Cognitive Enrichment, Self-Regulation, Life Satisfaction and Aging

by

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Abstract

The cognitive enrichment study investigated whether engagement in challenging cognitive activity was associated with changes in performance in memory skill among older adults. A sample of 63 independent community-living individuals (age range: 63 to 91 years) was recruited for the study. After attrition, 46 participants remained. Participants completed two surveys, the Self-Regulation Inventory (SRI) and the Satisfaction with Life Scale (SWLS), prior to taking two cognitive tests: the Ospan and the Wisconsin Card Sorting Test (WCST). Control participants were dismissed for 8 weeks whereas experimental participants were introduced to an online learning site and were instructed to select topics and study lessons for at least 60 minutes a week over the 8-week span. Following the intervention, all participants completed posttests on the cognitive measures. Twenty-nine experimental and 17 control participants completed the study. MANOVAs were conducted to determine if participant involvement in the learning intervention was related to changes in memory skill. Using the Ospan measure, levels of memory skill were compared in the two groups: experimental and control. There was a statistically significant effect of treatment on the Ospan scores: $\Lambda = .780$, $F(3, 41) = 3.86$, $p = .016$. The Wisconsin Card Sorting Test (WCST) was used to evaluate executive functioning and set shift response. Mean differences in the MANOVA did not reach statistical significance at $p < .05$. Total scores for self-regulation (SRI) and life satisfaction (SWLS) were correlated $r = .339$ ($p < .05$). The findings support the hypothesis that the treatment can produce improvement in general memory skill. Based on the study design, it appears that active self-regulated involvement of older adults in a challenging cognitive activity for at least 60 minutes each week enhanced cognitive functioning in terms of memory accuracy.

Keywords: Cognitive enrichment; memory; aging; self-regulation; life satisfaction; cognitive skill; lifelong development

Dedication

I dedicate this work to my brilliant supportive husband, Doug Blackley: “Grow old along with me, the best is yet to be.” (R. Browning). I want to thank my beloved son, Benjamin, for his inspirational and joyful ways.

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I need to thank my wonderful, generous, thoughtful participants who shared their time, energy, and personal lives with me. I am so grateful. This study would have been impossible without such willing volunteers.

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It has been a deep honour to have Dr. Phil Winne as my committee member. He stands unequalled in the area of self-regulation. He has an unparalleled ability to distil an article or discussion issue into one fundamental question.

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List of Acronyms

ACTIVE	Advanced Cognitive Training for Independent and Vital Elderly
AD	Alzheimer's Disease
CBLE	Computer Based Learning Environments
CE	Cognitive Enrichment
CEA	Cognitive Enrichment Activity
CEH	Cognitive Enrichment Hypothesis
CET	Cognitive Enrichment Theory
MCI	Mild Cognitive Impairment
MMSE	Mini-Mental State Exam
NVGP	Non Video Game Player
SLS	Seattle Longitudinal Study
SOC	Selection, Optimization and Compensation
SR	Self-Regulation
SRI	Self-Regulation Inventory
SRL	Self-Regulated Learning
SWLS	Satisfaction with Life Scale
VGP	Video Game Player
WCST	Wisconsin Card Sorting Test
WHO	World Health Organization

1. Summary of Thesis

1.1. Aging and Cognitive Decline

Despite significant advances in our understanding of health care for elders, there is uncertainty about how to maintain cognitive skill over the lifespan. This lack of knowledge is of particular concern because age-related declines in cognitive function are now impacting more people than at any other time in human history. In addressing the changing demands of the older population, it is helpful to understand this population's characteristics, strengths and needs. As of 2007, the World Health Organization (WHO) stated that the world's elderly population (60+) was 650 million. By 2050 it is projected to reach 2 billion (WHO, 2014). In Canada, projections are that by 2056 seniors (65 and older) will comprise between 25% and 30% of the Canadian population (Statistics Canada, 2010). In almost every country the proportion of aging people is growing faster than that of any other age group (WHO, 2014). The World Health Organization notes, "Ageing well must be a global priority" (2014).

Aging is the greatest risk factor for neurodegenerative disorders. Costs associated with normal declines and mild impairment are difficult to calculate. More than half of those with Mild Cognitive Impairment (MCI) progress to Alzheimer's Disease (AD). With increasing life expectancies and increases in AD, the socioeconomic impact on the US economy is more than $100 billion a year and is projected to increase 4-fold by 2050 (Lin, Laird, Fox & Gao, 2012). As the incidence of cognitive decline and impairment increases with advanced age, it is essential that researchers discover ways to assist individuals in keeping cognitively healthy for as long as possible. Understanding which variables in which combinations promote the maintenance of cognitive abilities across the lifespan is crucial to helping seniors retain normal levels of cognitive skill for a longer period of time to help them continue to lead independent lives.

1.2. Research Purpose

The research reported in this thesis was designed and implemented to advance understanding of one type of psychological intervention for addressing this critical social issue. Its primary purpose was to examine the extent to which a relationship exists between cognitive enrichment, cognitive skill, self-regulation, and life satisfaction through having older adults participate in a challenging online learning activity.

The study had several sub-purposes: a) to investigate whether involvement in a potentially enriching activity impacted participant cognitive skill; b) to evaluate the relationship between self-regulation and life satisfaction levels and participant cognitive skill; c) to determine if a relationship exists between self-reported levels of self-regulation and life satisfaction; d) to explore the relationship between participant study tool selection strategies to find common themes in their reasoning.

1.3. Conceptual Foundation

In almost every country in the world, the proportion of aging people is growing faster than that of any other age group (WHO, 2014). Meeting the needs of the elderly will become increasingly difficult as unprecedented numbers of baby boomers reach old age. An awareness of these realities has led the WHO to suggest that *all* health care providers now be trained on aging issues regardless of their specialty areas. Aging is going to be everyone's area of health promotion and concern.

It is perspective-giving to look at cognitive decline through the data presented by the Alzheimer Society of British Columbia. As of 2014, they state that there were more than 70,000 British Columbians living with Alzheimer's or another form of dementia. Nearly 10,000 are younger than 65. Extrapolating this data to Canada as a whole, over 500,000 individuals would have a similar diagnosis (Alzheimer Society, 2014). Mild cognitive impairment (MCI) is the label given to individuals whose cognitive functioning falls between normal and dementia. These individuals may go on to develop dementia or they may remain relatively stable (Simon, Yokomizo, & Bottino, 2012). The exact understanding and diagnostic criteria for MCI are not uniform at this time (Alzheimer's

Society of BC, 2014). In America, looking at Alzheimer's Disease alone (and not other forms of dementia or MCI), estimates are that by 2050 health care costs to Medicare and Medicaid will increase nearly 500% to a total of $1.1 trillion (Small et al., 2012).

Research involving elderly patients indicates that cognitive enrichment may have positive effects on cognitive skill. Cognitive enrichment may enhance cognitive skill and the quality of life or daily coping for those who are potentially healthy (Alzheimer's Society, 2012). Further evidence raises the possibility that increases in cognitive exercise may increase cognitive skill for those already diagnosed with mild cognitive impairment and dementia (Goldberg, 2005; Small et al., 2012). This evidence indicates that cognitive exercise may be one area to examine in order to determine if it will assist aging individuals to minimize the losses to cognitive abilities they may be experiencing either due to the normal aging process or due to diseases that are associated with advanced age.

Improving cognition through physical activity is currently promoted for aging individuals. Participation in regular physical exercise has been shown to increase individual quality of life and also lower the burden of medical costs for the individual and society as a whole. In a similar vein, there may be ways to improve cognitive skill through greater levels of cognitive exercise. The question is how would this enrichment be designed? How would the cognitive changes be evaluated? Would gains made in one area be transferred to other contexts? Would gains endure over time? What role does self-regulation play in cognitive enrichment and success? What role does life satisfaction have in cognitive enrichment and success? To begin this investigative journey, cognitive enrichment processes need to be tested to see if extended involvement impacts cognitive skill levels in the short-term.

Cognitive enrichment is an area that merits study as a means of finding new methods to assist aging individuals in retaining cognitive fitness. Cognitive fitness refers to the extent to which a person has developed cognitive abilities such as thinking quickly, accurately, and efficiently**.** Research has shown the link between physical fitness and cognitive fitness. Health gains associated with the promotion of physical exercise and physical fitness are well-documented (Geda et al., 2012; Maes & Karoly, 2005; Petrovich & White, 2005). Warburton, Nicol, and Bredin (2006) conducted a meta-

analysis evaluating the health benefits of physical exercise. They noted that there appears to be a linear relation between physical activity and health status suggesting that more exercise will yield even more substantial gains in health. The interaction between physical exercise and cognitive gain has also been shown to have an association. Geda et al., 2012, as an illustration, found that participants who engaged in both moderate physical exercise and computer use had significantly decreased odds of having MCI (odds ratio [95% CI], 0.36 [0.20-0.68]) compared with a reference group.

There is call for more experimental research to isolate the effects of a cognitive intervention as distinct from physical and social interventions. It appears all 3 areas may impact cognitive skill. Using a sample of 776 nondemented subjects 75 years of age and above, Karp, Wang, Silverstein, Winblad and Fratiglioni (2006) set up a study where they separated mental, social and physical components and determined a score in each of these areas for each participant. Participants were followed 3 years later to isolate dementia cases. Their results indicated that participants with higher ratings in all 3 areas (mental, social, physical) performed the best after 3 years. The most beneficial effects were present in those participants who had high scores in 2 or more of the areas. These researchers suggest that it is beneficial for aging individuals to be engaged in more than one type of activity in order to reduce the onset of cognitive decline.

To further evaluate the cognitive enrichment hypothesis, basic, easily-accessible, and functional ways to train, measure and evaluate cognitive skills are required. To this end, research that examines cognition and assists individuals in establishing and retaining their memory and processing skill is vital. If a clear understanding of the relationship between cognitive enrichment and cognitive skill can be established, then cognitive enrichment might be viewed as an important partner to physical fitness in creating a healthy lifestyle.

Determining which activities are most effective at enhancing cognitive skills depends upon carefully defined research that isolates specific types of cognitive exercise to determine the relative efficacy of cognitive exercise on its own. Maintaining executive functioning is likely a part of this process. Executive function involves self-regulation as well as “the ability to plan, organize, and monitor the execution of behaviors that are strategically directed in a goal-oriented manner” (National Institute of

Health, 2012). The goal of slowing the onset of mild cognitive impairment (characterized by “a state of cognitive functioning that is below defined norms, yet falls short of dementia in severity”) is a useful starting point for the development of programs that may assist the elderly in this critical area of their cognitive healthcare (Feldman & Jacova, 2005, 645). One chief aim of this thesis was to establish a connection between potentially cognitive enriching activities and enhanced cognitive skill. This was evaluated through conducting an online cognitive intervention designed to improve cognitive skill in older adults (63+).

The adequate provisioning of many services for the rapidly aging population is expensive and difficult to sustain. This has already been noted in a number of countries including Canada where the pension plan will take effect at age 67, instead of the traditional age of 65 (Service Canada, 2012). According to the Chief Actuary, the number of persons qualifying for pension in Canada will jump from 4.8 million in 2010 to 9.3 million in 2030 (Service Canada, 2012). One investigation determined the total one-year healthcare costs associated with patients with delirium (Leslie, Marcantonio, Zhang, Leo-Summers, & Inouye, 2008). In this American study, delirium was defined as a decline in individual cognition and attention that limits patient ability to cope. This study indicated that in their sample, those patients with delirium accrued costs 2.5 times greater than those without. From a sample of over 800 hospitalized patients, 109 developed delirium. The total cost estimates per patient with delirium ranged from $16,303 to $64,031 which indicates that the burden that delirium adds to the health care system may range from $38 to $152 billion a year (Leslie et al, 2008). Economic realities necessitate that any preventative measures that may be taken to slow or minimize cognitive decline must be undertaken with a sense of urgency. Cognitive fitness programs involving self-regulation are proposed as such preventative measures.

The theoretical perspectives of lifespan developmental theory and self-regulation theory unite in this research on cognitive enrichment. These theories assert that development is possible throughout the lifespan and that development is enhanced by self-regulation. Self-regulation refers to agentic actions that are intended to achieve particular goals. Improving the self-regulating skills of elderly individuals is theorized to promote more productive mental and physical health behavior, which in turn, may slow declines and independence losses. Research has been conducted which suggests

cognitive gains in memory ability, accuracy and speed may be made through having older adults pursue cognitively stimulating and challenging tasks (e.g., Boekaerts, Pintrich, & Zeidner, 2000; Fingerman & Birditt, 2010). For example, Gross and Rebok (2011) evaluated memory and strategy use in older adults as part of the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study. Findings indicated that older adults could and did acquire cognitive skills and the effects of the cognitive training were durable. Self-regulated cognitive enrichment activity is an important area of research as it may indicate where changes might easily and affordably be implemented for a significant number of aging persons. It may hold that those who self-regulate and practice sound lifestyle management skills are healthier and more autonomous.

Setting up a physical exercise routine and maintaining one's physical health through self-regulation has been repeatedly shown to be an effective self-management and health promotion style (Cassel, 2002; Grodesky, 2006, Hertzog, Kramer, Wilson & Lindenberger, 2008). As we advance into a new era of lifespan extension, emphasis now needs to be placed on cognitive fitness. Part of a comprehensive medical check-up may begin to include brain scans every few years; it is not logical to examine the body and ignore the brain (Goldberg, 2005). It may be possible to examine brain changes and design brain fitness programs to promote cognitive health. The question is, what cognitive tools will be useful to the new aging demographic and how may they be used in ways that can be made available to an aging population to assist them in retaining their independence? Online learning activities such as gaming and communication may well afford one avenue for exploration. Lifelong development is possible; scientific evidence of physical brain development suggests that cognitive enrichment exercise may play a role in promoting cognitive fitness (Goldberg, 2005) and thus actively enhance and develop the aging brain. Examinations of the effect of self-regulation will play a paramount role in helping to create individualized self-sustaining cognitive enrichment programs.

Life satisfaction is another factor that interacts with one's health and behaviour. Researchers have found relationships between higher ratings of life satisfaction and better cardiovascular health and even increased longevity (Diener & Chan, 2011). Studies also exist that illustrate the healthful power of positive affect (Lyubormirsky, Sheldon & Schkade, 2005). Life satisfaction may play an important role in the acquisition

and retention of cognitive skill and fitness.

In the future, there may be cognitive gymnasiums or online virtual rooms where people meet to get their cognitive workouts. For now, there is no doubt that the individual must assume an active role in health care as the system must change and is changing to address excessive demands (Maes & Karoly, 2005). Active regulation of one's health care is the future; passive participation in healthcare is the past.

Both lifespan developmental psychology and self-regulation theory inform this study on cognitive enrichment, self-regulation, life satisfaction, and aging. In the literature review, a summary of relevant research examines the developmental processes relevant to cognitive aging, discusses the use of self-regulation as a procedural tool and presents cognitive enrichment as a potentially vital and essential process in an active model of productive cognitive functioning.

Four primary themes emerge from the review of literature. First, there is a recurring sense of urgency presented due to the realization that the population is aging and people are living longer. Maintaining the current level of healthcare will be challenging given increased demands. Second, there is a line of thought that indicates that through cognitive enrichment exercise, aging individuals may retain and maintain skill at higher levels for a longer period of time. Third, there is an indication that those individuals who are more skilled at self-regulation may have an advantage in the cognitive fitness race. Fourth, there is a belief that cognitive exercises, including those available as Internet activities and games, may be united with the technology that is now readily available at this precise moment of human history. This coupling of cognitive exercises and technology has not previously been so affordably and conveniently available to so many.

1.4. Research Questions

1. To what extent does participation in a challenging learning activity, learning Quizlet vocabulary sets, impact participant cognitive skill?
2. To what extent is there a relationship between self-regulation, life satisfaction and performance on measures of cognitive skill?

3. To what extent does a relationship exist between self-regulation and life satisfaction?
4. To what extent do participants modify their initial study tool and strategy choices after studying a vocabulary set? What commonalities are there to the reasons participants provide for their self-regulated learning?

1.5. Method

This research was designed to evaluate the relationships between cognitive enrichment, cognitive skill, self-regulation, life satisfaction and aging. The target population for this study was individuals 63 years of age and older primarily residing in Vancouver and on Vancouver Island in British Columbia, Canada. Experimental participants engaged in a challenging vocabulary learning activity called Quizlet that involved practicing memory, speed of processing and strategy skills. A control group participated in the evaluations of cognitive ability as well as responding to the two self-report instruments, the Self-Regulation Inventory and the Satisfaction with Life Scale. Two cognitive measures, the Ospan and the Wisconsin Card Sorting Test evaluated memory, speed and strategy and were administered before and after the intervention so that changes could be evaluated. Over the course of 8 weeks, experimental participants were asked to engage in the challenging learning activity for a minimum of 60 minutes a week: e.g., two or three times a week for 30 minutes. Quantitative data were collected for the cognitive measures and surveys. Some self-report data (i.e., open-ended questions) were collected and analyzed. The purpose was to examine whether the experimental participants would experience benefits to memory, speed and strategy ability compared to control participants. A subgoal was to determine if self-regulation and life satisfaction ratings were associated with levels of participation. If older adults could enhance or maintain cognitive skill using free or inexpensive learning activities on the Internet, then one piece of the cognitive decline puzzle could be addressed. This research may be a catalyst for identifying readily available learning activities that people may use for cognitive enrichment in order to maximize and maintain their cognitive skill.

1.6. Results

There are four main findings in this study. First, using the Ospan measure, a statistically significant relationship was found indicating positive change in experimental participant cognitive skill levels between pretest and posttest. As the Ospan provides a measure of changes in memory accuracy, this improvement in the scores suggests that there is an association between engagement in the learning activity and performance in this aspect of memory function. Second, the scores associated with the Wisconsin Card Sorting Test were statistically detected ($p = .086$) but did not reach statistical significance at the set level of $p < .05$. This suggests that improvement on this test was not as strongly associated with time spent doing the learning activity. Third, total scale scores on the Self-Regulation Inventory (SRI) and the Satisfaction with Life Scale (SWLS) were positively associated with each other ($r = .339$) at $p < .05$. Fourth, participant feedback regarding study tool use and strategy design and evaluation indicated that certain tools and strategies were judged to be more helpful than others in the acquisition of new information with the study sets in Quizlet.

In sum, the study suggests that involvement in challenging cognitive activity is associated with an improvement in memory skill. This is good news and what one would hope to see. The suggestion then would be to continue involvement in a challenging cognitive activity for at least an hour a week as this is associated with increased cognitive skill in terms of memory accuracy.

1.7. Definitions of Key Terms

As there are multiple definitions of primary terms in the area of aging, it is necessary to clearly define and present the concepts upon which this study is designed. The terms are presented in alphabetical order. With certain definitions, a brief discussion is given to explain the application of this concept in the context of this study on cognitive enrichment, self-regulation, life satisfaction and aging.

1.7.1. Cognitive Enrichment

Cognitive enrichment refers to a process that holds the potential to improve the quality of the cognitive skill of an individual through involvement in “intellectually engaging activities [that] could be part of a larger profile of an active, involved, individual” (Hertzog et al., 2008, p. 166). The cognitive enrichment process in this research involves using learning tools and developing strategies to practice memorizing and learning new words and ideas.

1.7.2. Cognitive Skill

This refers to the cognitive ability level that may be evaluated before and after engagement in cognitive enrichment activity to determine if the cognitive enrichment process had an impact on participant cognitive functioning. The cognitively-stimulating and challenging enrichment activities may hold the potential to improve participant cognitive skill in memory, memory accuracy, speed of processing and executive functioning. This outcome may be viewed as a potentially malleable level of skill.

1.7.3. Cognitive Enrichment Hypothesis

This hypothesis states that individual behaviors can have a positive impact on cognitive skill as one ages (Hertzog et al., 2008). To test the cognitive enrichment hypothesis, experiments are performed to evaluate the strength and degree of change in cognitive skill due to involvement in particular cognitive activities. This includes those gains in executive functioning that call for independent, purposeful and strategic involvement of the participant (Lezak, 2004).

1.7.4. Learning Strategy.

A learning strategy refers to a “structured set of alternative tactics for navigating a task. It unfolds over the course of engagement with a task” (Winne, 1996, p. 329).

1.7.5. Life Satisfaction.

Life satisfaction refers to an individual's personal judgment about the quality of his/her life using chosen criteria. The Satisfaction with Life Scale (SWLS) sets forth 5 criteria that involve rating life on a 7-point scale. Individuals rate life as being close to their ideal, having excellent conditions, creating personal satisfaction, achieving goal attainment and accepting life's turns and changes. The measure of life-satisfaction is considered to be a measure of well-being (Diener, Emmons, Larsen, & Griffin, 1985).

1.7.6. Memory Accuracy.

Memory accuracy may be best distinguished by noting two memory metaphors: the "storehouse" and the "correspondence" metaphors (Koriat & Goldsmith, 1996). As Koriat reports, in this context, what is important is that "the correspondence metaphor entails the evaluation of memory in terms of its faithfulness in representing events, rather than merely in terms of the number of items remaining in store" (Koriat & Goldsmith, 1996, p. 491). The difference between quantity and accuracy is significant. Importantly, memory accuracy is under the strategic control of the individual whereas memory quantity is not (Koriat & Goldsmith, 1996). Therefore, the possibility of improving one's memory accuracy may be seen as more malleable as a cognitive skill. The Ospan cognitive measure assesses memory accuracy as represented by the Koriat & Goldsmith's correspondence metaphor.

1.7.7. Mild Cognitive Impairment.

(MCI) Mild cognitive impairment refers to "a state of cognitive functioning that is below defined norms, yet falls short of dementia in severity. It exists across a cognitive continuum with borders that are difficult to define precisely" (Feldman & Jacova, 2005, p. 645). It is often the case that when an individual seeks help for memory or functioning difficulty that there is no prior measure against which to evaluate the individual change. Further, MCI is "a common condition among the elderly, [that] is defined as a deterioration of memory, attention, and cognitive function that exceeds what would be expected for the individual's age and level of education, yet does not interfere significantly with the activities of daily living" (Etgen, Sander, Bickel & Forsti, 2011).

Given the breadth of this definition, there is controversy surrounding exactly what constitutes MCI (Petersen, Knopman, Boeve, Geda, Ivnik, & Jack, 2009). Many individuals with MCI are not diagnosed.

1.7.8. Normal Cognitive Aging.

This is a pattern of aging that is characterized "by most individuals reaching an asymptote in early midlife, maintaining a plateau until the late fifties or early sixties, then showing modest decline on most cognitive abilities through the early eighties, with more marked decline in the years prior to death" (Schaie, 2010, p. 27).

1.7.9. Self-regulation.

In this study, self-regulation refers to choosing agentic actions that are intended to achieve particular goals. More broadly, the self-regulation concept "refers to autonomy, emotional independence, and the ability to actively regulate one's own life in order to achieve one's needs and aims and to engage in appropriate health-seeking behaviour" (Marques, Ibanez, Ruiperez, Moya & Ortet, 2005, p. 1045). The ability to self-regulate was evaluated in this study using the Self-Regulation Inventory (SRI).

1.7.10. Speed of processing.

Speed of processing is defined as "either the amount of time it takes to process a set amount of information, or, conversely, the amount of information that can be processed within a certain unit of time. It is a measure that reflects mental efficiency" (NIH, 2012). The Ospan and the WCST measure speed of processing as well as failure to process. Speed of processing declines are huge issues for aging persons as these effect everyday activities essential to independent living such as driving, reading and accessing information.

