1
3. Travels on public transportation when assisted or accompanied by another..... 1
4. Travel limited to taxi or automobile with assistance of another..... 0
5. Does not travel at all..... 0

### G. Responsibility for Own Medications

1. Is responsible for taking medication in correct dosages at correct time..... 1
2. Takes responsibility if medication is prepared in advance in separate dosages..... 0
3. Is not capable of dispensing own medication..... 0

### H. Ability to Handle Finances

1. Manages financial matters independently (budgets, writes checks, pays rent and bills, goes to bank); collects and keeps track of income..... 1
2. Manages day-to-day purchases, but needs help with banking, major purchases, etc..... 1
3. Incapable of handling money..... 0

**Scoring:** For each category, circle the item description that most closely resembles the client's highest functional level (either 0 or 1).

Lawton, M.P., & Brody, E.M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *The Gerontologist*, 9(3), 179-186.

Copyright © The Gerontological Society of America. Reproduced [Adapted] by permission of the publisher.



A series provided by The Hartford Institute for Geriatric Nursing,  
New York University, College of Nursing  
Email: [hartfordign@nyu.edu](mailto:hartfordign@nyu.edu) 405-200-0100 ext 4000 [www.hartfordign.org](http://www.hartfordign.org)  
Copyright © 2009 [www.CenterForGeri.org](http://www.CenterForGeri.org)

## APPENDIX 15: LAWTON'S IADL RECORDING SHEET

<u>Sports Stacking Intervention (Lawton's IADL)</u>				
	<u>Name</u>	<u>Pretest Scores</u>	<u>Posttest Scores</u>	<u>Improved</u>
<u>No.</u>				
<u>1</u>				
<u>2</u>				
<u>3</u>				
<u>4</u>				
<u>5</u>				
<u>6</u>				
<u>7</u>				
<u>8</u>				
<u>9</u>				
<u>10</u>				
<u>11</u>				
<u>12</u>				
<u>13</u>				
<u>14</u>				
<u>15</u>				
<u>16</u>				
<u>17</u>				
<u>18</u>				
<u>19</u>				
<u>20</u>				
<u>21</u>				
<u>22</u>				
<u>23</u>				
<u>24</u>				
<u>25</u>				
<u>26</u>				
<u>27</u>				
<u>28</u>				
<u>29</u>				
<u>30</u>				

<u>31</u>				
<u>32</u>				
<u>33</u>				
<u>34</u>				
<u>35</u>				
<u>36</u>				
<u>37</u>				
<u>38</u>				
<u>39</u>				
<u>40</u>				
<u>41</u>				
<u>42</u>				
<u>43</u>				
<u>44</u>				
<u>45</u>				
<u>46</u>				
<u>47</u>				
<u>48</u>				
<u>49</u>				
<u>50</u>				
<u>51</u>				
<u>52</u>				
<u>53</u>				
<u>54</u>				
<u>55</u>				
<u>56</u>				
<u>57</u>				
<u>58</u>				
<u>59</u>				
<u>60</u>				

