Patterns of association in older adult gamers: Demographics, gameplay patterns, and perceived benefits

by

Taylor Rose Gayowsky

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Name:	**Taylor Rose Gayowsky**
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Title:	***Patterns of association in older adult gamers: Demographics, gameplay patterns, and perceived benefits***
Examining Committee:	**Chair:** Carolyn Mamchur, Professor

David Kaufman
Senior Supervisor
Professor

Shawn Bullock
Supervisor
Associate Professor

Allan MacKinnon
Internal/External Examiner
Associate Professor

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Abstract

The over-sixty population is the fastest growing age group worldwide. This rapid growth in the older-adult population requires the need for additional resources to mitigate the effects of aging. Leisure activities have been shown to provide informal learning opportunities that help with various aspects of social and cognitive wellbeing in older adults. A survey asking about gameplay patterns, demographics, and perceived benefits of playing digital games was administered to 590 older adults over the age of 55. Descriptive statistics and non-parametric comparison of means were used to identify associations between variables to find which demographic and gameplay characteristics impacted perceptions of socio-emotional and cognitive benefits. Both perceived socio-emotional and cognitive benefits were associated with a large number of gameplay characteristics, such as time spent playing digital games, people with whom they play digital games, and playing games online. Results provide us with a more nuanced understanding of how older adults play digital games and which factors influence their perceptions of benefits.

Dedication

This one goes out to the ones I love.

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1.0 Introduction

Older adults are the fastest growing population in the world, the number of those over sixty years old expected to grow to more than two-billion by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2013). Canada is no exception to this global trend. Today, approximately 3 in 10 Canadians are part of the baby boomer generation, those born between 1946 and 1961 (Statistics Canada, 2015). The average life expectancy for Canadian women was 86 years old and 84.6 years old for men in 2014. The average life expectancy in 2014 for Canadian women was 86 years old and 84.6 years old for men. These increases in life expectancy will also increase the demand for resources to support the aging process of individuals. The Conference Board of Canada has estimated the aging population will cost the government approximately $3.3 billion dollars in spending in the next year to support the needs of this demographic. This number will total $17.5 billion over the next five years (The Canadian Press, 2015). Although an aging population puts financial strain on public spending, it also provides an opportunity for policy makers to increase the quality of support services for members of this demographic to ensure they maintain their autonomy in various aspects of their lives for as long as possible (Carstairs & Keon, 2009). Innovative and low-cost solutions to aging challenges are more important now than ever.

Discussions surrounding the challenges of aging successfully have been of interest in the research community since the 1990's, when the oldest of the baby boomer generation reached middle-age. The earliest piece of research discussing what it means for someone to age well was developed by Rowe and Kahn (1997) in their paper Successful Aging. They defined successful aging as having "low probability of disease and disease-related disability, high cognitive and physical functional capacity, and active engagement with life" (p.433). Each of these three components were seen as being interrelated with one another, and all three need to be present in order to fulfill the definition of successful aging. Since the release of this paper, researchers have

continually critiqued the true value of this model and have proposed alternatives, such as including spirituality as a fourth dimension (Crowther, Parker, Achenbaum, Larimore, & Koenig, 2002) or reconsidering the entire aging process as an ongoing process instead of a static stage in life (Stowe & Cooney, 2015). Despite this focus on attempting to define what it means to age well, the research community still has no agreed upon definition and this concept remains a subjective interpretation.