1.7.11. Study tool.

Tools are implements or instruments that may be used to accomplish goals. In this study, the term study tools refer to the 6 specific study tools provided within Quizlet:

Flashcards, Speller, Learn, Test, Scatter and Space Race. These study tools might also be labelled study methods. Study tools provide a user-chosen palette of implements or instruments designed to present the set materials in different fashions to the learner to assist the learning process.

The definitions of the main terms for the study have been briefly detailed herein. Due to the complexity of the terms, these brief definitions are isolated to highlight the main features relevant to this particular research. More detailed discussions, examples, and presentations of these terms within the research context will follow in the literature review and methods chapters.

2. Literature Review

2.1. Introduction

For this study on cognitive enrichment, self-regulation, life satisfaction and aging, the literature review is organized into four sections. First, the theoretical frameworks upon which this research is founded are presented: lifespan developmental theory and self-regulation theory. Second, relevant research that illustrates possible relationships between cognitive enrichment and cognitive skill is overviewed. Transfer is discussed within this context. Third, the online cognitive enrichment intervention activity and the measurement instruments used in this study are briefly presented. Fourth, this literature review concludes with a discussion of the gap this thesis addresses in the area of cognitive enrichment and self-regulation.

2.2. Theoretical Framework

This study tests the cognitive enrichment hypothesis and is informed by two lifespan development models and self-regulation theory. These models are Baltes' Lifespan Development Theory and the Schaie-Willis Stage Theory of Adult Cognitive Development. The developmental models indicate that adulthood is a stage in which the individual has the potential to experience positive cognitive growth. Both theories accentuate the autonomy of the individual, and note that development in the later stages of life is qualitatively distinct from development in the earlier stages of the lifespan. In addition, within this developmental framework, Self-Regulation and Self-Regulated Learning Theory are presented. Self-regulation theory views change as motivated by the individual and goal-directed.

2.2.1. Paul Baltes' Lifespan Development Theory

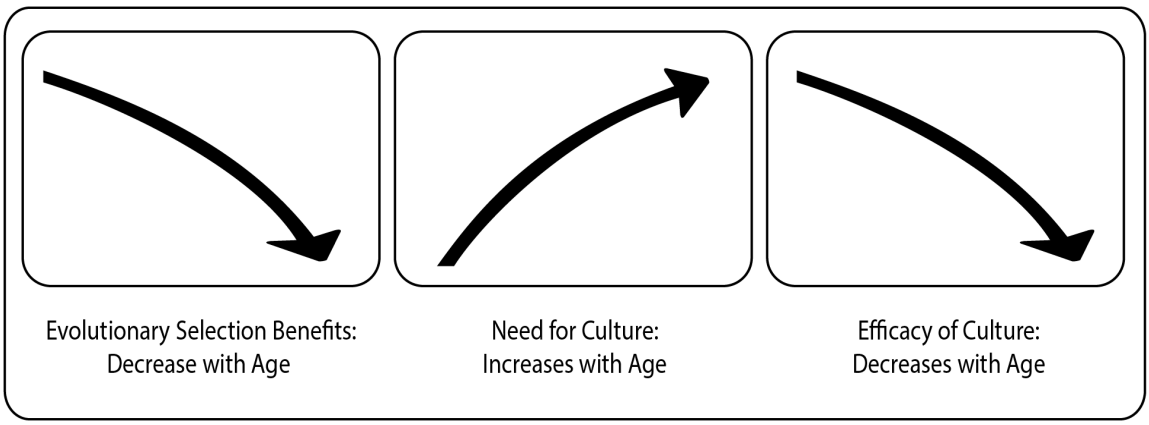
Baltes proposed a theory of lifespan psychology that embodies the interplay between biology and culture. Figure 2.1 illustrates several key facets of his Lifespan Theory: there is a directionality to development; development has three primary adaptive goals: growth, maintenance and the regulation of loss. Development is based upon the interplay of three processes of behavioral regulation: selection, optimization and compensation (SOC) (Baltes, Staudinger & Lindenberger, 1999). Within this perspective, development is viewed as a process that continues across the entire life course. Cultural and societal realities are changing; a longer lifespan and a greater proportion of older individuals in society demand that former ageist ideas that portray aging as inevitable loss and decline are abandoned (Baltes et al., 1999). New possibilities for cognitive skill maintenance and acquisition need to be found to address the changing needs. As individuals age, cognitive abilities often deteriorate and the use of compensatory strategies has been shown to be a productive adaptation.

The first phase of Baltes' theory indicates that as one ages, the primary advantages for reproductive functioning reach their peak and sharply decline. In the second phase of lifelong development, the need for culture rises. The cultural needs include all of the psychological, social, material and symbolic resources created by humans over the millennia (Baltes et al., 1999). Cultural resources include "cognitive skills, motivational dispositions, socialization strategies, literacy, written documents, physical structures, and the world of economics as well that of medical and physical technology" (Baltes et al., 1999, p. 475). Cognitive skill may be enhanced through use of the strategies and documents that are part of these cultural resources. As individuals age their need for these cultural resources increases. In our modern technological world there are opportunities for individuals to increase the richness of their lives. This has been less commonly the case in North America in the past as few reached old age and fewer yet had the opportunity to have high educational status. Now, through improvements in healthcare, social provisions, and technology, education has become far more advanced (Baltes et al, 1999) and may extend throughout the entire lifespan. Newer research findings suggest that retaining strong cognitive abilities and developing productive patterns of thinking promotes better cognitive skill that will last into older age (Goldberg, 2005). In the third phase of lifelong development, there is a reduction in the

efficacy of cultural resources for the aging individual. It is at this stage that the older adult will need more cultural provisions and, as well, is likely to require more cultural assistance while simultaneously experiencing lower levels of cognitive functioning (Baltes et al, 1999).

Entering later life with a foundation of greater knowledge and cognitive skill may have protective value and even shield aging persons from the ravages of diseases involving cognitive impairment and dementia. Greater levels of cognitive skill may assist aging individuals to adapt to the changes that normal aging entails. The diagram below outlines the three conditions and their trajectories that form the architecture of Baltes' Lifespan Development Theory. The middle phase of Baltes' lifespan model, accentuating the need for culture, is the focus of the intervention used in the present study.

Figure 2.1. Representation of dynamics between biology and culture across life span



The schematic representation of the average dynamics between biology and culture as these vary across the lifespan (adapted from Baltes, Staudinger & Lindenberger, 1999).

In sum, Baltes' lifespan development theory provides a framework for understanding the gains and losses individuals experience as they age. The "constancy and change" in behavior over the life course is illustrated through his co-constructionist view of the interplay between biology and culture (Baltes, 1987, p611). There are three principles involved. First, over the lifespan the biological potential of the aging individual declines. Second, as the individual ages, cultural resources become more necessary to maintaining positive development. Third, over the lifespan, due to losses in biological potential, cultural resources become less efficacious (Baltes, 1997). These three

principles of development reflect the changes in fluid and crystallized intelligence over the lifespan (Baltes, 1997). Natural fluid abilities tend to decline as one ages, and cultural resources are required to help aging individuals maximize their potential. Later in life, the cultural resources become less efficient. Baltes' lifespan developmental theory illustrates the processes that impact the individual's ability to influence the gains and losses he/she experiences over the lifespan due to the natural processes of aging.

The allocation of cultural resources has become more evenly distributed across the socio-economic classes. Modern electronics mean that learning tools, once the luxury of wealthy individuals, are now inexpensively available to all either through individual acquisition or through libraries and public agencies. Further, the ease of using modern computers coupled with the availability of applications and games means that culture is more freely available and accessible than it has ever been in human history. This may have a huge impact on the possibilities for "cognitive health care" for the next generations as they enter the latest developmental stages. These thoughts connect with Baltes' Selection, Optimization and Compensation Theory (SOC) as it becomes particularly applicable as a technique to enhance cognitive functioning in the later stages of the lifespan. In fact, this thesis is based in part upon the acknowledgement that through strategic actions, participants may modify and adjust their behavior in earlier life stages in ways that enable them to maximize their abilities and compensate for the losses that accompany their individual aging process.

To illustrate, life presents an antecedent condition such as the slowing of cognitive function - perhaps a slowing of speed of processing. Orchestrating processes exist such as the ability to select appropriate strategies such as active rehearsal and repetition: an individual may practice a cognitive game, learn a new language, get involved in active volunteer work or learn how to play an instrument. These means could be used to stimulate cognitive development and optimize one's speed of processing. Several strategies might be tried and the best ones would be selected to compensate for the original loss of skill. In this way, the individual's selection of an optimizing technique could be used to compensate for a natural loss that might accompany the aging process. Looking at an expert self-regulated learner will clarify. Concert pianist, Arthur Rubinstein, aged 80, explained three strategies helped him to compensate for a slowdown in ability and to maintain his high level of proficiency and creativity (Baltes et al., 1999).

Rubinstein's steps fit into SOC: selection involved deciding on playing fewer pieces; optimization involved practicing these pieces more often; and, compensation involved playing more slowly at the top and faster at the end to make the playing sound faster (Baltes et al, 1999). Rubinstein's self-regulating behavior may be used to illustrate the power of the SOC strategy in accounting for the losses experienced by aging in a skilful way so as to maximize one's performance. As an example, having individuals select, adopt and evaluate their strategies for choosing study tools for learning new vocabulary and concepts in a challenging context with varied choices might permit individuals to practice and adopt SOC in a way that promotes both more strategic learning and improved cognitive functioning.

Baltes (1997) makes the distinction between cognitive mechanics and cognitive pragmatics. Whereas cognitive pragmatics refers to the acquired knowledge that individuals possess and which may actually increase with age, cognitive mechanics refer to fluid thinking processes that tend to decline with age. These again illustrate the cultural aspect of knowledge (pragmatic) is most stable whereas the biological (mechanic) intellectual endowment changes across the lifespan and is more vulnerable to the process of biological aging (Baltes et al., 1999; Goldberg, 2005). In this thesis, the maintenance, improvement and retention of cognitive mechanics are evaluated. This study of cognition and aging asserts that developmental changes occur throughout the lifespan. The need for study is highlighted by the fact that the population is aging and the lifespan is far longer than ever before in history. What are the potentialities for cognitive development and enrichment in the later stages of the lifespan? How much plasticity is possible? What cognitive changes may be easily enhanced? The physical fitness movement has been successful in a variety of contexts (Hertzog, Kramer, Wilson & Lindenberger, 2008; Cassel, 2002; Grodesky, 2006). The cognitive fitness movement has just begun, but it may be the next essential step in the evolution of lifespan psychology. Understanding what is possible in the promotion and maintenance of better cognitive skill through examining free accessible cognitive activities that are readily available using the World Wide Web is one small step in exploring this important direction.

2.2.2. Schaie and Willis Stage Theory of Adult Cognition

Schaie and Willis formulate a stage theory of adult cognition. They state that in the later stages of life, individual cognitive development does not entail higher levels than Piaget's formal operations, but rather that development comes to reflect different uses of the intellect (Schaie, 2010). In the later stages of adulthood, beyond the ages of 60 or 65, the intellectual pursuits become a reintegration that is similar to Erikson's Psychosocial Stage of ego integrity versus ego despair where the individual resolves this tension in a positive or negative manner (Schaie, 2010). In the Schaie-Willis Model, this stage involves a reintegration as individuals reevaluate their expenditure of time and resources. Part of this process involves planning how one's resources (physical, financial, cultural, cognitive) will last for the next phase of life which may now extend three decades (Schaie, 2010). In order to maintain one's quality of life at a standard that is acceptable to the individual, certain lifestyle choices may be more optimal than others. There is a departure from Erikson's Lifespan Theory insofar as generativity is characteristic of outer focus or a focus outside of oneself and toward others for Erikson, whereas Schaie and Willis liken this stage to a more transitional stage where the aging individuals are more self-focused and engaged in finding methods to maximize their own quality of life and future independence. To this end, as part of Schaie and Willis' reorganizational stage, high levels of cognitive functioning are required. The maintenance of flexible cognitive styles is needed so that the aging individuals can cope with the changes in their life due to retirement, loss of independence, and changes in resource availability and control (Schaie, 2010). With longer life expectancies, this stage may be 15-30 years longer than in the past. Attaining greater levels of cognitive skill to cope with massive lifestyle change requires mental flexibility and adaptability. These skills may be promoted through involvement in cognitively-stimulating activities. These cognitive skills may possibly be promoted easily and affordably through using free online activities. Personal agency, as exercised through self-regulation, is likely to form an integral part of the process of redesigning one's cognitive exercise routine and may possibly establish a greater level of cognitive skill.

Cognitive enrichment may be one way to bridge the gap between normal cognitive aging and the typical cognitive impairment that many currently experience. Obviously, many facets of aging are beyond individual control; however, many others

may be malleable. With some alterations in one's cognitive enrichment behaviors, it may be possible to extend normal or possibly higher cognitive skill for a longer period of time. It may be possible to reverse some memory, speed of processing and strategy losses before these become permanent. At the very least, at the present moment there does seem to be evidence to suggest that preserving normal cognitive skill levels before impairment sets in is a wise move.

2.3. Normal Cognitive Aging

Normal cognitive aging has been defined by cognitive psychologists as "continuing to function at a level characteristic of our age group as influenced by relevant demographic factors" (Powell, 2006, p. 1). Normal cognitive aging is defined by neuroscientists as the absence of disease (Rinn, 1988). Taken together, knowledge from both of these sources combines to create a more meaningful understanding of cognitive aging. Both evaluate normal cognitive aging within the context of change and abnormality. Psychologists evaluate normal cognitive aging by using standardized tests and criteria that separate normal from impaired performance. Neuroscientists evaluate brain abnormality through standardized criteria and through magnetic resonance imaging (MRI) and positron emission tomography (PET) technologies. As both normal cognitive aging and pathological aging are accompanied by changes to memory skill and speed of processing it is difficult to draw a line between what constitutes normal change and what indicates pathology. Group norms have been developed using standardized tests and these continue to be refined: (e.g., DSM-III-R criteria for dementia which examines memory, abstract thinking, judgment; the Buschke Cued Recall Test which measures free recall; the WAIS-R which measures similarities, comprehension, and digit symbol) (Ritchie, Fredricks & Tuokko, & Rinn, 2007). The Canadian Study of Health and Aging established norms that reflect a varied Canadian population (Ritchie et al., 2007). Establishing cognitive aging norms is an ongoing process. Longitudinal data are not all reporting similar findings. Cross-sectional data have proven unable to differentiate between cohort effects and age-related declines (Rinn, 1988). Each method used to describe normal cognitive aging has its limitations but also its merits. Data from several sources will help build a new model for investigating age-related cognitive decline in a way that permits a union of data from both cognitive studies and neuroscience.

Studies evaluating the effects of cognitive training on older adults have yielded some positive results. For example, the COGNITO study data were used to evaluate the effect of working memory on performance to presentation time for younger and older adults: increases in performance were associated with longer presentation times and with increased memory store. Twelve different tasks involving working memory, episodic memory and speed were used to promote information processing. The study results suggest that memory updating (involving adjusting to changing information) was improved by the intervention which was set to evaluate "day to day variability and plasticity of cognitive functioning" (Shing, Schmiedek, Lovden, & Lindenberger, 2012, p. 451). The final results indicate that the older adults improved their memory function to the same level as younger adults within 100 days of practice (Shing et al., 2012). The researchers suggest that in order to promote productive cognitive change, it is important to ensure that task difficulty and demands are aligned to the learners. Further, they suggest that researchers pay more attention to other factors that impact older adult learning such as motivational factors. Another study evaluating working memory and older adults was conducted by Bailey, Dunlosky and Hertzog (2014); the study results examined age-related deficits in working memory and evaluated the utility of teaching older adults encoding strategies to promote better memory function. Participants completed a self-paced strategy training procedure that illustrated potentially productive memory learning strategies. Final results indicated that the strategy training did improve performance for both younger and older adult learners (Bailey et al., 2014). Importantly, this research promotes the idea that specific strategy training can promote better memory function (Bailey et al., 2014).

Neuroscientists look at the normal brain to find neural decline, atrophy and loss (Cabeza, Nyberg, & Park, 2004). Atrophy in the prefrontal gray matter is accompanied by a change in cognitive behavior. With such pathology, a decrease in the size of the prefrontal cortex and decreased glucose metabolism is found in the frontal lobes (Haut, Chen, & Edwards, 1999). MRI and PET scans are used to illustrate brain changes in living subjects. Brains may be rescanned and monitored to note the physiological changes that accompany the normal aging process as well as those changes that indicate pathology. The neuroscientific findings may be examined and evaluated in the

context of the corresponding cognitive-behavioral changes that have been observed. To illustrate, white matter abnormalities shown in MRI scans are associated with deficits in speed of processing, memory, and executive functioning (Gunning-Dixon & Naftali, 2000). Within this arrangement, cognitive-psychology and neuropsychology can more fully examine cognitive and neurological changes side-by-side.

Normal cognitive aging is defined within the context of abnormal cognitive aging. MCI is viewed as the beginning of Alzheimer's disease and is not normal age-related decline. Criteria may be used to differentiate between normal cognitive aging and mild cognitive impairment. Powell (2006) suggests that there are 7 cognitive changes that indicate greater than normal decline. First, there is marked memory ability loss in about a six-month span. Second, there is impairment in at least one other domain: attention, judgment, or problem-solving. Third, there is impaired functioning in community or home affairs. Fourth, some potentially dangerous lapses in memory occur. Fifth, these changes occur fairly gradually over about six months. Sixth, other medical disorders have been ruled out. Seven, the individual and another informant confirm the findings (Powell, 2006). These criteria provide cognitive-behavioral ways to evaluate cognitive aging decline to determine if it falls within the normal range or if it indicates MCI or AD.

In contrast, normal aging change is much more gradually sloped so that by age 60 an individual is only functioning at about 10% less on the Wechsler Adult Intelligence Scale (WAIS) than a 30 year old. In the next decade there is another IQ drop of 9% and this decline continues so that by 75 years of age there may be another 10% drop (Powell, 2006). These are normed averages based on participants who were not matched for demographic or other characteristics. The trend of maintaining normal cognitive functioning until 60 and then experiencing more significant loss is noted in many studies (Schaie, 2010). The good news is that of those who experience no discernable pathology and with those where intraindividual data have been collected longitudinally, there is evidence that many individuals do not seem to experience substantial decline regardless of their age (e.g., Small et al., 2012; Goldberg, 2005) The implication is that engaging in certain healthful enriching activities may have benefits on an individual's overall cognitive health. As particular cognitive skills appear to be more susceptible to normal cognitive aging, these may warrant immediate investigation. The

literature has repeatedly shown that speed of processing and memory performance decline differentially with age (Schneider, Pichora-Fuller, Craik & Salthouse, 2000).

Defining normal cognitive aging in a manner that makes it clearly distinct from cognitive impairment is elusive. Standardized tests are given and illustrate levels of normal cognitive performance. Neuroscientists have sophisticated images that indicate brain changes. Findings of cognitive-psychologists and neuroscientists provide scientific knowledge that assists possible interested parties in solving difficulties associated both with normal and pathological aging. Still, more knowledge is needed to more fully understand the relationship between aging and cognitive performance. Does participating in cognitively difficult and challenging enrichment activity promote better brain functioning? Is it possible to slow normal cognitive aging? Is it possible to reduce or slow the levels of cognitive loss in those with pathology? Is it possible to train the individual to utilize strategies that help one to bypass some of the effects of cognitive aging? These are all important questions.

How does one differentiate between normal aging and impaired aging? The current thinking is that “normal cognitive aging and Alzheimer’s Disease are not separate entities, but lie on a continuum” (Powell & Whitla, 1994, p. 28). The boundary that separates normal cognitive aging from impaired cognitive aging involves matters of judgment. Normal aging appears to involve cognitive declines at levels that do not severely impede individuals in the performance of everyday tasks. As soon as the cognitive losses impair individual functioning, then a diagnosis of MCI or AD may be given.

The goal of cognitive aging research is to understand how to extend cognitive skill for longer periods of time (Azevedo & Loewenstein, 2007). Studies that investigate cognitive enrichment activities seek to find ways to have a positive effect on cognition and a delaying effect on the onset of cognitive impairment. For example, the Advanced Cognitive Training for Independent and Vital Elderly Study (ACTIVE) examined over 2800 community-dwelling adults (Azevedo & Loewenstein, 2007). Participants were assigned to groups that engaged in 1 of 4 conditions: memory, reasoning, speed of processing or no-contact. The intervention lasted approximately 6 weeks and involved 10 sessions of about one hour of training. Booster sessions were given at 11 and 35

months after the intervention. Results showed that all of the intervention subjects exhibited gains in cognitive performance and these gains persisted 2 and 5 years following the initial intervention (Azevedo & Loewenstein, 2007). A number of other scholarly studies have reported similar findings. Edwards, Wadley & Vance, (2005) used the Timed Instrumental Activities of Daily Living Test to evaluate processing speed. Following 10 sessions, participant speed of processing gains increased performance. In another example, a computer-based intervention that involved training in processing speed and working memory was used to track normal cognitive aging improvements. After an hour a day of intervention 5 days a week for 8 to 10 weeks, participants improved their processing speed and forward recognition memory span (Azevedo & Loewenstein, 2007). These findings are in concert with those reported in a number of other studies (e.g., Schaie, Willis & Caskie, 2004; Mahncke, Connor, Appelman, Ahsunuddin, Hardy, Wood et al., 2006; Kramer, Bherer, Colcombe, Dong & Greenough, 2004; Powell, 2006). Overall, the areas that have shown promise in improving normal cognitive skill levels have involved delaying declines in memory, and increasing speed of processing and utilizing effective strategies.

To better understand the trajectories for optimal, normal and impaired aging, the Mayo Clinic Study of Aging longitudinally examined over 2000 individuals in a random sample of 70 to 89 year olds (Peterson, 2009). The data revealed the following: 1) between 13 – 15 percent of individuals between 70 and 89 have MCI; 2) a further 10 percent have Alzheimer's Disease (AD); 3) the number of individuals moving from normal aging to MCI increases at a rate of 5.3% a year; and 4) those individuals with a diagnosis of MCI progress to dementia at a rate of approximately 10% a year (Peterson, 2009). At this time, there are no therapies for MCI and AD. There is, however, evidence suggesting that normal aging may be extended by providing cognitive enrichment interventions. As the number of cognitively impaired individuals is increasing; it is essential to find those methods which may extend normal cognitive abilities for a lengthier period and, those therapies that may assist individuals with MCI to delay the onset of AD.

Hope is an antidote to misery. Fears of cognitive loss and dementia haunt many aging persons. Steps may be taken to understand the weaknesses, strengths, and needs of an aging population. In the developed world, computers provide access to

many free and inexpensive activities. Researchers can gather evidence to illustrate which cognitive enrichment activities improve memory, speed, and strategy functioning and which activities do not. Quizlet is an example of a multi-faceted vocabulary learning activity site and game that people may freely access. Quizlet may offer tools and information that older adults can access to stimulate the parts of their brain that promote better cognitive skill and strategic thinking. Promoting the self-regulation of cognitive exercise may empower older adults to take charge of their cognitive fitness and empower them to exercise more control over their own cognitive destiny.

2.4. Self-Regulation and Self-Regulated Learning

Self-regulation is an important tool for developing and maintaining cognitive skill across the lifespan. Self-regulation means learners exercise influence and control over their own "motivation, thought processes, emotional states and patterns of behavior" (Bandura, 1994, p. 26). Self-regulation may be viewed as the exercise of self-control which includes adapting one's "physiological activity, behavior, and/or processes of consciousness" (Stoyva, 1976). To illustrate, one societal benefit in health care prevention and management may be the ability to self-regulate as it can help individuals in the early detection and management of medical issues (Leventhal, Forster, & Leventhal, 2007). Recognizing symptoms, assessing health threats and developing an action plan in response are cognitive strategies that may be undertaken at the individual level. Self-regulation is therefore important due to its potential impact on the independent practices of older adults.

In the past, aging was presented as a disengagement from life and decline into disuse of cognitive skills; research has begun to illustrate that older adults are capable of intellectual growth (Hertzog and Dunlosky, 2004; Roberson, 2005; Petrina, Feng & Kim, 2008; Yang, 2008; Tranter and Koutstall, 2008; Goldberg, 2005; Shreeve, 2012). In one experiment, Tranter & Koutstaal examined the effects of participation in self-regulated mentally stimulating activities on older adults' fluid intelligence performance. Fluid intelligence refers to the ability to creatively interact with the world in ways not dependent upon past knowledge (Tranter & Koutstaal, 2008). After intervention, these researchers found gains in participant cognitive skill (effect size d = .56). This research

indicates self-regulation promoting cognitive growth is possible for older adults. Much research shows that in the absence of cognitively challenging experiences, there is cognitive decline in skill in the elderly (Goldman, 2005; Seeman, Lusignolo, Albert & Bergman, 2001; Snowdon, 2003). Other research has indicated that a cognitively-rich environment may reduce the symptomology from brain disease: the nun studies conducted by David Snowdon provided evidence that active cognitive practice reduced Alzheimer's symptomology in participants, even those over 100 years old (Snowdon, 2003). Other studies have demonstrated gains are made in cognitive ability when active self-regulated learning is introduced (Stine-Morrow, Parisi, Park & Morrow, 2008).

A few studies exist that evaluate the short and long-term effects of strategy interventions on cognitive development for older adults. The National Institute on Aging (NIA) and the National Institute of Nursing Research, sponsored the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) trial which was set to examine the "effectiveness and durability of 3 distinct cognitive interventions in improving the performance of elderly persons on measures of cognition and on measures of cognitively demanding daily activities" (Ball et al, 2002, p2). These three areas were memory, reasoning, and speed of processing. They found that a significant number of individuals did have better cognitive skills as a result of cognitive intervention and these gains did persist for 2 years. This was a large-scale study with 5000 randomly selected participants assessed for eligibility. Multiple measures were used to evaluate cognitive gains: Hopkins Verbal/Auditory Learning Test, Everyday Problem Solving, Observed Tasks of Daily Living, and Driving Habits among many others (Ball et al., 2002).

In their meta-analysis of fitness training and the cognitive vitality of older adults, Colcombe and Kramer (2003) conclude that their research "establishes the efficacy of fitness training as a means to enhance the cognitive vitality of older adults" (p. 4). If individuals improve their health habits, they can live longer and healthier lives. If individuals self-regulate their lives, this can significantly impact healthcare costs (Gollwitzer & Oettingen, 1998; Bandura, 2005). Health systems must increasingly endorse a self-regulatory model as the demands of the healthcare system continue to outstrip the resources that are available. Sound health habits including the prevention of cognitive decline and the maintenance of cognitive skill need to be implemented in a similar manner to those programs that exist for physical health promotion; this must be

done with a particular sense of urgency as the baby boomers reach old age. The medical savings to society alone would pay back costs associated with such programs many times over, while emotional benefit to individuals and their families would increase quality of life for all.

Three systems must be present in order for an individual to self-regulate: 1) a self-monitoring system; 2) a goal-setting system; and, 3) a self-reactive or evaluative process (Bandura, 2005; Demetriou, 2005). These 3 processes involve both self-motivating incentives as well as social supports (Bandura, 2005). To illustrate and apply this model of self-regulation to this cognitive skill research using a vocabulary learning game as the tool, the following steps apply: 1) awareness that one's own level of cognitive skill has changed. Cognitive losses have been and are being experienced (e.g., speed of processing/ declines in memory attention and accuracy); 2) individuals participate in goal-setting which includes a willingness, commitment, and the actuality of participating in the online cognitive exercise; 3) examine to see if one's own scores (number of correct responses, efficacy of strategy choices, use of time) have improved or increased and examining if prior goals (e.g., 1.5 hours of weekly participation) were fulfilled. If goals are not reached, the individual will examine feedback and reevaluate to alter strategies as required.

2.5. Self-Regulated Learning

Self-regulated learning (SRL) emerged from self-regulation and metacognition as a theory that addressed "the interaction of cognitive, motivational and contextual factors" (Lajoie, 2008; Corno & Mandinach, 1983). SRL illustrated the role of effortful learning with personal agency as the driving force (Lajoie, 2008). SRL grew out of metacognition and self-regulation, with all three sharing some common dimensions. Dinsmore, Alexander and Loughlin (2008) sought to discretely define each. They conducted a review of 255 articles and concluded that metacognition is primarily defined as the thinking component and SR as the action component, whereas SRL contains components of both. SRL emerged in the academic context. In academia, computer based learning environments (CBLEs) are often used as complex tools with which to present learning opportunities and evaluate learner SRL. Aspects of metacognition and

self-regulation must both be studied to gain a broader understanding of the processes of self-regulated learning.

Winne and Hadwin's (1998) Model of Self-regulated Learning describes four phases of self-regulated cognitive processing. These four processes are defining the task, setting goals and plans, using study tactics to learn, and utilizing metacognitive processes to adapt to the learning demands (Winne & Perry, 2005). These phases are experienced in a unique way by individual learners who interpret the learning task conditions (e.g., resources, time) differentially based on their cognitive conditions (e.g., beliefs, motivations, domain knowledge) and, as a consequence, initiate a dynamic interplay casting themselves onto a learning stage upon which they continuously metacognitively monitor and control themselves in ways they believe will enhance their learning experiences and outcomes. To comprehensively track this process, capturing data from several angles is necessary. In a CBLE environment, certain data traces may be acquired unobtrusively through computer programs that collect such data as time on task, choice selection, and self-report data and test scores. However, to truly capture a composite view of SRL in motion, trace data that is more obtrusive affords a more complete understanding (Greene & Azevedo, 2010). The acquisition of obtrusive data has often been acquired through think-alouds where participants share their metacognitive thoughts as they occur (Winne, 2010); judgements of learning (JOLs) are often acquired through questioning and triangulated with other data to get a broader picture of the unfolding of the metacognitive and cognitive processes involved in SRL (Azevedo, Moos, Johnson & Chauncey, 2010).

SRL may be evaluated as an aptitude or an enduring ability, or it may be evaluated as an event. SRL as an event may be viewed as comprising "three successively more complex levels: occurrence, contingency and patterned contingency" (Winne & Perry, 2005, p. 535). The occurrence refers to a transition from a first state, which does not involve SRL, to a second state which does (Winne & Perry, 2005). For example, in learning vocabulary, a person may look at a set and think "I don't know any of these words, so this will be challenging for me." This would illustrate an "occurrence" of the first level of SRL in which the learner evaluates the learning situation and makes a thoughtful judgment about what might work to assist in the learning process. Second, the contingency refers to a relationship that may be viewed as an if-then event (Winne &

Perry, 2005). In this case the learner may proceed from, “If this is challenging” then, “I will select a strategy that I think will be helpful to me.” This “if-then” contingency pattern would illustrate the metacognitive process of evaluating and then monitoring one’s learning. Both action (self-regulation) and thinking (metacognition) together would indicate self-regulated learning. Finally, “a patterned contingency assembles several different if-then contingencies into a structured ensemble” (Winne & Perry, 2005, p. 536). For example, in studying a vocabulary set with 6 provided study tools as well as the learner’s own study strategy repertoire, a learner may strategically select, apply, and evaluate (monitor and control) different study tools and if one such tool is minimally useful, try a different study tool and so forth. After sampling each study tool, the learners will get feedback and then strategically select those tools that optimize their performance and reject those that do not. This cycle may repeat several times and vary due to content studied. Then, a combination of tools may be used to facilitate a study strategy that better promotes the learner goals. The marriage of action (SR) and thought (metacognition) would indicate that self-regulated learning was integral to this process. In this thesis, SRL will be evaluated through the collection of self-report data.

2.6. Relevant Research: Cognitive Enrichment

Whereas cognitive skill level may be used to evaluate individual functioning at a particular moment in time, self-regulation is a wilful sequence of actions that a person undertakes with a personal goal in mind. Historically, cognitive development has been viewed as the domain of the young. The capacity of the adult brain to develop, change physically, and develop new neurons was seen as “fanciful” (Goldberg, 2005). Neuroscientists promoted the idea that hemispheric development was static. Now neuroscience, with the help of modern technology, has begun to overturn some of these assumptions. The new findings have implications for the implementation of cognitive enrichment programs for older adults: cognitive change is possible throughout the lifespan.

It has been established in major aging studies such as those conducted through the MacArthur Foundation that advanced education can lead to better cognitive health in older age. There is also some suggestion that through high levels of cognitive exercise,

individuals may slow the onset of the symptoms of Alzheimer's disease even in the face of advanced stages of the disease (Snowdon, 2003; Goldberg, 2005). Verhaeghen and Marcoen's (2003) study of brain plasticity found that much of the difference in processing between younger and older adults was attributable to the older adults' lack of compliance with task parameters and with processing deficits rather than in their ability to learn. This leads one to wonder if more enjoyable activities pursued with an understanding that cognitive exercise could be vital to retaining cognitive skill might lead to better compliance. Given a greater understanding of the types of gains (e.g., memory, speed of processing) that are possible, older adults may become more compliant and less resistant to participating in new ways of learning.

In the current research context, there are two important changes to the way aging and cognitive enrichment is viewed. First, in the past, brain development was seen as occurring from birth until maturation and subsequently was followed by inevitable decline. Now, scientific evidence indicates that brain development is lifelong. Second, brain development was viewed as being nonspecific. Now, evidence suggests that particular parts of the brain atrophy sooner than others, and these areas may be targeted through specific cognitive exercises (Gilkey & Kilts, 2007). This is an area worthy of exploration as a result. There may be identifiable steps involved in becoming cognitively fit: 1) Understanding how experience affects brain development so that one may pursue worthwhile cognitive tasks; 2) Working hard at play as this stimulates new connections and growth; 3) Seeking novelty and innovation to challenge the brain in new and creative ways as this has been shown to promote neural growth (Gilkey & Kilts, 2007; Goldberg, 2005). This thesis evaluates participation in cognitive enrichment activities set in an enjoyable context to determine if active self-regulated learning and strategic learning promotes memory and speed of processing abilities that are relevant to cognitive skill. Cognitive level changes can be measured through participant performance on the Ospan which evaluates memory, accuracy and speed of processing. The Wisconsin Card Sorting Test (WCST) which measures memory, memory accuracy, strategy, and speed of processing will also be examined. In the following section, previous research evaluating the connection between the cognitive enrichment hypothesis and cognitive skill is presented.

2.6.1. Cognitive Enrichment and Transfer

Involvement in cognitive enrichment activity has been shown to enhance cognitive skill in older adults. Activities may involve direct or indirect communication with others or be solitary pursuits. These activities may involve active participation in computer-simulated games. Key ingredients in the cognitive involvement include active participation, extended participation (e.g., repetition) and challenging activities.

In a study called the Experience Corps Program, older adults (60+) were paired for one academic year with elementary students in order to teach reading and general literacy skills (Carlson et al., 2009). This study had older adults act as volunteer tutors and assist younger children with their reading and writing skills. This pilot study provided evidence to suggest that a community program designed to improve the executive functioning of adults could be effective in assisting older adults to gain cognitive skill. The implication is that cognitive activities "embedded within social settings may confer great cognitive and brain benefits for older adults" (Carlson et al., 2009). This study provides support for the cognitive enrichment hypothesis by supporting the notion that cognitive skill may be enhanced through extended cognitively-stimulating activity. In a different type of study, a cross-sectional one, engagement in cognitive activity was examined to determine its effect on normal cognitive aging and mild cognitive impairment (MCI) (Geda et al., 2011). This Mayo Clinic study used a random sample involving 1321 participants ranging in age from 70 to 89. In the one-year follow-up the findings were mixed: no significant gains were evident from engagement in magazine reading or artistic activities, and travel had only a marginally significant effect. However, there were 30 – 50% decreased odds of having MCI for those participants who engaged in more frequent and active cognitive activities including the following: computer use, crafts, playing games, reading books and watching less television (Geda et al., 2011). The partnership of active extended participation and cognitively stimulating enrichment activity led to cognitive gains for the participants in both of these studies. It appears both repetition and challenge are important components of a cognitive enrichment program.

Research evidence suggests particular skills may be enhanced through participation in specific computer and gaming enrichment activities. For example, Zelinski and Reyes (2009) set out to determine if digital action games would produce

cognitive benefits for older adults. They also sought to find evidence of far transfer where there is little similarity between the original learning context and the transfer setting. They found extended practice training was successful in this regard (Zelinski & Reyes, 2009). This involves the repetition of a skill sometimes hundreds or even thousands of trials. Repetition is viewed as the critical component in promoting far transfer or transfer from one context to a different context. (Zelinski & Reyes, 2009). For example, far transfer would be implicated in a situation such as where learners played active video games involving first person shooters and then, as a result, had better driving reaction times. Extended practice training has been shown to improve response times, increase efficiency in production, reduce performance variability and improve visual selective attention (Zelinski & Reyes, 2009). Because digital action games involve principles that are associated with extended practice training, they may be used to promote improved cognition in the areas of memory accuracy and efficiency as well as visual attention. Basak and colleagues (2008) created a study to determine the effects of a real-time strategy video game and its effects on attenuating cognitive declines in older adults. The participants were trained for 23.5 hours in a real-time strategy game. A number of cognitive tests were used to evaluate cognitive skill levels before and after the intervention (e.g., operation span, task-switching, N-back). A control group was also used. Basak found that there were significant benefits to executive control function as a result of participation. Quite specific gains were made in task switching, visual short-term memory, observational control and visual learning as well as reasoning (Basak et al., 2008). Transfer of the training was found in those tasks which required mental rotation or juggling ideas like in N-back tasks, but not in capacity of working memory (operation span task) (Basak et al., 2008). Change in task switch cost was correlated with change in the speed measure of the game; that is, a greater decrease in task switch cost (i.e., changing from one type of action such as matching to sorting) was related to an increase in game speed. Challenging online games may be an untapped resource for establishing cognitive enrichment programs that may even possibly target specific aging issues such as strategic thinking, memory retention, task-switching and speed of processing.

Aging and cognition is a vast and complex area, and research findings in some areas have mixed results whereas other research has yielded promising results. It is hoped that isolating some key facets will help piece together the puzzle of how to best

assist older adults in retaining their cognitive skills. The marriage of self-regulated active involvement in challenging tasks along with extended repetition seems to be a recurring theme in the research evaluating the cognitive enrichment hypothesis and older adults. As part of the Age Gene/Environment Susceptibility-Reykjavik Study, 2300 participants (66-92) were evaluated to determine the impact of their cognitive life activity on their brain function and development of white matter lesions on their brains. Researchers found that high activity in cognitively stimulating leisure activity (e.g., crossword puzzles, reading, using computers, attending a lecture, participating in social activities) was associated with improvements in speed of processing, memory ability, and executive functioning (Saczynski et al., 2008). Longitudinal evidence that intellectual decline may be reversed through educational intervention was revealed through the results of the Seattle Longitudinal Study (SLS). The SLS has tested its participants using a battery of 7 different quantitative tests evaluating mental abilities and psychological characteristics. The tests are administered every 7 years and every 7 years a new intake of participants is conducted. The study began in 1956 and is ongoing (Schaie, Willis &Caskie, 2004). Schaie and colleagues found that much decline for community dwelling individuals could be attributed to decline and disuse. In examining participants who received training in verbal reasoning, and number and word fluency, researchers found about two-thirds of the experimental participants showed significant improvement. Further, of those who had declined significantly, 40% were able to recover to their pre-decline level measured 14 years previously (Schaie et al, 2004). Control participants did not show improvements in cognitive skill levels. The SLS findings support the notion that cognitive enrichment is possible throughout the lifespan and not only is cognitive enrichment possible for maintenance but through extensive training, recovery to previous levels of cognitive skill may also be possible.

The results from 4 longitudinal studies on aging involving cognitively stimulating activities were gleaned for commonalties (Mitchell et al., 2012). The studies involved cognitive, physical, and social activity (the Octo-Twin Study, the Long Beach Longitudinal Study, the Seattle Longitudinal Study, and the Victoria Longitudinal Study). By compiling the data findings, researchers sought to answer two primary questions. Did cognitive activity at baseline predict cognitive skill over time? No, it did not. And, did change in cognitive activity predict change in cognitive skill over time? Yes, it did in all

four studies (Mitchell et al., 2012). Their results suggest that the risk of cognitive decline is increased for those who decrease their cognitive engagement relative to their baseline; further, increases in cognitive activity from baseline are associated with improved cognitive performance. Changes in the level of cognitive involvement impacted cognitive skill (Mitchell et al., 2012). In sum, the results suggest "individuals who exhibit changes from a previous level of cognitive activity can be expected to have associated fluctuations in cognitive performance" (Mitchell et al., 2012). This discovery is unique and may explain some inconsistencies in the findings of previous cognitive engagement research. The cognitive changes that individuals experience may be best understood through longitudinal research as it can track intraindividual behavioral and cognitive change across time. Individual gains in cognitive functioning may be tied to baseline functioning; as a result, evaluation of individual improvement may need to be evaluated in that context.

In sum, time involvement, repetition, and novelty may be essential ingredients in the recipe for cognitive enriching activity that promotes cognitive gains. There is research evidence supporting the cognitive enrichment hypothesis. More evidence may be found in examining changes within and between individuals. The next important facet in this research involves transfer.

2.6.2. Transfer

Of critical import to the utility of enrichment training for older adults is transfer. Will the skills practiced in the enrichment activity transfer to everyday activities? Will gains in speed of processing in a digital game increase, for example, speed of processing in real-life driving? In a randomized controlled study Nouchi et al (2012) examined the transfer effect of Brain Age (a Nintendo game package) on executive function and speed of processing in older adults. They found from 4 weeks of 15 minutes per day of cognitive training, gains were made in processing speed (Nouchi et al., 2012). As speed of processing is associated with the successful performance of daily living tasks, improvement in this area is important to an aging population. These researchers indicated that cognitive games were able to assist learners in the short-term; however, long-term effects are still undetermined (Nouchi et al., 2012). In another study involving older adults, the focus was the transfer-of-benefits from perceptual discrimination

training to working memory performance. Experimental participants received 10 hours of visual discrimination training over a 3 to 5 week period (Berry et al., 2010). The difficulty of the tasks kept shifting as the participants improved. The Sweep Seeker training program was used (a part of the Posit Science InSight software package). Following the intervention, experimental and control participants were reevaluated on a number of measures: Mini-Mental State Exam (MMSE); performance on dot kinetograms compared to baseline performance; working memory evaluation using interrupting stimuli, distracting stimuli and no stimuli; NeuroTrax measures of cognition, memory and executive functioning (Berry et al., 2010). Findings showed that individual improvement on a trained task correlated with discriminant improvements on an untrained task. This suggests that there was a transfer of training from the intervention to a separate learning context (Berry et al., 2010).

Green and Bavelier (2008) examined younger adult participants playing action video games to determine if there was transfer from the visual processing in the game to different contexts. The results indicated that video game players (VGP) had better visual acuity thresholds than non-video game players (NVGP) (Green & Bavelier, 2008). Green and Bavelier's research indicated that video gamers involved in first-person shooter games with rapid response requirements promoted a "wide variety of perceptual and attentional skills such as useful field of view, attentional blink, multiple-object tracking and subitizing" (Basak et al., 2008). Further, an experimental study was conducted to determine if skills from a complex computer game would transfer to real world flight operation (Gopher, Weil, & Bereket, 1994). Their findings were conclusive; after 10 hours of training there was a significant difference between the performance of VGP and NVGPs. In fact, the training game is now used by the Israeli Air Force as part of their flight simulation training (Gopher et al., 1994). The transfer of skills for visual processing and for activity simulation has been tested successfully with younger adults. Transfer from the video game to real life contexts has been established. Now, research is needed to see if similar transfer effects may be found using older adults and rapid response video games and say, driving reaction times.

In a working memory practice study including both younger and older adult groups, participants engaged in learning tasks for 15 minutes a day for 45 days using N-back tests (Li et al., 2008). Participants made gains on the practiced task and had near

transfer to similar tasks. Near transfer refers to skill gains that transfer to a similar application; in contrast, far transfer refers to skill gains that are applicable in rather different contexts than with the original training. No evidence was found for far transfer gains. However, this research provides evidence that concentrated repetitive study using a working memory task does improve working memory performance. Li et al., (2008) indicates that this study shows that deliberate working memory practice may help improve cognition in younger (20-30) and older (70-80) adults and may have some near transfer effects.

Transfer learning may be impacted by the extent of the knowledge one gains as this will impact one's ability to problem solve in real-life situations where strategic reasoning and pattern recognition is involved. Although transfer may be difficult to measure, it is certain that involvement in intellectually engaging activities should be an integral part of an active aging person's life: "well-adjusted, goal-directed, self-enhancing individuals create an abundant life that results in a positive cascade of benefits for the mind" (Hertzog, 2009, p. 6). Evidence has been accumulating over the past 50 years. For example, the SLS indicated intellectually engaging activities promoted cognitive skill gains (Schaie, 2005a). The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) study documented beneficial changes due to cognitive stimulation and challenge. This large-scale longitudinal study reported that positive cognitive changes were found to last in terms of thinking and learning. Memory skills were not seen to have a lasting effect after a decade (Rebok et al., 2014). Evidence of similar gains was found in other large longitudinal research: Octo-Twin Study, the Long Beach Longitudinal Study, the Victoria Longitudinal Study (Mitchell et al., 2012).

The fundamental question is, does involvement in cognitive enrichment activity alter cognitive skill levels in old age? Yes, is the most basic answer (Hertzog et al., 2008). Schaie (2005a) concludes that cognitive abilities are malleable throughout the lifespan. Based on 45 years of study about aging including the Seattle Longitudinal Study, Schaie says yes, if you want to maintain cognitive skill, practice it (Schaie, 2005a). Other research evidence supports this view (e.g., Ball et al., 2002; Zelinski & Reyes, 2009, & Geda et al., 2011) Other studies have been conducted which suggest that cognitive enrichment activity may enhance cognitive skill and that one needs to keep practicing the skills one hopes to retain in order to maintain those gains (Hertzog et

al., 2008; Mitchell et al., 2012). There does seem to be solid evidence that cognitive change is possible. There are indications that some level of transfer from the learning context to real-life situations is possible; however, transfer has proven to be more difficult to measure and establish. Nonetheless, several studies do exist that show some level of transfer and this is promising as improving cognitive skill levels in older adults in ways that improve functioning in daily life is one primary goal in lifelong developmental research.

2.6.3. Cognitive Enrichment and Life Satisfaction

Changing negative perceptions of aging is a necessary part of creating a context for successful aging. Stereotypes of aging have typically been derogatory and focus on loss and decline. Such attitudes influence decisions aging persons make and the way others approach aging individuals. Optimistic attitudes help to promote and acknowledge the role individual choice plays in determining one's cognitive health in the future. Old age is not guaranteed to be a time of decline; instead there are opportunities for growth, and behaviors that assist individuals in retaining and maintaining cognitive health. Satisfaction with life is affected and may be altered by the choices the individual makes. Self-construals that promote positive beliefs about individual self-regulatory ability and self-evaluation enhance feelings of self-esteem and independence (Leung, Moneta, & McBride-Chang, 2005).

Up until the 1980s much research on aging focused on impairment. Rowe and Kahn (1997) changed the focus to successful aging. This new focus has helped to change the way psychologists evaluate the aging process. In particular, life satisfaction has become a component of healthy aging. In fact, there is widespread belief that life satisfaction is the foundation and key indicator for psychological well-being (Leung et al., 2005; Diener, 1984). People's expectations mediate the effects that their health behaviors, decision-making processes, and activity engagement. All three of these affect life satisfaction. In short, the satisfied individual feels a greater sense of control. When the expectation is that one's conduct will have a positive effect, that individual is more likely to engage in behaviors that have a positive influence on life satisfaction. When the expectation is that one's conduct will have no effect or a negative effect on life satisfaction (i.e., with a negative view of aging as decline in cognitive and physical

functioning), then, that individual is less likely to self-regulate and participate in life in ways that have a constructive impact on his/her life satisfaction. In their study on aging and life satisfaction, Leung et al., (2005) evaluated 117 individuals 55 years or older, aged 56-89. They used a number of scales to evaluate the participants including the Satisfaction With Life Scale (SWLS). People's perceptions of the changeability of their situation will influence their behavior which in turn, will impact their level of life satisfaction and thereby their ability to age successfully. For example, if individuals believe that they can improve their memory function, they may be more likely to involve themselves in activities that promote memory function whereas those who feel decline is inevitable may passively accept declines. Thus, it is possible that those individuals who rate higher in satisfaction may have a greater propensity to participate in activities which promote cognitive skill than those individuals who are dissatisfied with life. Thus, interventions that promote cognitive enrichment need to address satisfaction with life as a potential variable.

Do optimism and hope impact an individual's adaptation to old age? Self-regulation may be impacted by one's perception of one's own ability to control the changes associated with the aging process. There seems to be a reciprocal relationship between one's adaptation to changing conditions and one's subjective well-being (Moraitou, Kolovou, Papasozomenou & Paschoula, 2006). In agreement with earlier research relating adaptation to strategy selection, (e.g., Baltes, 1997) these researchers found that adaptation to age-related change including a willingness to self-regulate their expectations and goals impacted participant satisfaction and, in turn, impacted their adaptation to their environment (Moraitou et al., 2006). Thus life satisfaction and goal pursuit are impacted by attitude. When societal attitudes about aging were primarily negative, this impacted the individual aging individual's perceptions and behavior. There was a sense of defeat followed by acceptance of decline and a withdrawal from life activities. Now, with a focus on positive and successful aging, this too is impacting the aging individual's level of satisfaction and adaptation to the life changes associated with the aging process. Rowe and Kahn (1997) presented findings from the Americans Changing Lives Study and the MacArthur studies and reported that three factors predicted productive activity for older adults: "functional capacity, education, and self-efficacy" (p. 438). Retired men and women who were more productive had greater

cognitive skill, higher levels of education, and greater feelings of self-efficacy. The capacity for positive change may be found in those who are more satisfied; as a result, this possibility needs to be examined. Successful aging includes satisfaction with life as a component, and self-regulation may facilitate one's ability to engage in productive behaviors that maximize one's potential over one's entire lifespan.

Fundamentally, the aging individual must be seen holistically. Cognitive enrichment gains are not made in isolation. Feelings of well-being and satisfaction with life may result in improved cognition. In their study which examined six dimensions of wellness and cognition in aging adults, Strout and Howard (2012) used the SWLS as one of their measures to determine if lifetime motivational reserve protected cognition in aging. They found that those "who demonstrated stronger cognitive performance in older age had high psychological well-being" (p. 201). Wellness helps individuals be productive and seek meaning in life (Strout & Howard, 2012). Satisfaction with life may be seen as an integral component in the study of the success of cognitive enrichment activity and as well, satisfaction may be an important component of effective self-regulation.

Chen (2009) evaluated the relationship between aging and life satisfaction and noted that social behavior including involvement with others through such activities as travel, handicrafts, gardening, and playing games and pursuing hobbies was affected by the level of activity rather than the changes in social activity. For example, in terms of life satisfaction, those that participated in several different activities did not seem to have an advantage over those who pursued just one. The other clear result of this study was that age itself correlated with lower satisfaction; the older one was, the less satisfied. This study was conducted in Taiwan using 4,412 participants 60 years of age and older. There may be differences with a more varied North American population and thus that is worthy of examination. Satisfaction with life may be related to the individual level of participation in activities after retirement which is important to this study as satisfaction may impact both cognitive enrichment pursuit as well as individual ability to self-regulate. Both of these may impact the cognitive gains one may make. Cusack and Thompson (2002) suggest goal-setting and achievement allows people to feel empowered, and decreases feelings of depression and increases feelings of self-confidence and esteem: "mental fitness is a state of mind in which we are open to enjoying our environment and

the people in it, having the capacity to be creative and imaginative and to use our mental abilities to the fullest" (Cusack & Thompson et al., 1996, p. 7). Feelings of accomplishment and satisfaction appear to promote participation and growth.

Finally, in her study of the relationship between everyday activities and successful aging, Menec (2003) found that solitary activities such as reading had more psychological benefits than social and physical activities. Importantly, she notes that much research is inconsistent in its defining of "activity" and as a result it is difficult to generalize across studies. Menec's study spanned 6 years, and indicated that not only is greater activity associated with greater well-being, but also greater activity is associated with less functional decline (2003). Therefore, it does appear worthwhile to examine the relationship that satisfaction or well-being has with the level of activity participation in enrichment activities.

In this study, active involvement in cognitive gaming (Quizlet vocabulary learning) was evaluated to see if it impacted memory, speed of processing, and strategic thinking. Further, self-regulation and life satisfaction were evaluated to see if a relationship existed between these and the cognitive outcomes. Finally, self-regulation and life satisfaction were evaluated separately from the cognitive intervention to see if there was a relationship between levels of self-regulation and levels of life satisfaction.

The Self-Regulation Inventory and the Satisfaction with Life Scale are used to collect self-report data. The Ospan and the Wisconsin Card Sorting Test are used as cognitive measures. All 4 of these instruments are discussed in detail in Chapter 3.

2.7. Cognitive Intervention

Quizlet is an organization that has set as its mission the development of simple software that will help students learn. In 2005, it was founded by a 15-year old boy named Andrew Sutherland who sought to create a tool to help him learn vocabulary (Source: http://quizlet.com/). Now Quizlet is among the largest educational websites in the world. Participants create word lists and add to the site so that it continues to expand daily. Further, a basic membership is free. As of December 2014, the site boasts 64,504,072 study sets (groups of associated terms and explanations). The study sets

range from basic learning sets (e.g., common versus proper nouns) to extremely sophisticated sets (e.g., university statistics, biology, entrance exam preparation). The program also reads any of the words and definitions aloud and has multi-language pronunciation for learning languages.

In brief, Quizlet offers an interactive vocabulary learning game that has different learning study tools. The user strategically decides which of the available study tools to use, when to use specific tools, and when to change from one study tool to another based upon one's study goals.

Six study tools are provided: Flashcards, Learn, Speller, Test, Scatter and Space Race. The study tools let the learner create a study strategy (e.g., select and adapt the topics, the tools, the order, the time limit, the level of mastery and so forth) with which to enhance and evaluate their memory skill and accuracy. As the program is computerized, all responses must be exact. The program provides feedback and loops back to retest incorrect responses**.** In the Learn tool, definitions, explanations and words are provided and the learner must fill in the blank with the exact correct response. If the response is incorrect, the correct response is provided and then the learner carries on to the next question. The Speller tool speaks the words and the learner types in his/her response. Again, if the response is incorrect, the correct answer is provided and the learner carries on to the next question. The fourth tool is called the Test. This section creates a fill-in-the-blank and multiple-choice test. At the end of the set, correct answers and scores are given. If one wishes to Test again, he/she can press reset and a new and different test is generated. The fifth study tool is called Scatter. Here the words and definitions are presented on one page and the learner clicks and drags the matching words to the proper definitions. The final study tool is Space Race. This works best if a person is a touch typist. Terms race across the computer screen and the learner must type in the correct response before the words run off the edge of the virtual page. As one gets more efficient, the words speed by more quickly. For this exercise there is a timer to show learners how well they are doing. In Quizlet, learning sets range from basic learning sets (e.g., common versus proper nouns) to extremely sophisticated sets (e.g., university statistics, World War maps).

Using games to promote cognitive skill has become big business, as is seen in the variety of fee-based websites that provide games to enhance memory and cognition (e.g., lumosity.com; mybraintrainer.com). It would be informative to understand which of these activities stimulate cognitive development and which ones do not. More specific study is needed to clarify exactly which cognitive skills may be improved and maintained through participating in specific activities. The online cognitive gaming activity used in this thesis research focuses on the potential for challenging vocabulary learning to assist in the promotion and maintenance of strategic thinking as well as the improvement of memory, accuracy and speed of processing. The Quizlet learning site used in this study is freely available to anyone who has access to a computer and the Internet.

2.8. Cognitive Enrichment, Self-Regulation, Life Satisfaction and Aging - Summary

Research investigating enrichment effects on adult cognitive development favours the hypothesis that intensive cognitive training programs promote better thinking and remembering (Hertzog et al., 2008). This research sought to examine the cognitive enrichment hypothesis within a self-regulated context. In much cognitive enrichment intervention research, the researcher, rather than the participant, controls the content, strategy use, and level of commitment. In this research, participants designed their own individual programs of study, evaluated their selected study tools, and monitored and altered their learning strategies based on their own goal definitions. Participants determined the intensity and extent of their involvement beyond the 60-minute per week minimum. This study also utilized freely accessible Internet resources. The study was designed so that participants could easily continue their cognitive enrichment after the study ended and also to serve as a preliminary exploration in using cognitive enrichment resources that are easily available for people with limited means. Survey data about participant self-regulation and life satisfaction were also collected.

Uniting self-regulation, life satisfaction, and cognitive enrichment together in one research study is aligned with the recommendations of Hertzog and his colleagues (2008) in their meta-analytic study of research involving cognitive enrichment and older adults. They suggest that building a cognitive enrichment framework requires looking at

the topic in a multi-faceted manner. This research seeks to evaluate and provide insight into how self-regulation plays a role in motivating older adult learners. As well, transfer is of great importance in the area of cognitive enrichment and older adults. In this study, memory accuracy was targeted as an area of transfer. To build a comprehensive theory on cognitive enrichment, a constellation of other aspects of life such as life satisfaction, locus of control, stress levels and other variables need to be formally studied in order to inform cognitive enrichment theory. This study seeks to focus on self-regulation and life satisfaction as important variables impacting the process of cognitive enrichment: investigating self-regulation as a possible partner to cognitive enrichment. This information may help guide future research that extends the findings in this research and also isolates other psychological components to assist in the development of an extensive cognitive enrichment theory.

3. Method

3.1. Introduction

This research examined the effect of regular engagement in a cognitively demanding activity, an online vocabulary learning site called Quizlet, on cognitive skill in older adults (63+). The relationships among participant self-reported levels of self-regulation and life satisfaction as well as their interaction with objectively measured cognitive skill using the Ospan and the WCST were examined. The research used a quasi-experimental pretest-posttest design with a control group to test the cognitive enrichment hypothesis which states that undertaking specific kinds of cognitively challenging activities can have a positive impact on general cognitive abilities. The overarching purpose of the research was to determine whether such regular cognitive activity could improve memory skill. The possibility that a relationship existed between self-regulation and life satisfaction was also evaluated.

3.2. Participants

The participants were 63 years of age and older and living independently or semi-independently at the time of the study. Independent living refers to the ability to manage personal and day-to-day living needs in a physically and mentally self-sufficient manner along with maintaining one's own living quarters. Semi-independent living refers to living within a shared seniors' facility but not in a hospice or care facility. Participants were required to have functional literacy in spoken and written English so they could take directions, follow instructions, and read and practice vocabulary sets. Vision and hearing within the normal range was required for participation.

Participants were located through advertising in local newspapers, in local seniors' facilities designed for semi-independent living, by word of mouth, through local

bulletin boards and through senior citizen organizations, community web sites and local newspapers. Participants were selected from a limited geographic area including Greater Vancouver Regional District and East Vancouver Island. The sample was a convenience sample of 63 individuals who were selected on the basis of meeting the eligibility requirements: (1) independent or semi-independent living conditions; (2) normal visual and aural acuity; (3) English literacy; and (4) at least 63 years of age at the outset of the study.

Although no a priori empirically based estimate of effect size was available for the planned intervention, a power analysis was conducted to determine the sample size needed to detect a difference between the intervention and control groups of 0.8 standard deviations. Assuming an α-level of .05, β = .80, and a two-sided test, the sample size needed to detect that effect size is 50 (25 in each group). Recognizing that there would be some attrition due to the age of the participants and the 8-week duration of the study, the target sample size was set at 60.

The primary settings for the research were the individual homes of the participants. Some of these homes were independent homes while others were senior facilities where individuals lived independently but shared recreational, cooking, and other facility offerings. The settings did not include hospitals or care facilities. The ability and desire to self-regulate was a component of the study; thus, individuals needed to be able to actively regulate their own participation. Other data collection was set up to be conducted online and at home on the personal computers of the participants; however, there were cases where several participants shared a seniors' home, and group computer use occurred as a function of this housing arrangement.

The Ethics Review Board at Simon Fraser University examined the study proposal and the study procedures and protocol were approved. Participants were given a page-long overview of the study (see Appendix B). Participants were informed of their right to withdraw from the study at any time. Participants were assured that their records would be kept secure and that their names would be recoded to ensure their anonymity. Each participant signed an informed consent release form acknowledging these rights as well as a willingness to participate in the study. (See Appendix C for the informed consent document.)

3.3. Measures

3.3.1. Self-Regulation Inventory (SRI)

The Self-Regulation Inventory (SRI) was used in this research to determine the strength of an individual's ability to independently achieve personal needs and aims and pursue well-being.

The SRI is a 72-item questionnaire designed by Grossarth-Maticek and Eysenck (1995). It is designed to assess coping behaviors related to health. To evaluate the psychometric properties of this version of the SRI, a sample of over 550 participants ranging in age from 18-78 was evaluated in a study conducted by Marques, Ibanez, Ruiperez, Moya and Ortet (2005). Their study included first and second level factor analyses. They concluded that self-regulation as an overall construct was supported. As well, five interrelated self-regulation factors were isolated. The findings indicate a robust internal structure for the SRI (Marques et al, 2005). In their study of self-regulation and mortality from cancer and heart disease, Grossarth-Maticek and Eysenck (1995) found that the SRI data strongly indicated a connection between self-regulation and health: the "psychological factors incorporated in the concept of the healthy personality have a profound influence on disease and mortality" (p. 792). In a 15-year prospective study, self-regulation scores were shown to have an inverse relationship to mortality in cancer patients (Grossarth-Maticek & Eysenck, 1995). The original English version of the SRI was analyzed in the context of Eysenck's personality dimensions of psychoticism, extraversion and neuroticism. These three dimensions corresponded to the five components of the self-regulation concept that represent SR as a coping style characterized by positive actions, controllability, expression of feelings and needs, assertiveness, and well-being seeking (Marques et al., 2005). The SRI indicates that self-regulation involves adaptive coping styles. The relationship between self-regulation and productive health-seeking was illustrated in a study examining self-regulation and the management of other chronic diseases (Frentzel-Beyme & Grossarth-Maticek, 2001).

The SRI was compared with the Eysenck Personality Questionnaire-Revised. Both test the basic dimensions of personality. Both internal consistency and temporal

stability were adequate with their sample. The test-retest reliability of the SRI scale was *r* = .87 (Marques, et al., 2005). The findings of the aforementioned study are similar to the reliability findings of the study herein. Reliability in the sample used in this study is reported in Chapter 4.

The self-regulation inventory is a measure of coping behaviour that asks 72 questions about an individual's everyday behaviour. The focus is on how an individual approaches life through positive actions, control, expression of feelings, assertiveness and well-being seeking. Successful learning has been shown to be impacted by personality variables that include how a person views the world, the possibility of change and an individual's self-perception (Fillett et al., 2002, Leung et al., 2005, Leventhal, Leventhal, & Contrada, 1998). An individual's coping style impacts learning and behaviour: assessing health issues which impact "outcome expectancies, time-lines" and other processes and adaptations that impact an individual are necessary and informative in understanding the learning process (Leventhal et al., 1993). As a result, the SRI is seen as a relevant measure of self-regulation as an aptitude that is important to the multi-faceted cognitive enrichment process.

3.3.2. Satisfaction With Life Scale (SWLS)

The Satisfaction with Life Scale (SWLS) states that "Life satisfaction can be defined as a global evaluation by the person of his or her life" (Pavot, Diener, Colvin & Sandvik, 1991, p150). The 5-item Satisfaction With Life Scale designed to measure life satisfaction, has demonstrated internal consistency and reliability across a wide range of ages (Pavot et al., 1991). Studies have been conducted to evaluate the validity of the SWLS using individuals using adult groups (53 to 92) and various income groups, as well as individuals in independent and semi-independent living situations. The impact of different relationship structures (married, widowed, divorced, single) was also examined. Pavot et al., (1991) had findings that showed consistency between test administrations (e.g., the mean for the first administration was 24.44 and for the second, 24.05. Wu (2009) studied stability coefficients across 2 samples tested on the SWLS and found the results to be stable across time with "satisfactory psychometric properties for longitudinal measurement invariance" (p. 396). In order to determine if the SWLS as a whole measured the underlying construct of life satisfaction, a factorial invariance analysis was

conducted to see if the satisfaction construct was equivalent across genders (Shevlin, Brunsden, & Mills, 1998). They reported reliability at *r* = .92 (1987). The internal consistency reliability of the SWLS instrument was assessed for the sample used in this thesis research, and the results are provided in Chapter 4.

The SWLS is a measure of well-being. Life satisfaction levels have been shown to promote or diminish feelings of self-efficacy and motivation. Those that are satisfied with their lives often show a more active and positive orientation to life and learning (e.g., Wu et al., 2009; Holahan, Holahan & Wonacott, 1999). The Life Satisfaction Scale has been used to determine if one's self-reported level of contentment with his/her life alters performance on cognitive tests.

3.3.3. Ospan

The computerized Ospan word or letter-span test that measures working memory capacity was used as a measure of cognitive fitness. The original pen and paper version of Ospan was originally designed in 1989 by Turner and Engle. Ospan was developed into a computerized version called Gospan in 2000 and then Millisecond Software developed an updated automated, self-scoring version of the Ospan (Draine, 2004). This is the version used in this study. It automatically scores all data.

The Ospan task has a participant perform math operations while trying to remember a string of unrelated letters. The arithmetic operations in the Ospan are designed to "activate the processing component of working memory and to prevent the employment of rehearsal strategy on the letters" (Lin, 2007, p. 10-8). The arithmetic operations are simple as they are meant to be distractors rather than tests of arithmetic skill. The arithmetic operations are limited to addition, subtraction, multiplication and division. Instructions are given to participants to complete each set as quickly and accurately as possible. The participant solves a simple math equation and then a letter briefly appears; then, a new math equation is presented and a new letter appears. A sequence of between 3 and 7 equations and letters may appear and then a panel of letters appears where the participant selects the correct letters in order. The test takes between 20 and 30 minutes to complete. The computerized Ospan version may be taken using a secured site and user identification or on a dedicated secure computer.

The setting may be the home of the participant. A supervisor is not required and data are automatically recorded for the researcher to examine. Features exist to minimize cheating (i.e., one cannot cycle back and redo a set). The test is a measure of working memory capacity, accuracy, and speed of processing (Lin, 2007).

With Ospan, a perfect total score would be 75 correct letters. The overall test score refers to the total of perfectly recalled letters. A second measure, the Value Ospan, is provided to give an overview of the total number of recalled sets. The math error score is not deducted from the total correct. Instead, an error threshold is typically set that will disqualify learners who perform below a certain level on the math questions (e.g., 75 - 85% correct). In this study, the total Ospan score is the variable that was evaluated and the math error threshold was set at 80%. This level was set for the older adult population involved in the study. Older adults have been shown to be more anxious and a bit slower to perform in tests involving speed. Due to a susceptibility to math anxiety, a threshold of 80% was set. This cut-off level has been used in numerous studies involving older adults or anxious learners (e.g., Durette, 2011; Greenstein & Kassel, 2009; Zakrzewska & Brzezicka, 2014; Seegmiller, 2010; & Beilock & Carr, 2004). In this study, the 80% accuracy criterion was imposed for all participants. They were encouraged to keep their math accuracy levels above 80% at all times.

3.3.4. The Wisconsin Card Sorting Test

The Wisconsin Card Sorting Test (WCST) was used in this research as a measure of cognitive fitness. It is designed to evaluate participant skill in three main ways: 1) ability to form abstract concepts; 2) ability to maintain set; and, 3) ability to utilize feedback (Dehaene & Changeux, 1991). These three skills must be managed swiftly and accurately for individuals to attain good scores. This test takes approximately 20 minutes and has four reference cards and four response cards. Cards are sorted into sets by colour, form and number (Grant & Berg, 1948; Dehaene & Changeux, 1991). Participants place a response card wherever they believe that card should go in order to create a correct response. The correct or incorrect response result is immediately given to the participant who then makes the next choice based on that feedback. For example, it may be that the first card response requires that the cards are sorted by colour; then the set shifts to pattern and then back to colour. As soon as the participant makes a

number of correct responses then the problem shifts to a different category (Grant & Berg, 1948). The test is used to evaluate executive functioning. Formerly a paper and pencil test, the WCST has been revised and now a computerized version is available. Millisecond Software developed an automated, self-scoring version of the WCST (Draine, 2004). This is the version used in this study.

The WCST has been used in multiple contexts for numerous purposes with varied results. The WCST is most commonly used to evaluate executive functioning (Strauss, Sherman, & Spreen, 2006). The task requires numerous skills including visual processing and speeded processing. The reliability of the WCST is varied depending on the particular study involved and whether the participants were functioning normally mentally or not. Age accounts for 20% of the performance variance on the WCST. Performance increases from 5 to 20 years and then stabilizes until about age 50 when declines begin to increase (Strauss et al., 2006). Overall, age has the strongest relationship to WCST performance. Declines in certain areas of performance are apparent after age 60.

A large-scale factor analysis using a sample of over found WCST is correlated with other measures but that it did not measure these other cognitive abilities well. In sum, the WCST has been used as a measure of executive functioning with the focus being on working memory and speed of processing. Though the WCST appears to measure other cognitive abilities, these abilities are not clearly established. There is some inconsistency in the WCST results. For example, some clinical studies have reported that WCST is sensitive to frontal lobe function and others have indicated no solid relationships. However, age-related declines have been examined using the WCST and studies have supported the WCST as a measure of working memory and processing speed (Strauss et al., 2006). For this study, older adults are the participants and these two areas are evaluated.

The WCST was used to evaluate cognitive skills including problem-solving in normal elderly and those with Parkinson's disease. Approximately 360 participants were tested and the data suggest that adequate construct validity was found for conceptualization/problem solving and failure to maintain set factors in both groups (Paolo, Troster, Blackwell, Koller & Axelrod, 1996). The factor structures for the normal

and Parkinson's groups were not identical and this may reflect the degree of the WCST's ability to evaluate cognitive changes (Paolo et al., 1996). Rhodes (2004) conducted a meta-analysis evaluating age-related differences in performance for the number of categories achieved as well as for the perseverative errors committed by participants. Results indicated that WCST is sensitive to age differences and the results showed over a standard deviation difference between younger and older participants on both of these measures (Rhodes, 2004). He concluded his meta-analytic review by stating that the WCST is viewed as a measure of executive function that is reliable.

In this study, the total score for the WCST was evaluated. The computer version of the test was used (Draine, 2004). The computer program automatically totals and scores the test. The total correct score is used to indicate the overall performance on the test. The subscales each reveal different information about individual performance on the test. There are 6 subscales. The total correct score presents the total number of correct responses out of a total possible of 128. The correct streak refers to a score out of 10 that indicates getting a series of correct responses in a row out of a possible 10. The total error indicates the number of responses that were incorrect out of a possible 128. The perseverant score is typically measured from 0 to 6. It indicates a failure to change set. The final subscales, the category completed and failure to maintain set are scored from 0 to 10. Completing a category (a run of consecutive responses in shape, color, or form) is a positive result indicating good attention whereas a high score in failure to maintain set indicates inattention or inability to see patterns in the cards (in shape, color, or form). In this study the total correct score was evaluated as it is the full-scale measure of the WCST. Typically, each individual measure of the WCST is evaluated if the full-scale measure reaches statistical significance. As the MANOVA for the WCST did not indicate significance, ANOVAS were not performed for the WCST subscales.

3.3.5. Cognitive Enrichment Intervention: Quizlet

Quizlet is an online learning site that presents terminology and learning sets for one to study. Learners may create their own sets or study the myriad sets already in existence. The sets are studied using what Quizlet refers to as study tools: a user-

chosen palette of implements or instruments designed to present the set materials in different fashions to the learner to assist the learning process.

Throughout the Quizlet learning intervention, insight into participant self-regulation was obtained through the examination of the choices the learners made. Characteristics of these data included information about the topic choices, individual study tool selection and evaluation, and sequential orders in which the tools were utilized. Details about how certain individuals grew and gained self-confidence in designing their own learning experiences was obtained. At the end of the study, participants discussed the reasoning behind their strategies for choosing what they felt were the most relevant study tools. As well they explained their strategies behind use of the tools in sequential orders that seemed to best facilitate their personal goal attainment.

3.4. Research Design

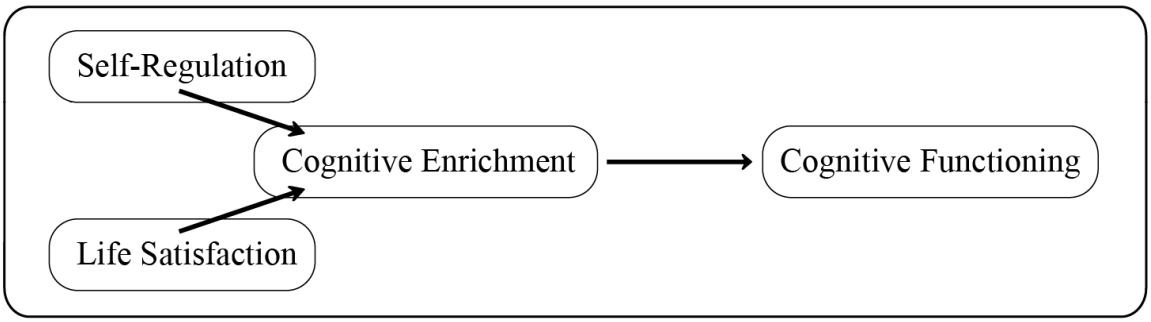
The independent variable in this study is 8 weeks of cognitive enrichment provided by regular use of Quizlet. The dependent variable is cognitive skill (as measured by the Ospan and Wisconsin Card Sorting Test). The level of cognitive skill was hypothesized to vary in response to the level of cognitive enrichment in which a participant engaged. Change in cognitive skill was evaluated by comparing the results from pretest to posttest with the Ospan and WCST measures. Control and experimental participant data were compared. Relationships among cognitive skill changes and self-regulation and life satisfaction were also evaluated.

The research was quasi-experimental and used the individual as the unit of analysis. It was not deemed possible to keep the study participants isolated from one another when they shared a common living context. As a result, in those cases all individuals likely to communicate regularly about the intervention were grouped together as experimental or control participants. In cases where individuals lived independently of other participants, these individuals were randomly assigned to one of the groups. There was no deception involved in the study. All participants, experimental and control, were informed of the study's purpose and intent. The pretest measures of cognitive skill

(Ospan and WCST) were compared between the experimental and control participants in order to evaluate group differences prior to the intervention.

Figure 3.1 illustrates the cognitive enrichment hypotheses underlying this research. The primary hypothesis was that cognitive enrichment would have an impact on cognitive functioning. Self-regulation may have an impact on participant involvement with cognitive skill acquisition. Further, life satisfaction was also evaluated as having a possible relationship with cognitive enrichment and cognitive skill acquisition.

Figure 3.1 Cognitive Enrichment Research Hypothesis



3.5. Procedure

Data collection began with 2 surveys and 2 cognitive tests. User identification numbers were provided to participants. Study data were collected using computer and or web-based versions of the tests and self-report instruments. The Ospan takes about 30 minutes and the WCST takes about 20 minutes to complete. The cognitive test data were compiled and retained in raw form on the testing site. Self-report data were compiled and retained on a separate self-report site and sent to the researcher's email for record-keeping and data analysis. The SRI self-report takes between 20 and 30 minutes to complete. The SWLS takes approximately 10 minutes to complete. Data were recorded in Excel and imported into SPSS for analysis (See Figure 3.2 for an overview).

For the intervention, participants were introduced (face-to-face or via video tutorial) to the set-up for the Quizlet gaming site. The intervention was also conducted with a web-based program. Participants signed on to the secured site using pre-

assigned user identification numbers and passwords and completed the tests. They were taken through an exercise of learning 10 vocabulary terms and shown all 6 of the different study tools provided with the learning sets. This established participant awareness of the way the learning activity works. Then, participants were instructed to complete one very basic learning set (of 10 words) to reinforce the system and to practice using all of the available study tools. Then, participants were instructed to select areas of interest and study vocabulary 60 minutes a week in any time arrangement. They were allowed to regulate their time on task as much as they wished beyond that 60 minutes a week minimum. Participants were encouraged to use their own personal strategies to determine the order of and overall number of study tools used.

In this study, participants were given the option to study existing sets, create their own sets, or use a combination of both. Participants were asked to record their time involvement and also briefly explain their study tool choices, strategy plans and modifications. A link to the Quizlet site is provided in the Additional Documents Form: Appendix K.

Following the intervention (8 weeks), the active study participants were given their post-tests in the Ospan and WCST. Following the passage of 8 weeks with no active study intervention, the control participants were given the same post-tests. Data were compiled for analysis. (Section 3.5.1 provides more precise study details).

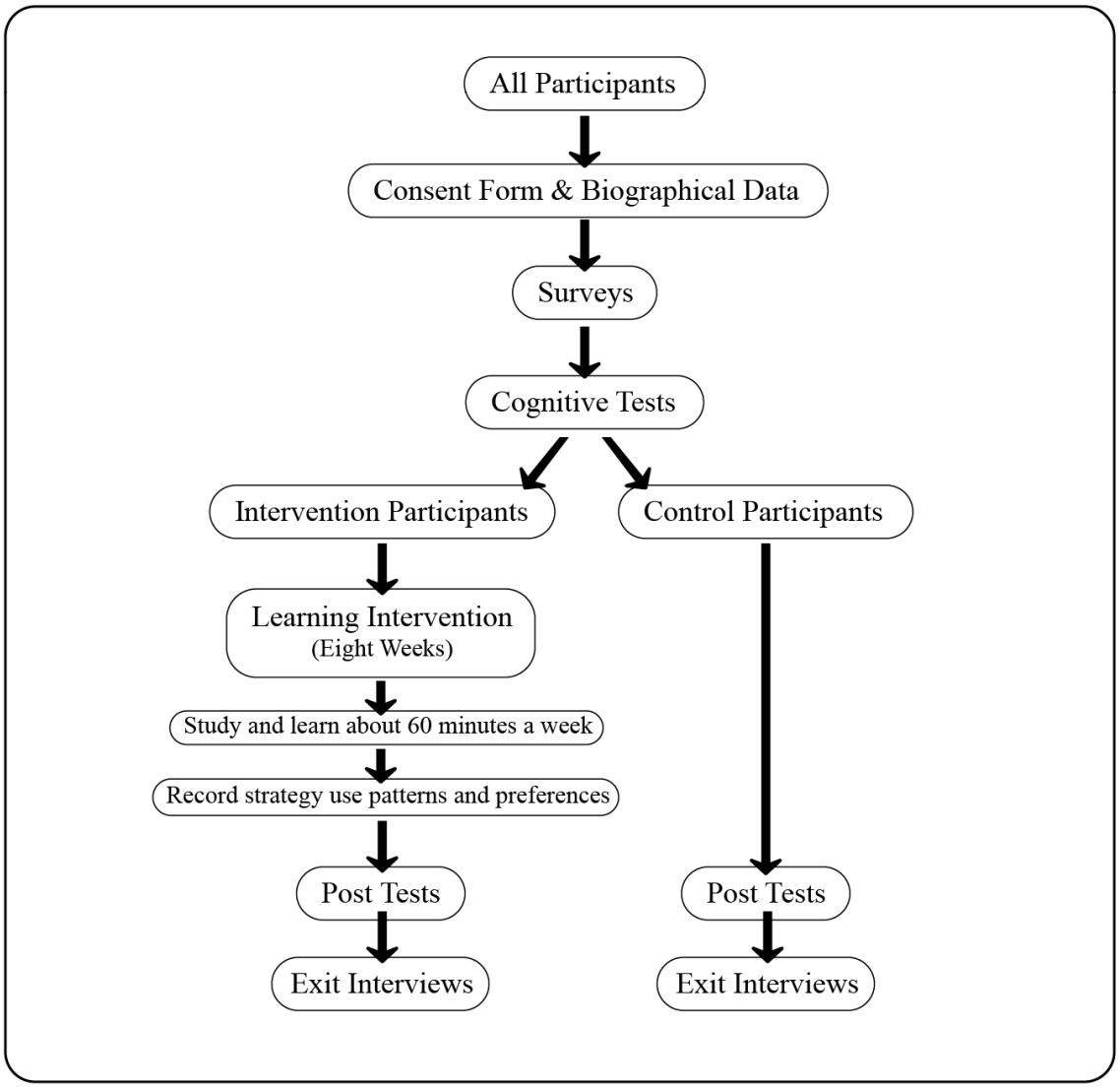
3.5.1. Outline of Procedure

Participants were invited to participate in this study on cognitive enrichment. They were given a data sheet or verbally told about the study (See Appendix B).

1. Participant involvement in the study began with participants filling out a consent form and a biographical data form (Appendix C & F).
2. As individuals volunteered for the study they were assigned to experimental and control participation on an alternating basis. When several individuals from one organization or facility were involved, these individuals were assigned to the same group: either experimental or control participants.
3. All participants completed all self-report instruments.

4. All participants completed two brief cognitive assessments that were given to evaluate memory skill, strategy, and speed. Together these take approximately 40 minutes to administer.
5. Once pretests and cognitive skill tests were complete, control participants were dismissed for 8 weeks whereas experimental participants were asked to participate in an online vocabulary activity for a period of 8 weeks. They were given a demonstration showing how the learning site worked and asked to participate a minimum of 60 minutes a week in the learning activity (Quizlet). They were asked to record their time involvement and comment briefly about their study tool usage, and strategy (Appendix L).
6. Following the 8 weeks of participation, both control and experimental participants were retested on the 2 memory skill tests (approximately 40 minutes). At this time, the principal investigator evaluated the findings. General summary information about the study results was made available to participants when this was available. Personal information will be kept secure at Simon Fraser University for a period of two years. These data are locked in a secured cabinet. For the duration of the study, participants were assigned user identifications (IDs) and passwords. (See Figure 3.2 below).

Figure 3.2. Procedures Overview



3.6. Step-by-Step Study Participation Details

Participants were asked to participate in a research study that was designed to promote better thinking skill, memory, and speed. Prior to the study they were asked to contribute inventory data via the completion of two questionnaires. One of these asked about self-regulation. The second one asked for an overall life satisfaction rating. These 2 inventories were given using an online questionnaire. Participants clicked on their responses and pressed a button to submit, taking 30 minutes to one hour to complete

both of these. User identification names were used to secure participant confidentiality. Collected data were automatically sent to the main researcher. Next, a thinking skill test that takes about 30 minutes was completed (Ospan see Appendix J). This test is to measure thinking accuracy and speed. In the WCST participants select cards and identify changing patterns of color, shape and number. This test is used to evaluate response time and memory accuracy (WCST see Appendix I). Some of the participants completed the tests on their computers while other completed the test on the primary investigator's computer. The test data helped the researcher to make connections between participant cognitive skill changes that occurred over the course of the vocabulary activity study. In short, participants completed 4 activities before they began the actual study. Taken together, all 4 take approximately 1.5 hours.

Following the 2 inventories and the 2 cognitive tests, the control participants were dismissed until the posttesting following the 8-week long intervention. The experimental participants were asked to participate in an online learning activity. These participants were told that they could complete the learning session in any time division they wanted such as in one long session or in 4 shorter sessions if they wished, but that 60 minutes a week was the minimum.

For the intervention itself, experimental participants engaged in a free online vocabulary learning game called Quizlet, looked at their correct and incorrect scores, and created strategies that shaped their usage of the online study tools as implements to aid in their goal attainment. After 8 weeks, all experimental and control participants were tested again to see if participating in the vocabulary game improved their cognitive skill. The two post-tests take a total of about 40 minutes. These data were used to help the researcher to identify possible relationships between thinking or cognitive exercise and gains in thinking skill, strategy and speed.

3.7. Organization of Data: Summary

Data analysis included evaluating the impact of the cognitive enrichment intervention on participant levels of cognitive skill. Pretest and posttest data were compared. Experimental and control participant results were compared. In order to

evaluate the nature of the relationships between variables including the strength and direction of the changes associated with the intervention, MANOVA and ANOVA tests were administered. In addition, journal entry data were coded and evaluated to determine if strategies for self-regulated learning had identifiable patterns that led to skill improvements (Ospan and WCST). Linear regression analyses were conducted to evaluate possible relationships between the cognitive skill changes and self-reported levels of self-regulation and life satisfaction. Further, self-regulation and life satisfaction levels were evaluated for possible correlations.

4. Results

4.1. Attrition

In total, 63 participants were recruited for this study. Participants were first tested using an online version of the testing software but due to technical issues, the cognitive tests were ultimately transferred to a dedicated machine. All 63 participants attempted the tests and 61 completed at least some portion of the 2 tests. Twenty-nine participants completed the full study as members of the intervention group and 17 as members of the control group. Another 17 participants were dropouts lacking complete data on the first two pretests. However, 12 out of these 17 dropouts completed at least one pretest, enough to allow for some meaningful comparison to determine if this group differed statistically from the participants in the intervention and control groups. An ANOVA evaluating the 3 groups (intervention, control, withdrawal) yielded no significant statistical differences between the groups at pretest (see Table 4.1).

Table 4.1. ANOVA comparing pretest performance for the 3 groups: intervention, control and withdrawal

Variable	n	Group	Mean	*SD*	*df*	*F*	*p*
Ospan							
Letter correct	29	Intervention	47.59	13.07	2 (55)	.671	.515
	17	Control	43.65	17.05			
	12	Withdrawal	41.08	25.79			
Value Ospan	29	Intervention	29.69	16.35	2 (55)	.494	.613
	17	Control	24.06	19.02			
	12	Withdrawal	28.42	23.34			
Math error	29	Intervention	8.48	5.85	2 (55)	2.350	.105
	17	Control	7.06	5.85			
	12	Withdrawal	12.75	10.91			
WCST							
Streak	28	Intervention	6.64	4.31	2 (54)	.082	.922
	12	Control	7.12	4.06			
	15	Withdrawal	7.00	3.33			
Correct	28	Intervention	70.00	8.80	2 (54)	2.310	.109
	17	Control	73.00	9.62			
	12	Withdrawal	76.75	9.73			
Error	28	Intervention	39.18	21.54	2 (54)	1.51	.230
	17	Control	35.06	18.06			
	12	Withdrawal	47.83	16.90			
Persevere	28	Intervention	9.43	5.23	2 (54)	6.74	.514
	17	Control	8.18	5.05			
	12	Withdrawal	10.58	6.90			
Category	28	Intervention	4.32	2.11	2 (54)	1.02	.370
	17	Control	4.41	2.06			
	12	Withdrawal	3.42	1.78			
Maintain	28	Intervention	.96	.96	2 (54)	6.62	< .001
	17	Control	1.12	1.32			
	12	Withdrawal	2.33	1.16			

The principal researcher was in contact with the participants and completed an exit review with each member of the study, including the withdrawals. Health complications and computer problems were the chief reasons for withdrawal from the study. As the participants were 63 years of age or older, the health complications included having a stroke, losing a partner, nervous anxiety issues, caregiving duties, and very painful shingles. In total, 8 participants withdrew for health reasons. The other main reason for dropping out of the study was computer hardware and/or software problems.

Six participants had difficulty opening and using the cognitive tests and/or accessing the intervention site and all of its components. In some cases, these problems were due to incompatibilities between operating systems, browsers, and the testing software. In other cases, unpredictable problems emerged on certain devices such as iPads. This was unsettling for these participants. The other primary cause of withdrawal was travel (3 participants). In total, there were 17 dropouts, which is a large number. However, the duration of the study was rather long (8 weeks), and, the participants were older and less computer savvy. As a result, many unforeseeable changes occurred: both hardware and online software difficulties presented problems. Once the testing software was installed onto a dedicated machine, there were no more technical issues with the testing components of the study. Health reasons remained the primary cause of dropout.

4.2. Missing Data

Using the Inquisit software package, Ospan and the Wisconsin Card Sorting Test were linked together as a continuous set. This was a requirement of the software licensing. At times, the second test did not launch. This meant that after a rather challenging 30-minute test, the second test froze. This software problem occurred in the crossover between the two tests and only for a few participants. After much trial and error, I found that some of the failure to launch problem appeared to be linked to the version and type of browser that the participant used. Older versions of Explorer locked up and froze for some participants. Firefox didn't launch the program on a PC but worked well on a Mac. The data that were lost were only for the second cognitive test. These data were missing completely at random due to software malfunction so that the probability that a missing response was related to another observation or to the value of any of the other variables was considered not likely. As a result, the missing data were considered random and although some of the power of the design was lost, the analysis of the data would remain unbiased. Data from these participants were not used on the test involved (WCST) and these participants were counted as attrition. In fact, only one participant who had the testing transfer problem remained in the study. The others did, in fact, withdraw as a result. The one remaining participant's data were not used for the test involved (WCST). However, her data for the Ospan were successfully retained and used in the study.

4.3. Normality and Outliers

The data were examined for normality. All pretest and posttest scores were converted into standard scores for the detection of cases ±3.0 or beyond. There were only two cases that reached the criteria for an outlier (3.00). These were both with the Wisconsin Card Sorting Test. The first outlier was at z = 3.0 on the WCST perseverative response scale. As well, this control participant had an extremely low score on the Ospan measure main measure (total letter correct) at z = -2.7. She could not recall ever learning division which is one of the mathematical operations in Ospan. Her performance on the Ospan was strongly affected by her inability to do simple math operations. It was not possible to truly measure her letter recall for this reason and her data were removed from the study. Another control participant was removed as an outlier. At posttest, she had two standardized WCST scores that exceeded 3.0. These were for the perseverative response score (z = 3.1) and the failure to maintain set (z = 4.6). All other participants' scores fell within ± 3.0 on each subscale.

In terms of skewness, the data were examined to see if any variables exceeded *Sk* = 3.0 (Tabachnick & Fidell, 2006). The range of skewness for all cognitive variables was evaluated. The range of skewness for all OSPAN variables was .222 to -.999. The range of skewness for the WCST variables ranged from -.145 to 2.94. Therefore, these levels fell within the acceptable range for skewness and were not expected to unduly affect analyses.

4.4. Descriptive Statistics and Preliminary Analyses

Participants were all 63 years of age or older at the outset of the study. The intervention group age range was 63 to 88 with a mean age of 72.2 years. The control group age range was 63 to 91 with a mean age of 73.2 years. In the intervention group there were 29 participants: 23 were female and 6 were male. In the control group, there were 17 participants: 12 were female and 4 were male. Education level ranges were similar: each year of regular school was counted until 12. Then, each year of post-secondary was added to that so that a bachelor's degree would mean 16 years of

education. The experimental group had on average 15.45 years of education (range 10-19) while the control group had 15.65 years (range 12-19).

The psychometric properties of the cognitive testing instruments, the Ospan and the WCST, are presented in Table 4.2. Correlation matrices for Ospan and its specific measures follow in Table 4.3. WCST data are presented in Table 4.4. A correlation matrix showing relations between the cognitive measures (pretest and posttest) alongside the self-report measures (SRI and SWLS) is provided in Table 4.5.

Table 4.2 Psychometric Properties of the Cognitive Test Variables at Posttest (Higher means indicate better performance except for on 4 subscales: Ospan Math Error and WCST Error, Persevere, and Maintain scores show improvement when means are lower).

Measure	α	Group	n	Mean	*SD*
Ospan					
Letter Correct	.993	Intervention	29	57.31	8.82
		Control	16	47.12	15.81
Value Ospan	.994	Intervention	29	37.86	13.52
		Control	16	26.47	16.67
Math Error	.991	Intervention	29	5.58	3.81
		Control	16	4.59	3.57
WCST					
Streak	.914	Intervention	28	8.32	3.12
		Control	16	8.00	3.37
Correct	.974	Intervention	28	72.46	9.84
		Control	16	73.59	9.55
Error	.995	Intervention	28	33.61	19.96
		Control	16	36.00	16.06
Persevere	.986	Intervention	28	7.54	3.00
		Control	16	9.18	4.10
Category	.990	Intervention	28	4.71	1.74
		Control	16	4.24	2.14
Maintain	.992	Intervention	28	.96	1.60
		Control	16	.94	1.14

Note. The intervention group had higher math error scores than did the control group at pretest. The posttest results reflect this a priori difference. Following the intervention, the intervention group improved (lowered) their math error scores at a greater rate in comparison to the intervention group. The higher score overall for the intervention group reflects the uneven difference between the groups that existed prior to the intervention.

Table 4.3 Correlation Matrix: Pretest (1) and Posttest (2) Measures of Ospan (*n*=45)

	1	2	3	4	5	6
1. Letter Correct 2	-					
2. Letter Correct 1	.586**	-				
3. Value Ospan 2	.842**	.465**	-			
4. Value Ospan 1	.630**	.897**	.600**	-		
5. Math error 2	-.173	-.461**	.037	-.338*	-	
6. Math error 1	-.225	-.606**	-.141	-.484**	.366*	-

*$p < .05$, two-tailed **$p < .01$, two-tailed.

Table 4.4 Correlation Matrix: Pretest (1) and Posttest (2) Measures of WCST (*n*=44)

Measure	1	2	3	4	5	6	7	8	9	10	11	12
1. Streak 2	--											
2. Streak 1	.330	--										
3. Correct 2	-.445**	-.040	--									
4. Correct 1	-.115	.317*	**.061**	--								
5. Error 2	-.313*	-.453**	-.037	-.111	--							
6. Error 1	-.353*	-.842**	.124	-.247	**.371***	--						
7. Persevere 2	.333*	.178	-.121	.303*	-.135	-.103	--					
8. Persevere 1	.427**	.263	-.170	-.202	-.219	-.395**	**.033**	--				
9. Category 2	.440**	.273	-.002	.195	-.648**	-.247	. 9**	.217	--			
10. Category 1	.451**	.669**	-.194	.265	-.389**	-.821**	.134	.526**	**.344***	--		
11. Maintain 2	-.440**	-.253	-.488**	-.256	.162	.275	-.457**	.025	-.474**	-.314*	--	
12. Maintain 1	-.271	-.435**	.098	.298*	.263	.301*	.137	-.201	-.089	-.359*	**.117**	--

Note. pretest = 1, posttest = 2.

Table 4.5 Correlation Matrix: Main Measures

	1	2	3	4	5	6
1. Pretest Ospan	-					
2. Posttest Ospan	.586**	-				
3. Pretest WCST	-.172	-.173	-			
4. Posttest WCST	.225	-.003	.061	-		
5. SRI	-.034	.114	-.113	.153	-	
6. SWLS	.098	-.070	-.157	.209	.309*	-

*$p < .05$, two-tailed **$p < .01$, two-tailed.

Psychometric properties for the self-test instruments, the SRI and SWLS, are provided in Table 4.6. Correlation matrices follow in Tables 4.7 and 4.8. Following these descriptive data, the next section will present the research questions along with relevant data findings. Figure 4.1 displays the pretest and posttest means for Ospan. Figure 4.2 displays the pretest and posttest means for the WCST.

Table 4.6 Psychometric Properties of the Self-Report Variables (*n*=44)

Measure	α	Mean	*SD*
Self-Regulation Inventory SRI			
Positive Actions	.975	84.18	14.65
Controllability	.917	57.95	10.71
Expression of Feeling	.720	39.68	7.98
Assertiveness	.394	26.98	5.36
Well-being Seeking	.980	106.91	19.32
Total SR	.960	317.05	41.93
Satisfaction With Life Scale (SWLS)			
Total SWL	.894	28.41	5.13

Table 4.7 Correlation Matrix for the Self-Regulation Inventory (*n*=44)

Measure	1	2	3	4	5	6
1. Positive Actions	–					
2. Controllability	.194	–				
3. Expression of Feelings	.428**	.109	–			
4. Assertiveness	.304*	.323*	.421**	–		
5. Well-being Seeking	.809**	-.044	.372*	.310*	–	
6. Total SR	.831**	.316*	.556**	.503**	.770**	–

*p < .05, two-tailed **p < .01, two-tailed.

Table 4.8 Correlation Matrix for the Satisfaction with Life Scale & Questions (*n*=44)

Measure	1	2	3	4	5	6
Q1	–					
Q2	.716**	–				
Q3	.697**	.826**	–			
Q4	.666**	.765**	.828**	–		
Q5	.352*	.340*	.369*	.347*	–	
Total SWL	.718**	.583**	.638**	.599**	.536**	-

*p < .05, two-tailed **p < .01, two-tailed.

4.5. Research Question One: Did the intervention affect Ospan and WCST performance?

MANOVAS comparing the experimental group and the control group showed a statistically significant between-subject (groups) effect of cognitive enrichment with the Ospan measure: Wilk's Λ = .780, F (3, 41) = 3.86, p = .016. See Figures 4.1 and 4.2. However, the MANOVA for the WCST fell short of statistical significance: Wilks Λ = .752, F (6, 37) = 2.03, p = .086. Following the MANOVA, ANOVAS were conducted for the Ospan subscales (See Table 4.9). Two of the three subscales, the Total Letter Correct (p = .020) and the Value Ospan (p = .035) were found to be detectably different while the Math Error subscale was not (p = .104). The Ospan total score is calculated using the letter correct measure which indicates the total number of letters recalled in the correct positions. The value Ospan represents the overall sum of correctly recalled sets (Unsworth et al., 2005). The total math error score refers to the number of math errors that are made due to speed and accuracy.

An ANCOVA was conducted to examine the variability in cognitive test scores across the intervention and control groups. A one-way ANCOVA was conducted to determine a statistically significant difference between pretest and posttest while controlling for pretest differences. There was a significant effect of the posttest on cognitive test scores on the Ospan, F(2, 44) = .764, p = .014, p < .05, partial eta = .136. The ANCOVA results for the Wisconsin Card Sorting Test, F(1, 43), =.764, p = .387, p < .05, partial eta = .018.

Table 4.9 ANOVAs on Ospan Posttest (Subscales)

Measure	Intervention Mean (*SD*)	Control Mean (*SD*)	*F*	*p*
Ospan *df* 1(43)				
Letter Correct	57.31 (8.82)	49.19 (13.74)	5.84	.020*
Value Ospan	37.86 (13.52)	28.13 (15.71)	4.77	.035*
Math Error	5.58 (3.81)	4.44 (3.63)	2.76	.104

*p < .05, two-tailed **p < .01, two-tailed.

Figure 4.1 Ospan: Pretest and Posttest Results for Experimental and Control Groups

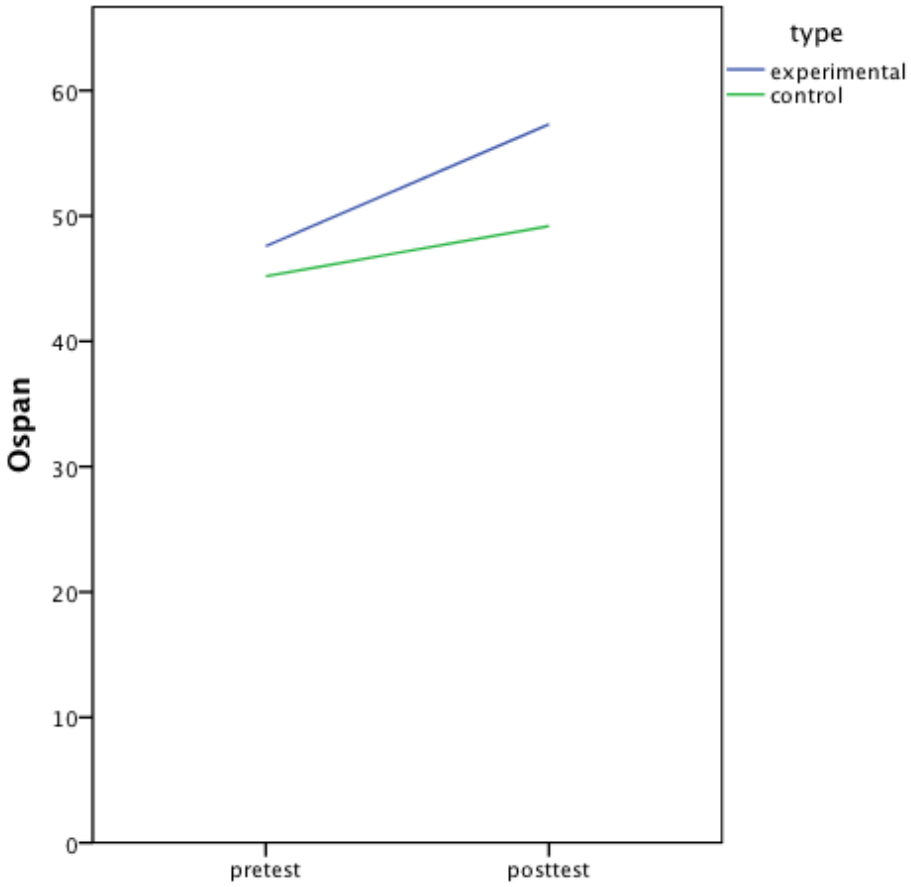


Figure 4.1 illustrates the changes in participant results on the Ospan cognitive test. The figure shows an increase in both the experimental and control groups in the overall Ospan score. Overall, the experimental group shows greater gains from pretest to posttest.

Figure 4.2 WCST: Pretest and Posttest Results for Experimental and Control Groups

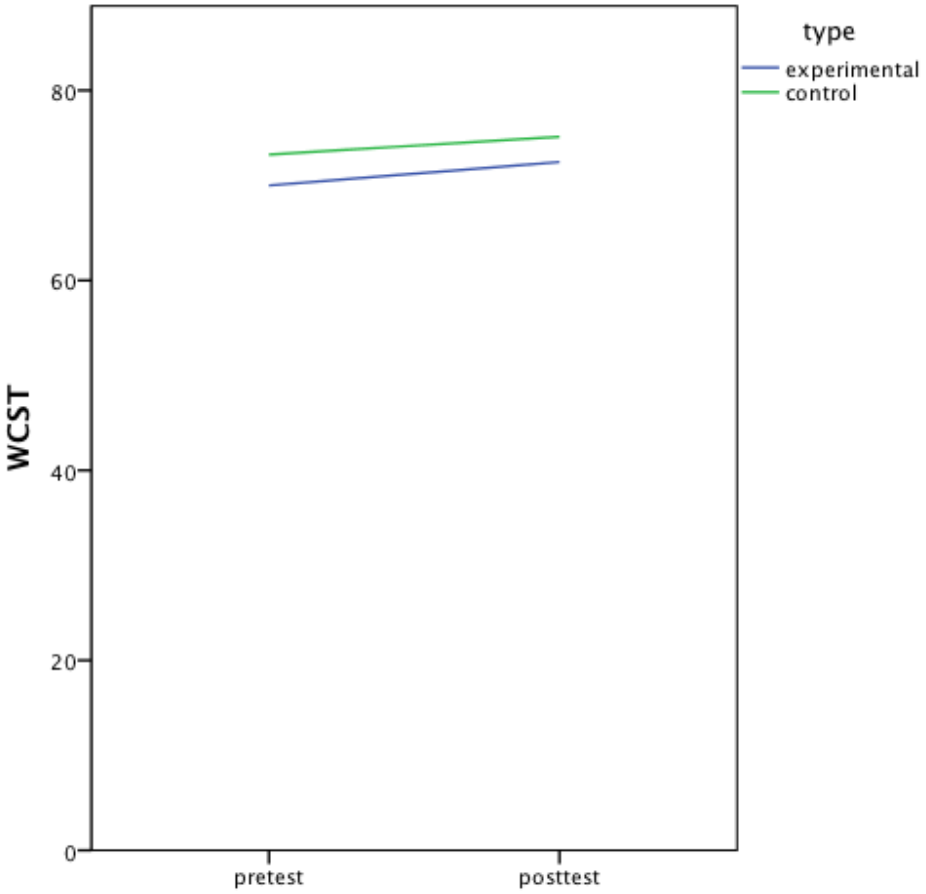


Figure 4.2 illustrates the changes in participant results on the WCST cognitive test. The control group begins with a higher score in the WCST pretest results. Neither group experiences statistically significant change from WCST pretest to posttest.

4.6. Research Question 2: Is there a relationship between participant scores on the self-regulation inventory and/or life satisfaction scale and final scores on the cognitive measures?

Standard multiple regression was conducted to determine if a linear relationship existed between the aggregated self-report variables (SRI and SWLS) and the post-intervention measures of cognitive functioning (Ospan and WCST). The sample size falls well below what is often considered a prerequisite for multiple regression by various 'rules of thumb' and power analyses (Green, 1991). However, the multiple regressions were undertaken for two reasons. The first reason was to explore an upper limit on the magnitude of relationship in the present data between the aggregated self-report scales and each of the dependent variables. The second reason was that it is possible for an underpowered analysis to detect a statistically significant relationship. The problem of interpretation occurs in the case where the analysis does not detect a relationship and the researcher concludes that none exists.

For the Ospan, the regression results were R = .336, R^2 = .113, R^2adj = -.031, F(6, 37,) = .787, p = .586. For the WCST, the results were R = .402, R^2 = .162, R^2adj = .022, F(6, 36,) = 1.159, p = .350. (See Table 4.10). Regression results indicate that the overall model did not significantly predict a linear relationship between the cognitive measures and the self-report variables.

Table 4.10 Regressions Predicting Ospan and WCST

	B	*Beta*	*p*	Bivariate *r*
Ospan				
Positive	.023	.030	.924	.158
Control	.345	.325	.086	.232
Express	.075	.053	.779	.066
Assertive	-.198	--.093	.618	.062
Wellbeing	.087	.147	.627	.148
SWLS	-.366	-.193	.288	-.070
WCST				
Positive	.053	.086	.779	.108
Control	.064	.076	.679	.147
Express	-.431	-.381	.045	-.213
Assertive	.041	.024	.895	-.010
Wellbeing	.058	.123	.680	.055
SWLS	.389	.258	.154	.209

4.7. Research Question 3: Does a relationship exist between self-regulation and life satisfaction?

The third research question examined the extent to which a relationship existed between self-regulation (SR) and satisfaction with life (SWL). The following correlation matrix (Table 4.11) shows significant correlations between both the full-scale measures and one of the subscales. The full SRI and SWLS measures indicate a statistically significant correlation (r = .339) at the p < .05 level. Of the five subscales the Control Subscale of the SRI shows a significant correlation with the SWLS (r = .352) at the p < .05 level.

Table 4.11 Correlations between Self-Regulation (SR) and 5 subscales and Satisfaction With Life (SWL)

Measure	α	1.	2.	3.	4.	5.	6.	7.
Main Scales								
1. SR	.968	–						
2. SWL	.853	.339*	–					
Subscales								
3. Positive	.972	.831**	.247	–				
4. Control	.917	.316*	.352*	.194	–			
5. Expressive	.720	.556**	.259	.428**	.109	–		
6. Assertive	.394	.503**	.137	.304*	.323*	.421**	–	
7. Wellbeing	.978	.770**	-.002	.809**	-.044	.372*	.310*	–

*$p < .05$, two-tailed **$p < .01$, two-tailed.

4.8. Research Question 4: How did participants modify their strategies in the Quizlet learning environment?

The fourth research question involved collecting self-report data from the participants. Open-ended comments were gathered to investigate patterns in strategy creation and use. These strategies included how the participants selected and used any of 6 possible study tools offered by the Quizlet program (e.g., electronic cue cards, speller or scatter). Information about study tool choice, strategy design and change was collected. The aim was to determine if commonalities could be found to show which study tools and strategies had the most use to the participants and to begin to understand and explain why participants made specific study tool selections and self-regulated learning strategy modifications.

4.8.1. The Learning Activity Components

Within the Quizlet learning environment, learning activities are organized into 6 different formats of study tool. A learner may select and change to any of the study tool options and combinations in the software program at any time. At the beginning of the study, participants were instructed to try all of the different study tools and then settle on the individual study tools that worked best for them (see Table 4.12). The first of the six study tools is flashcards using digital cue cards. The second is, learn, which has a fill-in-

the-blank response box where the learner types in the correct word when supplied with a definition. The third is speller where the word or definition is spoken aloud and the learner types the exact response into a response box. If a mistake is made, the answer is provided and the procedure is repeated until mastery is attained. Fourth, the test study tool has the words and definitions cast into various multiple choice and fill-in-the-blank tests. Tests may be reset and repeated and the configuration is changed each time. Fifth, scatter presents a jumble of words on a page and the learner needs to drag a response to its corresponding partner. Once all of the words have been paired off the scatter test is successfully completed. One may race against the clock when using this. The final study skill is called race. This adds an unavoidable component of speed of response to the studying session. Words race across the screen and the learner needs to type in the exact word or phrase before it runs off of the screen. As one gets better, the speed with which the words race across the screen increases. It is rather important that one can type well in order to use this tool. A brief summary of the study tools is presented in Table 4.12. The study tool choices, refined strategic choices and switching patterns of the participants are summarized in Table 4.13. The overall learning experience may be shaped by the select-optimize-compensate components: select the initial study sets, strategically optimize by finding the most appropriate study tools, compensate by selecting shorter sets and taking more time to study.

Table 4.12 Types of Learning Strategies

Quizlet: Summary of Learning Strategies

1	Read flashcards	Traditional flashcards in digital form
2	Learn	Given an answer and learner types in correct term/definition
3	Speller	Response is spoken aloud and learner types in correct answer
4	Test	Tests are generated with the terms: Fill-in-the-blank and multiple choice
5	Scatter	Words are in a jumble on the screen and learners drag and drop to join partners
6	Race	Terms race across the screen and the learner must promptly type in the exact term or phrase before it races off of the edge of the screen

4.8.2. Participant Study Tool Use: Strategy, Selection and Modification

Overall, there was much variability in individual preferences for study tool selection. As participants self-regulated their learning process and topic choices, the utility of various strategies differed a great deal due to the different sets they opted to study. As an example, one participant studied sites on World War I. He studied 7 days a week for 15 or more minutes every morning. He used the flashcards to study these sets. In contrast, one participant used the study time to learn Spanish. She studied three times a week for 30 minutes each time and used speller as her chief study tool because it pronounces the words aloud. For these reasons, it is apparent that the study tool choices would be impacted by the topics one elected to study. Other participants just tried all of the strategies and pursued a variety of topics. Nonetheless, despite these variations, recurrent patterns do appear in the comment data as presented in Table 4.12.

For basic learning of a new set of terms and ideas, the flashcards were the most popular and the most consistently used. Once the set had been studied using the flashcards, the next most popular method was scatter. This study tool has the participant match terms and definitions until all in a set disappear from the screen. This has the gaming component of racing against the clock. Many participants really liked to better their times and found scatter to be challenging and rewarding at the same time. Not surprisingly, the space race study tool was not popular for those who were not touch typists. The other techniques held individual worth to participants. Most clearly, the flashcards and scatter were the preferred methods of study. In terms of trying different study tools and reordering one's preferences for strategic usage, there was a shift over time that had scatter emerge as the best choice for mastery. The learn study tool also became popular as a study method that improved outcome success. Space race was found to be an extremely effective study tool for those who were good typists and also, it was noted that using this method had the bonus of simultaneously improving one's typing speed and accuracy. Often learners came to build strategies that incorporated 2 or more of their favourite study tools alongside with their own personally created learning tools and techniques. For example, some created their own handwritten notes to serve as a part of their learning design. Others printed out the lessons and highlighted items in

addition to using the Quizlet study tools. For some learners, a measure of the old ways and the new ways proved the best strategy for optimal learning.

Table 4.13 Learning study tools selected and modified during the learning intervention (rank ordered by reported frequency)

Six Study Tools	In order of frequency used	Rated most helpful	Rated least helpful	Stopped using over time	Switched to as best new choice
1 read flashcards	1	1 tie	3	4	5
2 learn	3	2	1 tie	3	2
3 scatter	2	1	4	5	1
4 speller	4	4	1	2	6
5 test	6	3	5	1	4
6 space race	5	5	2	6	3

Participants also provided brief comments to promote a better understanding of their study tool selections and strategic changes. Reading and studying the flashcards was the most consistent study tool selected. Given the age range of the participants (63-91) this technique was the most familiar to many. Participant comments included that "this was more typical of my experience" and "this was good and helpful with the repetition and mastery." Having a known technique and seeking mastery were common points in favour of flash card use (both paper-based and online). Another positive part of the flashcard tool is that the time was controlled entirely by the participant. The cards didn't switch until the participant was ready.

For those who liked the "learn" study tool, this was the best method because it was not too difficult to navigate. Others were annoyed with this tool and found it to be inconsistent and too rigid with the necessity of having "perfectly exact" responses.

Scatter was the main switched-to tool. Those participants that used scatter enjoyed it both as a learning tool and as a game. Comments included "it was the most fun for developing my accuracy and memory. It made my brain tired!" Another stated, "it was challenging the motility of my mind." One participant even stated, "I used this for all of the sets that I did. It was the most useful to me." Another learned 120 new French words (100 was her goal) as she was off to a trip to France later in the year. She used

scatter to overlearn the words visually. The individual monitoring of the utility of the study tools and the strategic selection of those tools which were most helpful in goal-attainment, would indicate self-regulated learning was an integral part of the study process.

Speller was good for hearing words for recall. Many just did not like it although they didn't explain precisely why that was. The "test" tool was good because it gave feedback until mastery was achieved. At the beginning one participant felt it was difficult to retain new words but by the end "test" showed that "my brain was more experimental and responsive." Another said, "I usually worked with the terms until I got 100% on the tests." Last, "space race" was mainly found to be "too fast." Often, the definitions were too long to type. Advocates found that "as the race got faster my typing skills improved." "Race was good because I had to concentrate on more than one instruction, as it were." It was challenging and tiring both (see Table 4.12 for details).

In sum, the participants engaged in self-regulating their learning topics, choices and styles. As a result, many were able to customize their learning to assist them to be motivated to continue with the study sessions. The sessions were like experiments instead of lessons since, as one participant said, "we got to take charge of our learning."

4.8.3. Conclusion

Research findings indicate that there were differences between pretest and posttest measures. First, the Ospan measure results indicated statistically significant change between pretest and posttest findings. The Wisconsin Card Sorting Test results fell short of statistical significance. The sample size was not sufficient to determine that no relationship existed between the predictors and the dependent variable. With the survey data, there was an indication of a positive relationship between the two measures. Finally, the self-report study tool and strategy data did indicate some common findings in the strategy selection, and modification patterns amongst the participants.

5. Discussion & Conclusions

This chapter provides a summary of the research, its implications and limitations. It concludes with an evaluation of the import of this research in the greater context of cognitive enrichment research and aging. Future directions for further research are presented.

5.1. Summary and Implications

The main question evaluated in this study involved the effect of participating in a game-like activity called Quizlet on memory ability of older adults. Following the Quizlet learning intervention, a statistically significant relationship was found on the Ospan measure indicating a benefit for the experimental group compared to the control group. This suggests a relationship exists between challenging cognitive activity and improvements in memory skill.

It is informative to make a distinction between episodic memory and working memory here. This study evaluates working memory. Episodic memory refers to a person's individual memory of an event. This may include such examples as where a person was when a significant historical event occurred (e.g., the lunar landing). Episodic memory includes such detail as where, when, and why information. Episodic memories can be consciously recalled. In contrast, working memory refers to a temporary storage of information while actively manipulating that information. An example of working memory is remembering a phone number for a brief time (UCSF, 2014). In this study, the focus was on working memory store.

Ospan provides a measure to evaluate working span memory accuracy. Retaining information accurately is essential in everyday life where people need to remember directions, medication particulars, rules, people's names, addresses and so

forth. Data collection using the Ospan measure involves having participants retain information while being distracted by an unrelated secondary activity. Within the Ospan, the participant goes through a training session that illustrates the process: after one completes a simple mathematical calculation, a letter flashes across the screen and then disappears. Immediately following the letter, a new math equation appears and then a new letter appears and so forth. The participant needs to recall the letters in sequential order while still coping with the mathematical distractions. After a sequence of 3 to 7 math operations and letter flashes, a screen appears where the participant can select the letters in proper sequence. This operation requires that the learners retain the letter information despite the constant interruptions of the math computations. This pairing is much like real life episodes where a person is doing one activity and then interrupted by another.

In this research, the Ospan measured gains in memory accuracy from participation in the learning intervention, Quizlet. In Quizlet, the lessons are set up and conducted by a computer program that provides corrective feedback. This program is limited to having participants put in exact answers or the computer marks the responses as incorrect. Thus, there is similarity between the required precise and accurate recall demanded by Ospan and also demanded by Quizlet. The Ospan measure sets the pace of the test for each learner based on his/her own speed during the practice sessions. This is done so that participants are unable to spend time actively rehearsing the letters at the same time as they do the math calculations. Similarly, in Quizlet the scatter and race strategies speed up as a participant improves his/her skill. Overall, there are similarities between the skills being practiced on the Quizlet and the basic testing tenets of the Ospan. Near transfer is indicated in the study results (See Section 5.2 for details). Although the activities certainly are not equal, the activities share a focus on memory accuracy and speed, which indicates that they share some underlying skills.

The WCST is seen as a measure of executive functioning involving the use of strategy-shifting and pattern recognition. There is some commonality between the WCST and Quizlet. In Quizlet, learners sort cards into proper groupings and then must adjust, rather than persevere, when the rules of the game change. Quizlet also requires executive functioning and involves strategy-selection and shifting in a more complex manner. The WCST, (as a measure of strategy-shifting and pattern recognition) and the

Quizlet share similarity in terms of demanding attention and metacognitive monitoring of strategy success. It must be noted that there were two unexpected developments with the WCST. There was interference in some cases for some of the participants who played regular card games such as solitaire or blackjack. They were confounded by the fact that the card sets were unusual and didn't sort into games they knew. In a small sample, having a few participants experience this trouble with the test may have altered the findings.

As the principal investigator was present as participants did the two tests, it was clear that the Ospan was a cognitively exhausting and intense experience where people sighed and relaxed after completion whereas a number of participants indicated uncertainty and were puzzled after completing the WCST. This result may have been related to the age of the participants. Some didn't see an overall logic to the test design for the WCST whereas the Ospan seemed quite straightforward. This may have affected the results on this test.

5.2. Transfer of Learning and SRL

In order to evaluate transfer of learning involving Ospan and Quizlet, it is necessary to note the details that separate the two while recognizing that they share one end goal: evaluating memory accuracy. Ospan involves short-term sequential single letter recall and the performance of simple mathematical equations (addition, subtraction, multiplication and division). The mathematical equations act as interrupters to prevent learners from actively rehearsing the letters that they need to recall. This test takes 20-30 minutes to complete. In contrast, Quizlet is a learning site that presents thousands of learning sets and provides six different study tools to assist individuals in learning and studying presented words and concepts. Each learning set has a series of words and a corresponding set of explanations or definitions and/or diagrams and photographs that illustrate and explain the concepts. Topics range from simple translations (e.g., yes and oui) to complex academic concepts and ideas (e.g., dna mapping, genome analysis, components of metacognition). Using Quizlet study tools involves much self-regulated learning (SRL).

Quizlet study may be evaluated by using the five conditions of self-regulated learning outlined by Winne (2014). The model includes conditions of the task, operations conducted, products generated, evaluations of work and standards of evaluation: the COPES model (Winne, 2014). Applying these SRL COPES stages to the Quizlet intervention illustrates the connection this intervention made between SRL and transfer. For participants, the *conditions* for learning were independent learning in one's own home using topics of personal interest for 60 minutes a week. The *operations* the learners carried out included devising strategies for selecting the study sets, deciding how much time to use for each of them, and choosing levels of mastery. Learners adjusted their operations through deciding which topics and strategies were most effective. Based on performance outcomes, the learner would change or alter certain parameters. *Products* that were generated included new understandings of concepts, increased vocabulary and a more developed understanding of the relationship between one's own learning style and the efficacy of the strategies selected. Evaluating the success of the learning included judgments of learning (JOL), examinations of the percentages correct, and also assessing the number and complexity of terms and concepts studied. The *evaluation* was monitored against the individual standard of feeling of knowing levels (FOK), and of meeting a personal *standard* of achievement (i.e., 100% mastery or less) (Winne, 1996). The level of involvement is determined by the participant: learner satisfaction is the prerogative of self-regulated learners (Winne, 2014). Through paying attention to their patterns and successes, these learners appear to be metacognitively monitoring their learning and adjusting their tactics accordingly in order to promote greater success (Perkins & Salomon 2012).

The easily measured findings of this learning intervention indicate near transfer with regard to memory accuracy. However, the examination of other forms of transfer appear to be warranted due to the complexity of underlying processes involved in the SRL process. How do the underlying processes of selecting, studying, evaluating and revising study tactics and evaluating their utility contribute to transfer in other areas of life? Although these complex processes are difficult to quantify, they seem worthy of examination and study. Following the intervention, subjectively, a number of participants stated that they felt that their ability to retain information had improved (e.g., didn't need to write down a shopping list, were more easily able to retain names in social situations).

Others expressed greater openness to doing things in new ways instead of only using one well-known strategy (e.g., trying different exercise routines instead of just walking, using ebooks instead of only paperbacks). In this study, near transfer is evidenced through learner gains in memory accuracy as measured on the Ospan, but given the extensiveness of the SRL and metacognitive monitoring involved in the Quizlet study, other types of transfer may be implicated. Further studies of this sort should focus on transfer with more consideration of how to design the study to collect data that supports such findings.

5.3. SRL and Cognitive Enrichment

The second and third research questions involve the self-regulation and life satisfaction survey data. The second research question addressed the relationship between the self-regulation inventory and the satisfaction with life survey and the measures of memory accuracy. Multiple regression analyses were conducted to evaluate the possible relationships between the cognitive measures and the self-report surveys. Overall, the sample size was not sufficient to adequately analyze all possible relationships that may have existed. The third research question evaluated survey data to determine if a relationship existed between self-regulation and life satisfaction. The finding was that a positive relationship did exist between self-regulation and life satisfaction. In this study, the intervention itself was different from most research as there was a high level of self-regulation involved. Participants governed virtually every aspect of their intervention study: topic choice, level of difficulty and mastery, strategy design and adoption, and tool selection. This makes self-regulation relevant in this study. Further, as a correlation was found between self-regulation and life satisfaction this may suggest that a self-regulated intervention is efficacious. Still, it must also be noted that correlations between self-report data instruments may hold importance but must be evaluated with care. It may be that there are other variables interacting with the self-report data that are not clearly known. The finding of a correlation between the life satisfaction and self-regulation ratings may provide reason to gather more data from different sources that evaluate the possible relationship between life satisfaction and self-regulation. If a relationship does exist between life satisfaction and self-regulation, it may be that the promotion of self-regulation might help learners improve their overall

ratings of life satisfaction. Taken from the other direction, it may be that those who are more satisfied with life are more receptive to gaining new skills in self-regulated learning. An exploration into how self-regulation interacts with life satisfaction and cognitive enrichment activity warrants further study. These variables may individually and collectively play integral roles in motivating learners as they pursue cognitive enrichment activities.

Self-regulated learners monitor their learning and regulate their own metacognition, motivation and learning behaviour (Winne, 2014). The participants in this study actively self-regulated their involvement in the learning intervention by their strategic choices of study topics, study tools, and the levels of difficulty they sought to master. They attempted to use the study tools provided by Quizlet and selected and rejected the tools on the basis of their ability to promote successful learning. Successful learning was defined by some as complete mastery, by some as enjoyable learning of interesting new ideas, and by others in terms of memory improvement on the self-study tests. They thought about how they were learning and how effectively these tools aided their process. If the study tools were not helpful, the learners chose other tools or created their own. Many found different ways to motivate themselves to study: interesting topic choices, using increasing difficulty levels, enjoyment of particular study tools, creative interest in developing one's own sets, a competitive thrill by improving their previous scores or times. They were serious about what they did and did not like and about what they felt did and did not work. One participant said every night for about an hour before bed (instead of television) she made herself do sets over and over until she got the absolute best time. One fellow took people to Europe for tours, so he created digital Quizlet sets with audio and video to orient his clients to the destinations while they were on the bus tours. He was excited and motivated and driven. In terms of assuming the behavioural aspects of their own learning, the participants ranged in age from 63 to 91. As a result, there was a range in terms of the way they organized themselves for effective learning. Some set up specific times and locations for their study. Some studied in pairs. Others took charge and used the entirety of Quizlet as their tool: they made their own cue cards and edited and designed their own sets. Some were very busy people, so they scheduled their study time to repeat at a certain time weekly. Neighbours walked to each other's places and then studied by asking the other person

for responses aloud, making it into a fun shared experience for both. Many were excellent self-regulated learners. Some were quite surprised to find out about their own tastes and techniques. They were discovering who they are now as learners as opposed to who they once were. Some who had had negative school experiences seemed to feel empowered by their successful learning experiences with Quizlet.

The overall self-regulation that participants engaged in as they completed the learning intervention involved setting their target goal and then trying different learning strategies until they found the best combinations of study tools and learning techniques and strategies to assist them. Study tool selection and strategic planning changes proved to be one area that was possible to track. Participants set goals for learning, monitored and critiqued the utility of the study tools, developed strategies for their use, tried them out for success, and then revised their tactics. Ultimately, many participants selected one or two winning study tools as they created their most successful learning strategy. Others varied their learning strategy based on the level of difficulty of the set. Some had two Quizlet tools that they found the most productive to their learning process, but still added pen and paper learning to the game. Overall findings suggested there was a trend that suggested certain study tools (e.g., Flashcards, Scatter) were found to be more useful and helpful than others. Some were found to be less helpful in promoting recall and mastery (e.g., Speller and Space Race). The study tools the participants selected varied depending on the sets they studied; however, despite the differences in topics, the preferred study tools had some continuity over time. Further, the participants had to set their own topics of study and, in this regard, were self-regulating their choices and actions throughout the intervention itself. The ability to track and evaluate self-regulation as a process is an important facet of understanding how to set up successful program involving multiple cognitive enrichment activities. In tracking SRL within CE, participant learning could be tracked as a sequence of temporal events to understand which methods of study are most successful and which ones are not (e.g., Winne & Perry, 2000). The role self-regulation plays in helping create successful CEA will impact the content and structure of programs that are designed.

5.4. Cognitive Enrichment and Skill Development

From their systematic review of the literature on cognitive aging and older adults, Hertzog et al., (2008) make three global conclusions. First, evidence from cognitive training studies has demonstrated that older adults can improve cognitive functioning when they are given “intensive training in strategies that promote thinking and remembering” (p.1). Second, a number of studies indicate that an intellectually-stimulating lifestyle predicts both improvement and maintenance of cognitive skills and reduces the risk of Alzheimer Disease in later life (Hertzog et al., 2008). Third, physical exercise is shown to have a positive impact on cognitive function in later life. Hertzog and his colleagues (2008) recommended further study about the interaction of cognitive aging with stress, self-efficacy, locus of control, and life meaning.

In this research conducted with Quizlet, participants made strategic choices to guide their learning process. The individuals in the study were most interested in pursuing cognitive activity in a way that would make their daily lives more intellectually stimulating and decrease their odds of getting Alzheimer’s Disease. This study also focused on the ability to enhance self-regulation of one’s behaviour and thereby create intellectual growth. Finally, life satisfaction was explored as a measure of meaningfulness in life. Physical fitness was not a part of this study, but research has shown it should be a part of the design of a cognitive enrichment program (e.g., Geda et al., 2012; Maes & Karoly, 2005; Petrovich & White, 2005).

5.5. In the Direction of Cognitive Enrichment Theory

This study on cognitive enrichment and aging has involved the collection of person, task and strategy data, but in order to get more generalizable data, larger-scale studies conducted within a program that is able to collect multiple forms of data about SRL and learner metacognition would be useful. Gathering objective fine-grained SRL and metacognitive data is difficult due to the interior nature of metacognition and much of self-regulated learning activity. One tool that may assist in collecting more data is nStudy which is a web application that permits the collection of data about user actions and choices (Winne & Hadwin, 2013). nStudy can record specific information about

learners such as time spent doing each operation, patterns of events such as making new notes, reviewing terms, and modifying concept maps as well as engaging in chat (Winne & Hadwin, 2013, p302). Having access to these data would help researchers gain insights into the patterns that successful self-regulated learners follow. In conjunction with evaluating learner memory function in more conventional ways, using tools such as nStudy to collect data could help educators create resources and programs that would be more aligned with the needs and practices of older adult learners as they navigate the Internet and the possibilities that it might afford them.

Data collected for this study were quantitative with some responses to open-ended questions. An informal exit interview with participants revealed anecdotal details about study choices, tool evaluations, and the learning intervention as a whole. The Ospan data indicates that the cognitive enrichment activity did improve memory accuracy in the experimental participants. In addition, from the participant notes on strategy building, appropriateness, and change, a trend was shown about which study tools were rated as the most useful in terms of goal attainment. The exit interviews indicated that in some cases, participants interacted with one another and exchanged ideas and sets. Also, there were some common goals shared by certain participants (e.g., the desire for better Spanish fluency for an upcoming trip). These individuals shared tips, resources and enthusiasm and thus propelled each other forward into more extensive cognitive enrichment involvement. Using more advanced tools to gather such difficult to quantify detailed data involving SRL and cognitive enrichment could shed light on the metacognitive processes involved that are more difficult to observe and record. For example, using nStudy tools, one might be able to create a collaborative environment wherein aging learners chat, use the kit exchange, note templates, and coaching tools to record the trace data revealing their actions and interactions. The learning intervention involved would have aspects of individual SRL and socially shared regulation which is “processes by which multiple others regulate their collective activity” (Hadwin Oshige, Gress, & Winne, 2010). From this thesis research comes a few answers and many questions. These unanswered questions may be used to design future research that is able to capture more facets of the cognitive enrichment acquisition process.

With application to aging persons, the cognitive enrichment theory must include aspects of the cognitive, social, and physical learning environment that shape the learning process. These 3 areas overlap and interact with one another. There are other pieces of the puzzle that warrant further examination such as self-regulation, self-regulated learning, life satisfaction, motivation, and perseverance.

5.5.1. Long-term Perspective & Relevance

Hertzog et al., (2008) frames the cognitive enrichment hypothesis in terms of a life-span perspective of development that is informed by Paul Baltes' perspectives on the aging process. The gains and losses associated with cognitive aging form a part of this theory as the gains and losses may be mediated by enrichment activity despite the limit that biological aging imposes. Future research needs to provide more definitive evidence and connection between which types of CE will enhance cognitive gains as well as to highlight those cognitive abilities which are more malleable.

A critical question in designing cognitive enrichment activities is sustainability. In the Quizlet study, the gains were made and sustained up to 8 weeks. Longitudinal information would be needed to track and see if cognitive gains were maintained over longer periods of time. The lack of longitudinal data is a recurring problem in aging research. A basic study might be replicated and have repeated evaluations of CE over time. This would provide valuable information about the level and type of skills that are retained over time as well as which cognitive skills diminish more swiftly.

Cognitive enrichment effects that arise from participation in mentally-stimulating activities may have more general effects on cognitive functioning than from participation in more specific and narrowly-defined classical studies (Hertzog et al., 2008). Assessing the CE effects that occur in response to broad mentally-stimulating activity is challenging. Issues such as level of cognitive demand, self-report data limitations, undifferentiated mental-stimulation activities, and methodological issues are difficult to separate and confound data analyses. For example, there is a difficulty in isolating cognitive enrichment activity from the social connection that may come with it. However, the study does provide insight into the SRL process in a way that suggests what might be pursued in future research (e.g., there is a need to trace metacognitive learning

processes in a more systematic manner; it would be useful to measure the role that social interaction plays in motivating aging learners to participate and perseverate in a learning situation that involves challenging cognitive enrichment activity). The general effects of CE that are more difficult to measure may be suggested in smaller studies and then this information may be used to design more targeted research that responds to this knowledge and captures information-gathering in a more directed manner. For this reason, both small exploratory experimental research projects as well as larger scale aging research are partners in data collection in the diverse field of aging and cognitive enrichment.

The relevance of research in the area of cognitive enrichment is now heightened by the reality of an aging population. The incidence of mild cognitive impairment (MCI) and dementia are increasing at alarming rates because of the aging population; in Canada alone, those over 65 will increase by 4.3 million between 2010 and 2030 (Service Canada, 2012). Estimates of mild cognitive impairment and dementia in that population are difficult; however, as life expectancy increases, so will the incidence. Any techniques which increase cognitive skill in this age group may prove to have value both to the individual involved and society as a whole. Estimates suggest that approximately 10 percent of adults over 65 will experience some form of dementia. The incidence rises as the person ages. A prevalence rate of 1.5% might apply to 65-69 year olds whereas in the 85-89 year old group the prevalence might look closer to 16% (LaPierre & Hughes, 2009). Research has been conducted to determine if involvement in challenging tasks can impact cognitive skill. The Advanced Cognitive Training for Independent and Vital Elderly study had findings that indicated that through specialized training, cognitive gains could result (Gross & Rebok, 2011). Further, self-regulation has been associated with the acquisition and maintenance of cognitive exercise routines (Hertzog et al., 2008).

If cognitive gains may be made throughout the lifespan, as this research suggests, then cognitive enrichment activity needs to be designed in a way that is easily accessed and freely available to aging individuals. This thesis investigated using freely available resources and participants who selected and self-regulated their own learning. Freely available resources and self-regulated routines are integral aspects in designing a fiscally manageable, large-scale cognitive enrichment training program for an aging

population. Just as individuals may independently go for a walk or a run or a swim, they need to be able to strategically choose to access cognitive resources at their own times and in their own ways.

A research goal herein was to expose participants to freely available, cognitively challenging resources so minimal cost – a computer and Internet access – was required to gain access to more cognitive enrichment. Also, through having the participants design their own learning according to their individual interests, they were beginning to self-regulate their learning in a way that may be more motivating and thus, might be more likely to continue beyond the intervention study. The strategy setting and evaluating that the participants naturally engaged in followed the Winne and Hadwin (1998) model of self-regulated learning (SRL). Each of the four SRL processes outlined by Winne and Perry (2005) were used by the participants: 1) defining the task (organizing the study schedule and lesson topics); 2) setting goals and plans (deciding on specific study sets and themes); 3) using study tactics to learn (selecting and trying different provided strategies); and, 4) using metacognitive processes to adapt to the learning demands (evaluate the utility and efficacy of the strategies and then switching or altering learning strategies and study sets as needed). These processes allowed individuals to design their own learning exercises in ways that they felt were more useful and productive. Participants self-selected the topics they found to be the most beneficial and stimulating. Many participants expressed concern about what would happen after the study ended. They wished to continue their learning sessions. A number of them had defined plans and goals for more study sessions and also indicated that they felt their memory had improved as a function of the study sessions. The process of being able to define and control independent learning was empowering for many participants and suggested SRL is a vital component in the pursuit of cognitive enrichment.

The finding that learning and development is possible across the lifespan is affirmed in research (e.g., Schaie, 2010). The reality of mild cognitive impairment and dementia in a rapidly aging population is formidable. The maintenance of flexible cognitive styles is critical given that life expectancies may be 15 to 30 years longer than in the past (Schaie, 2010). The possibility exists that cognitive enrichment and physical exercise may slow, lessen or potentially reduce the onset of these horrible problems. Much research is still needed to explain the roles and interactions that positive thinking,

support arrangements, and social networks play in improving or diminishing an individual's pursuit of cognitive enrichment. These areas all need further study to see how much impact they have on individual participation, motivation and compliance. Although the enrichment programs may be formulated and presented, the pursuit of cognitive enrichment must be internally-driven. Self-regulation will need to be a partner in this process.

5.6. Limitations and Recommendations for Future Research

The Ospan is a measure of working memory skill. Following the training session of the test, most learners had a sense of the task they needed to complete. The computerized Ospan test makes for uniformity of delivery and scoring. The WCST had more variability in its results. The sample involved aging persons (63-91) and it became apparent that some of the participants did not see a pattern in the cards and just became flustered. In some cases, participants wanted the cards to go into Solitaire piles and other card game configurations that were familiar to them. This was particularly true of those who played cards regularly. As a result, there were a few unclear attempts at the WCST. In such a small sample, this impacted the results of the test.

The main limitation of the study was the small sample size. The data collection was extensive and time consuming. As the principal investigator I spent between 6 and 10 hours with each participant. As the duration of the study was 8 weeks, this meant that a certain percentage of participants had travel plans and health issues that interfered with their ability to join or remain in the study. Second, there was a problem with the original fully online cognitive testing software. This resulted in some participant withdrawals at the outset of the study. When the previously online version was installed onto a fixed computer, this problem was solved.

A huge time commitment was involved in recruiting participants. Quite naturally, individuals did not wish to be evaluated in terms of their memory or thinking. There was much fear of dementia and mild cognitive impairment. Many participants were older and had had negative school experiences, and did not wish to appear foolish on the tests. There was more anxiety about taking the two cognitive tests than I had anticipated. One

wonders if such fears prevent people from acquiring information and seeking help. Another time-consuming area involved computer issues and conflicts. In several cases, the participants had not really used their computer before. In other cases, a new computer or iPad was acquired and individuals did not know how to navigate the device and/or the Internet. At times, I needed to sort out the technology so participants could do the intervention. For example, they needed to know how to use a browser, find a site, bookmark a URL, navigate through menus, open an email, make an attachment, and use the search function. Programs needed to be updated.

There was much self-regulation involved in the intervention. Some of the data were not collected in a way that permitted quantitative analysis. In the future, it may be that through using the nStudy software it may be possible to record data that will allow researchers to have insight into the choices and actions that the learners take during their learning intervention. Having the ability to easily record time involvement, strategy selection and learning steps would allow more evaluation of how learner self-regulation impacts the cognitive enrichment process. In this study, as the learning was on a free online site, many learners found a way to get to the learning site without signing in; therefore, it was not possible to effectively evaluate the impact of time on the cognitive intervention.

The sample was drawn from lower and middle income areas of Vancouver and Vancouver Island. The individuals all volunteered for the study and were provided with no monetary incentive. A few participants were personally touched by someone with dementia and this motivated them to join the study. The participants appear to be more educated than the general population in that both in the control group and in the experimental group the average level of education was approximately 16 years thus indicating a bachelor's degree or entry level degree. As a result, the generalizability of the findings may be impacted by the level of education of the participants. As well, there were more female participants than male (37% male). The racial configuration of the sample was diverse, but due to the type of intervention (all English tests and surveys); the participants needed to be literate in English in order to participate.

Time data were not available to determine the possible interactive effect between treatment and time. This occurred for two primary reasons: technical problems with the

software designed to gather these data prevented participants from gaining access to the site and also often participants forgot to record their time data. This issue could have been solved if the technical problems had been resolved.

One other limitation involves the measurement devices. Other more sophisticated, all-encompassing measures of cognitive skill might have been used such the Wechsler Adult Intelligence Scale-R, the Buschke Cued Recall Test or the Hopkins Verbal/Auditory Learning Test. These are expensive measures that may have been more able to detect general findings, smaller changes and/or provide more conclusive data. As well, although the results of this study are consistent with the idea that SLR activity contributes to cognitive enrichment, the research design was not able to investigate that hypothesis.

Overall, the main limitation was sample size. The amount of time involved in recruiting and assisting participants was also more extensive than anticipated.

5.7. Conclusion

Delaying the onset of cognitive decline is vital in a world where the proportion of persons over 65 is projected to be upwards of 25% of the total population. Aging well has been proclaimed to be the health priority of The World Health Organization (2014). The loss in the quality of life when MCI and dementia seize hold of individuals is giant and expensive. The best way to address the problem of cognitive decline is to be proactive. With self-regulated healthful behaviours, aging individuals can begin to make changes in their daily cognitive habits to promote better cognitive functioning. Given information and knowledge about techniques and sources of cognitive exercise that may work, the aging individuals may be better able to make choices that may assist them in retaining and preserving cognitive skill and even possibly, in reversing certain cognitive declines that are associated with the aging.

This study confirms the idea that repeated engagement in challenging cognitive enrichment activity is associated with improvement in memory accuracy. The cognitive intervention was self-regulated by each participant and thus, the content and focus of the study was more interesting and motivating to those individuals. Chosen cognitive

exercise routines may be added to physical exercise routines and together these may help create a society where the expectation is that at the individual level, people are capable of self-regulating their own complete mind and body fitness enhancement routines. Most of the participants were on modest pensions and could not afford expensive learning games. Many had to choose between going out for a meal or going to a show that week. They need free and affordable ways to pursue cognitive enrichment.

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Appendix A.

Example of Poster Advertisement

Department of Educational Psychology, Simon Fraser University, B.C.

PARTICIPANTS NEEDED FOR RESEARCH IN Aging, Memory, & Cognition

We are looking for volunteers 65 years of age and up to take part in a study of *aging, memory and thinking skill.*

The goal of this research is to determine if involvement in certain learning activities and games will promote memory skill and development for older adults.

As a participant in this study, you would be asked to:

Complete 2 questionnaires and 2 tests of memory and thinking skill (1 hour 30 minutes).

Participate in an online computer learning game. Experimental participation involves 60 minutes a week of word game play for the duration of 8 weeks. You may participate at your leisure in your home as fits your schedule.

Or, you may be asked to complete only the questionnaires and tests. In this case, total involvement in the study would be approximately 3 hours.

After the at-home gaming activity ends, you would participate in a retesting of the cognitive memory skills (40 minutes total).

After the research information is analyzed, all participants will receive a summary of the research findings about aging and memory skill.

For more information, or to volunteer for this study, please contact:

Sabrina Fox

Simon Fraser University (Burnaby Campus)

At

Email:

This study was reviewed by, and has received ethics clearance through, the Office of Research Ethics, Simon Fraser University.

Appendix B.

Example of Email Request to Potential Participants

Dear _____(name of individual if known)

I am writing to tell you about a research project involving aging, memory and cognition that I am conducting for my PhD research at Simon Fraser University.

I am looking for volunteers 65 years and up to participate in a study of older adults and memory and cognition.

I am seeking your permission to contact you to provide you with more details and information about the study.

The goal of this research is to determine if involvement in challenging learning activities will promote memory skill and development for older adults.

The following is a basic description of the directions for the study.

As a participant in this study, you would be asked to:

Complete 2 questionnaires and 2 tests of memory and thinking skill (1 hour 30 minutes).

Participate in an online computer learning game. Experimental participation would involve 90 minutes a week of word game play for the duration of 8 weeks. You may participate at your leisure in your home as fits your schedule.

Or, you may be asked to complete only the questionnaires and tests. In this case, total involvement in the study would be approximately 3 hours.

After the at-home gaming activity ends, you would participate in a retesting of the cognitive memory skills (40 minutes total).

After the research information is analyzed, all participants will receive a summary of the research findings about aging and memory skill.

For more information, or to volunteer for this study, please contact:

Sabrina Fox

Simon Fraser University (Burnaby Campus)

At

Email:

This has been reviewed by and has received ethics clearance through, the Office of Research Ethics, Simon Fraser University.

Appendix C.

Informed Consent

Participant Instructions: Read this consent form carefully. Ask as many questions as you wish before you decide whether you want to participate in this research study. You may ask any questions at any time before, during or after the research experiment.

Project Information

Project Title: Cognitive Enrichment, Self-Regulation and Aging

Project Number:

Principal Investigator: Sabrina Fox

Senior Supervisor: Dr. John Nesbit

Organization: Simon Fraser University

Email:

Phone:

Research Locations: Private Homes, Group Homes, Education Computer Labs, and Online

Purpose of the Study

The purpose of this study is to look at online vocabulary game playing as a form of thinking exercise and enrichment to see if participation in a challenging thinking activity can improve participant thinking ability or cognitive health. There may be a similar relationship between cognitive exercise and thinking ability as there is between physical exercise and physical health. This research study is being conducted to collect evidence to support the idea that participating in an online learning activity might promote thinking skill.

Overall Procedures At-A-Glance

You are being invited to participate in this study on cognitive enrichment.

Your involvement in the study begins with your being asked to fill out a consent form and a biographical data form.

Following this, you will complete 2 surveys. Together these will take approximately 40 minutes.

Next, you will be given 2 brief assessments to evaluate your memory skill, strategy, and speed. Together these will take approximately 40 minutes.

There are 2 types of participants. Control participants will complete all surveys and tests but not participate in the vocabulary study experiment. Experimental participants will complete all surveys and tests and participate in the vocabulary study experiment.

Once initial pretests and thinking skill tests are complete, experimental participants will be asked to participate in an online vocabulary activity for a period of 8 weeks. You will be asked to participate, at minimum, 3 times a week at intervals of 30 minutes or more. You will be asked to record your time involvement and scores and also comment briefly about your strategy selections.

Following the 8 weeks of participation, both control and experimental participants will be retested on the 2 memory skill tests (approximately 40 minutes). At this time, the principal investigator will evaluate the findings. You will receive information about the study results when these are available.

Your personal information will be kept secure at Simon Fraser University for a period of two years. These data will be locked in a secured cabinet. For the duration of the study, you will be assigned identification information (IDs) and passwords.

Step-by-Step Study Participation Details

You are being asked to participate in a research study that is designed to promote better thinking skill, strategy, and speed. Prior to the study you will be asked to complete two questionnaires. One of these asks about your self-regulation or self-management style. The second one asks about your overall life satisfaction rating. These 2 inventories will be given to you using an online questionnaire. You will click on your responses and press a button to submit. It will take between 30 minutes to one hour to complete both of these. You will be given a user identification name so your private name is secure. Your information will automatically be sent to the main researcher. Next, you will participate in a thinking skill test that will take about 20 minutes of your time. The researcher will administer this brief computer-based test. This test is to measure your thinking accuracy and speed. You will be asked to select cards and identify changing

patterns of color, shape and number. Next, you will complete one more thinking skill test that will take approximately 10 minutes; it evaluates your response time and memory accuracy. This information will help the researcher to make connections between your level of participation and the level of thinking skill you achieve over the course of the vocabulary activity study. In short, you will complete 4 activities before you begin the actual study. Taken together all 4 should take approximately 1.5 hours of your time.

For the study itself, you will be asked to participate in a free online vocabulary learning game and look at your correct and incorrect scores. The scores are given to you on the game site by clicking on a button. You are asked to play the vocabulary game as often as possible over the course of 8 weeks, but minimally three times a week for 30 minutes. After 8 weeks, you will be tested again to see if participating in the vocabulary game has improved your thinking abilities. The two posttests will take a total of about 40 minutes. This information may be used to help the researcher to understand the relationship between thinking or cognitive exercise and gains in thinking skill, strategy and speed.

Possible Risks

This is a minimal risk study. There are no significant risks to participants. No greater risks are encountered than those participants would experience through pursuing similar online learning activity as a part of their everyday life.

Information about participant levels of thinking skill, strategy, and speed will be collected using cognitive health measures. This information would indicate the level of cognitive functioning of each participant. None of this information is used to provide or deny any services to people. User names and passwords will be used to secure the data and protect participant identity. The overall difference between pretest and posttest scores may show an improvement in or decrease in levels of thinking skill that may potentially cause some distress to a participant who does not improve over the course of the study. It may be that some level of frustration may occur as participants gain familiarity with the online game.

Possible Benefits

This research could be beneficial both to the individual and to the target population for which this research is designed (63 years and up). Individuals participating in the cognitive study may learn adaptive strategies to monitor their thinking strategy and speed. They may discover that they are in control of their cognitive health and become more active in pursuing cognitive exercise.

The research could be beneficial in illustrating a connection between pursuit of cognitively enriching activity and self-management (self-regulation) and how together these impact cognitive health. This information may be used to create and provide programs that promote either or all of these. Further, awareness of connections between cognitive enrichment, self-regulation and life satisfaction may assist aging individuals in participating in more extensive cognitive activities to promote their levels of cognitive functioning. If positive findings are revealed in the study that link cognitive enrichment activity, self-regulation and the use of online vocabulary gaming, this information may serve as a catalyst for more research in the area. Free online learning games may be an excellent way to help an aging population maintain their cognitive health.

Complaints

Complaints may be directed to _____

Office of Research Ethics, Simon Fraser University,

Burnaby, B.C. Canada, V5A 1S6

Phone _____ Email _____

Questions

Questions about research results may be directed to the principal investigator:

Sabrina Fox

Information Collection and Storage

This research study has been reviewed and approved by the Office of Research Ethics (ORE) at Simon Fraser University. Data will be stored for 2 years in a secured filing cabinet at Simon Fraser University in the Faculty of Education, Department of Educational Psychology.

Reminder: Termination of Research Study

All participants are free to choose whether they wish to participate in the study. In addition, any participant who seeks to withdraw from the study may do so at any time without penalty. Should you choose to withdraw you are asked to please notify the primary researcher.

Any further questions you have about this study will be answered by the Principal Investigator:

Name: Sabrina Fox Email: Phone:

Authorization:

I have read and understand this consent form, and I volunteer to participate in this research study. I understand that I will receive a copy of this form. I voluntarily choose to participate, but I understand that my consent does not take away any legal rights in the case of negligence or other legal fault of anyone who is involved in this study. I further understand that nothing in this consent form is intended to replace any applicable Federal, Provincial, or Municipal laws. I understand that I may withdraw from the study at any time with no penalty.

Subject Last Name _____

Subject First Name _____

Contact Information:

Phone: _____

Email: _____

Subject Signature:

_____ *Witness:* _____

Date: _____

Appendix D.

Sample Consent Request form for Organization/Facility Director

SFU Letterhead

Consent to approach research participants

Researcher: Sabrina Fox
Doctoral Candidate
Department of Educational Psychology
Simon Fraser University, B.C.
-

Date

Dear *(title of appropriate person/director or manager)*

I am a graduate student researching memory skill and aging at Simon Fraser University. I am undertaking a research study titled: *Cognitive enrichment, self-regulation and aging.* The purpose of this study is to determine if participation in a challenging thinking activity game will improve memory speed and accuracy in adults 65 years and up.

Prior to undertaking the study I require your agreement/consent to advertise and approach individuals within your organisation to take part in the study. I will recruit people to the study using posters and emails *(attached) – (e.g., Appendices A and B)*. I hope to recruit 100 participants in total including approximately 5 and 10 participants from your facility. I am applying to the Office of Research Ethics of Simon Fraser University for ethical approval for the study. I have attached the study overview to this letter.

My research is supervised by Dr. John Nesbit, Professor of Educational Psychology, and Associate Dean, Graduate Studies in Education.

If you have any questions or concerns, feel free to contact me at /or

Your signature is needed on the attached form. You may either contact me and I will pick it up in person or you may email it to me.

Thank you for your time and consideration.

Yours sincerely,
Sabrina Fox
SIGNATURE
Study

Overview

1) Project title: Cognitive enrichment, self-regulation and aging.

2) Researcher: Sabrina Fox,

3) Goals of the study: The goal of this study is to determine if certain challenging learning activity games can help to improve memory accuracy, speed and strategy in older adults 65 years of age and up.

4) Benefits of the study: The study may provide information that promotes more exploration and research to evaluate the effects of cognitive exercise to see if it helps individuals maintain thinking and cognitive functions for a longer period of time. The research may also stimulate further research in the area so that progress is made in terms of finding and developing methods to help older adults function better and longer in order to maintain a higher quality of life and greater independence.

5) Risks: This is minimal risk research. There really are no greater risks than perhaps experiencing some frustration in learning the game at the outset of the research.

6) Procedure: There are experimental participants and control participants in the study. Those individuals who are control participants will complete 2 questionnaires and 2 memory tests. Then they will be dismissed until post-intervention 8 weeks later when they repeat the cognitive tests. The experimental participants will complete all of the questionnaires and tests and in addition over the course of 8 weeks they will play an online learning game for about 30 minutes three times a week.

7) Complaints and concerns: You may register any complaint with the Director of the Office of Research Ethics, Office of Research Ethics; Simon Fraser University; 8888 University Drive, Multi-Tenant Facility, Burnaby, B.C. V5A 1S6

Appendix E.

Sample Permission Form for Director/Manager

Letter of Permission

Please read and sign and return to the principal investigator: Sabrina Fox

My signature below indicates that I consent to allow members of my organization/facility to participate in this research project on Cognitive Enrichment, Self-Regulation and Aging # 2013s004 by granting the researcher the ability post posters and to contact and test suitable individuals 65 years of age and up. I understand that the project researcher wishes to email potential participants. Her email and contact information will be made available to members of my organization/facility.

I hereby authorize Sabrina Fox, a graduate student of Simon Fraser University, access to individuals within my organization/facility for the purposes of research in her project involving cognitive enrichment. I understand that any members may withdraw from the study at any time and for any reason without any penalty whatsoever.

Name: _____

Organization: _____

Phone: _____

Email: _____

Signature: _____

Date: _____

Appendix F.

Biographical Form

Biographical Information Form **Today's Date: _____**

Instructions: Please answer the following questions providing as much detail as possible.

1. Full Name: _____
2. Email Address: _____
3. Marital status: _____
4. Number of Children: _____
5. Date of birth _____
6. Place of birth _____
7. Highest level of education attained _____
8. Primary places lived _____
9. Current place lived _____
10. Primary career(s) _____
11. Retirement Information

    Answer the questions below which apply to you.

- Are you currently retired? _____
- How many years since you formally retired? _____
- Are you working or volunteering? How many hours per week?

  _____
- What are the primary activities you pursue in your spare time?

  _____

  _____
- What, if any, issues are you preventing you from participating in certain activities?

  _____

  _____

Thank you for your information.

Your biographical data will be kept secure in a locked cabinet at Simon Fraser University.

For the study, you will be given a user identification name and password.

Your user identification and password will be provided to you immediately and sent to your email.

Your user identification is: _____

Your password is: _____

Appendix G.

Self-Regulation Inventory (SRI)

Marques, M.J., Ibanez, M.I., Ruiperez, M.A., Moya, J., & Ortet, G. (2005). Self-Regulation Inventory.

Access to the SRI for this research was facilitated by Generos Ortet, Professor of Psychology and Self-Regulated Inventory (SRI) development team, Castello, Spain.

Instructions: This questionnaire contains 72 statements concerning every-day behaviour. After each statement you are asked to say to what extend your actions and feelings are like those detailed in the statement. Each statement is followed by a string of 6 numbers, either:

NO 1 2 3 4 5 6 YES
Or:
NO 6 5 4 3 2 1 YES

To answer, select the number that best represents your own behaviour. If the statement exactly represents how you behave, or feel, or react, put a circle round the number nearest to the 'YES'. If the statement completely misses your own behaviour, or feelings, or reactions, put a circle round the number nearest to the ' NO'. If you think something in between complete acceptance or rejection is more correct, put a circle round the intermediate number you think appropriate. Three sample questions are provided.

(1) I discuss my personal problems and needs with other people. How frequently?
Very rarely 1 2 3 4 5 6 Very frequently

(2) I get a feeling of well being through the way I act towards myself and towards others.
Very seldom 1 2 3 4 5 6 Very often

(3) I would rather go along with others than make demands for myself.
NO 6 5 4 3 2 1 YES

Appendix H.

Satisfaction with Life Scale (SWLS)

Diener, E., Emmons, R., Larsen, J., & Griffin, S. (1985).

The SWLS is in the public domain. Permission is not needed to use it.

Below are five statements with which you may agree or disagree. Using the 1-7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding. The 7-point scale is as follows:

1 = strongly disagree

2 = disagree

3 = slightly disagree

4 = neither agree nor disagree

5 = slightly agree

6 = agree

7 = strongly agree

__ 1. In most ways my life is close to my ideal.

__ 2. The conditions of my life are excellent.

__ 3. I am satisfied with my life.

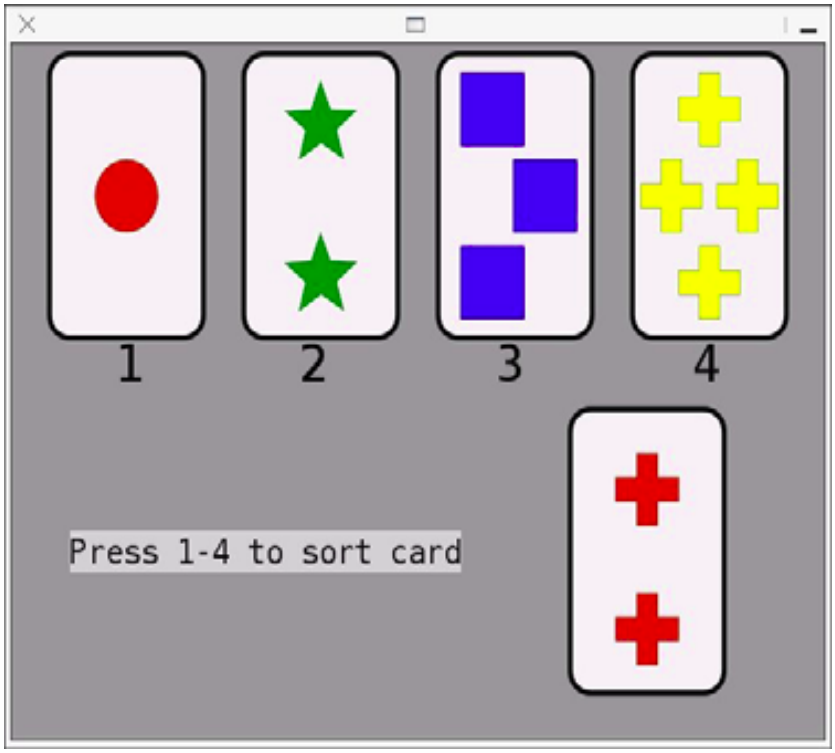
__ 4. So far I have gotten the important things I want in life.

__ 5. If I could live my life over, I would change almost nothing.

Appendix I.

Wisconsin Card Sorting Test (WCST)

The original test used paper cards which had to be sorted into piles in front of four stimulus cards. The computerized version creates a simulation of the same process. The cards can be sorted by the number, colour or shape of the symbols. Psychological Assessment Resources (PAR) provides a digital version of the test.



The illustration shown above presents the four different numbers:1, 2, 3 or 4; the four different shapes: circles, stars, squares or crosses; and the four different colours: red, green, blue or yellow. The two red crosses can be matched by ‘two’ or ‘red’ or‘cross’. Participants will be told if choices are correct or incorrect. This will prompt participants to make the next move. The rule is applied for a run of trials and then changed without warning. The digital version of the WCST also scores participant responses.

Appendix J.

Ospan

Ospan is a word-span test that measures working memory capacity. It is a computerized version of Ospan which was originally designed in 1989 by Turner and Engle. The web-based version, Ospan was developed by Li (2007) under the supervisor of Professor Kinshuk. In Ospan there are 60 words and 60 arithmetic operations (Li, 2007). The arithmetic operations are designed to "activate the processing component of working memory and to prevent the employment of rehearsal strategy on the words" (Li, 2007, p. 10-8). The arithmetic operations are simple as they are meant to be distractors rather than tests of arithmetic skill. Instructions are given to participants to complete each set as quickly and accurately as possible.

A demonstration of an automated version of the Ospan program is available online. It is based on the 2005 version by Unsworth, Heitz, Schrock and Engle at http://www.millisecond.com/download/library/v4/OSPAN/AutomatedOSPAN.web

A screenshot from the site depicting one page of the test is given below: Certain letters flash across the screen. The participant is then asked to remember and type in the correct letters as quickly as possible and press enter. Then the next screen appears.

Select the letters in the order presented. Use the blank button to fill in forgotten items.

F	H	J
K	L	N
P	Q	R
S	T	Y

BLANK

QJ

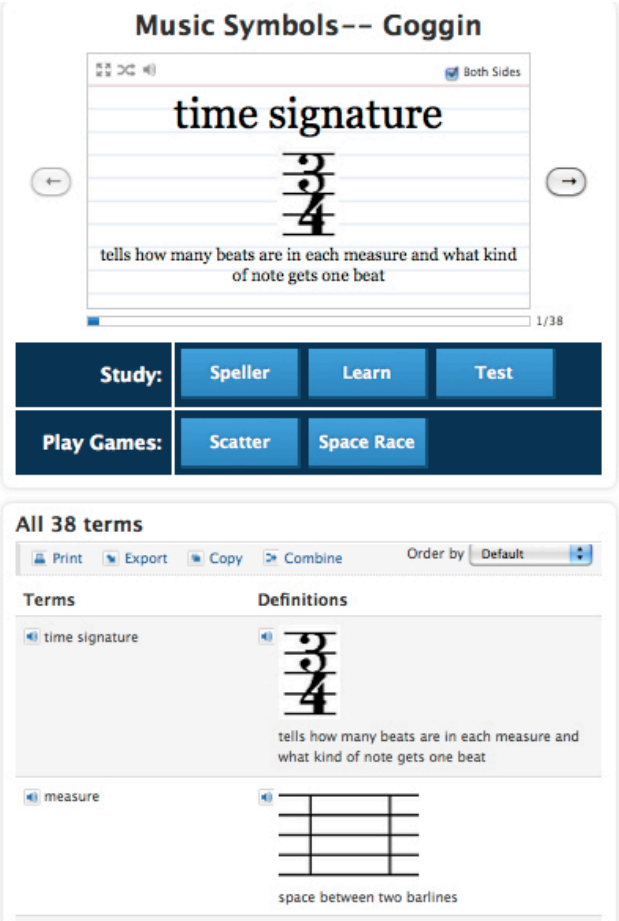
CLEAR EXIT

Appendix K.

Quizlet Information

Quizlet is a vocabulary site that provides lessons in many different areas: English grammar, second language learning, statistics, music and preparation for many standardized tests. For example, there are numerous unique lessons about music. One music lesson offers basic music symbol recognition and explanation (see below). For each lesson, learners may select and utilize a number of different learning strategies: study, speller, learn, test, scatter and space race. Quizlet.com

Quizlet Music Symbol Lesson Example



Appendix L.

Study Tool & Strategy Reflection Form

Instructions: There are 6 study skill choices in Quizlet. You are asked to record which study tools you found the least and most helpful. In addition, provide any comments expressing your feelings or perceptions about the strategies you selected and the reasons you chose these. Of particular interest is if you selected certain strategies to begin your lesson but shifted to others. Explain which strategies you selected, found useful or not useful, and which ones you changed. Provide as much specific information possible. The six strategies are listed below. The site is addressed Quizlet.com

LOG SHEET - Memory and Cognitive Skill Research Study

Researcher: Sabrina Fox -- Email: --

Study Site:

Learning Site Help & Directions: _____

Participant ID Name: _____

Check the study tools you used and liked. Put an X for the study tools that did not work for you. If you sign on more than once a week, add checks or X's to the boxes OR add in a new session number.

If you like, make a comment after each session. If not, make one whenever you wish to.

At the end, please indicate which strategies you preferred overall and why. Also, indicate which study tools you did not find helpful and why. Thank you for your contribution to our understanding of this knowledge!

Session #	Time Spent	Flashcards	Speller	Learn	Test	Scatter	Space Race
Example 01	45 minutes	✓	✓	✓	X	✓	X

Example <u>Comment</u> *Session O1: I found the flashcards to be helpful to learn the words. Then, scatter helped me to practice. Space Race was too fast for me.*

Comments about Study Skills: Which ones were the most helpful? Least? Which ones were not what you expected? Why?

Think of the last time you changed a study tool. Why did you make a change? Was your new strategy choice an improvement? Why or why not?

What other comments do you have about your strategy methods and choices?