Social isolation and cognitive decline are two negative effects to the aging process and have consistently been identified by older adults as some of their main concerns in the aging process (Duay & Bryan, 2006; Reichstadt, Sengupta, Depp, & Palinkas, 2010; Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007; Tate, Swift, & Bayomi, 2013; Laditka, et al., 2009; von Faber, et al., 2001). Feelings of loneliness in older adults are related to a number of lifestyle factors associated with the aging process, such as spouses dying (Dykstra & de Jong Gierveld, 2004) and declines in physical health (Buchman, et al., 2010; Rosso, Taylor, Tabb, & Michael, 2013) as well as demographic characteristics such as non-married status, older age, gender (females experiencing more loneliness than males), and living in a nursing home (Cohen-Mansfield, Hazan, Lerman, & Shalom, 2016). Cognitive decline in older adults is complicated, as certain cognitive functions have been shown to decline over time, while others remain relatively stable. Crystalized cognitive abilities have been found to be relatively stable throughout the lifespan, while fluid abilities show more decline (Kramer, Bherer, Colcombe, Dong, & Greenough, 2004). However there is some evidence showing age-related decline in crystalized abilities as well (Ghisletta, Rabbit, Lunn, & Lindenberger, 2012).

In addition to the complexity of social well-being and cognitive functioning in older adults, research has found these two dimensions to be associated with one another. Studies have not yet uncovered the directional influence, with research implying social well-being having an influence of cognitive functioning and vice versa (Gerstorf, Lovden, Rocke, Smith, & Lindenberger, 2007; Boyle, Buchman, & Bennett, 2010). Because of the inter-related nature of social and cognitive functioning, solutions to aid in the aging process should focus on both of these dimensions of wellbeing. One area that is gaining popularity amongst researchers is providing opportunities for learning and education throughout life. Providing older adults with the opportunity to learn, either formally through courses and programs, or informally through leisure activities and social events,

has been found to increase mental functioning, improve feelings of social connectedness, increase life satisfaction, and develop self-concept (Dench & Regan, 2000; Hammond, 2002; Field, 2009). Education and learning has also been found to be positively correlated with improved overall health and an increase in life expectancy (Hammond, 2002). Learning through leisure activities or informal environments has been a popular area of research for developmental psychologists focusing on children for decades, most notably through the various works of Vygotsky (1978) and Piaget (1955). However, this same attitude is not as widely accepted in older adult populations and researchers are trying to draw more attention to the value of informal learning in leisure settings (Golding, Brown, & Foley, 2009).

The Canadian Government has been proactive in its dedication to improving the care and resources available to older adults. The Action for Seniors Report (2014) identified six key areas in helping older adults maintain a high quality of life; “Ensuring financial security for seniors, enabling active participation in the labour force and the community, helping seniors to age in place, healthy and active aging, combatting elder abuse, ensuring seniors have access to information, services and benefits” (Government of Canada, 2014). As a way to accomplish these goals, the government has provided support to many initiatives across the country, including funding to the Technology Evaluation in the Elderly Network at Queens University and the recently funded AGE-WELL National Centre of Excellence, both which investigate the best available technological solutions to common aging problems. Technological solutions for older adults also provide them with the opportunity to learn how to use these various tools in a way relevant to them. It keeps them connected with the modern world and gives them meaningful context to learn (Zickuhr & Madden, 2012).

There are a number of different technologies available today developed specifically for older adult populations, such as fall detectors and applications to manage their medications. In addition to these specialized technologies, older adults are growing more technologically savvy and integrating commonplace technologies into their daily lives, such as the internet (Zickuhr & Madden, 2012) and information communication technologies (Vroman, Arthanat, & Lysack, 2015). Older adults have previously been stereotyped as being stuck in their ways and slow to adopt. However, this does not mean they are unwilling to learn how to use new technologies if they are able to perceive the technology to have more benefits than negatives. (Heinz, et al., 2013; Mitzner, et al.,

2010; Shapira, Barak, & Gal, 2007). As a response to the increase of technological adoption among older adults, researchers have also begun to evaluate the potential benefits these technologies may be having on the users. This is an important area of investigation since it looks at how accessible resources are contributing to the process of successful aging. Solutions that may come from these commonplace tools will reduce the cost of developing or investing in specialized technology.

Research in older adults' use of the internet is the most common form of technology evaluated in the context of this demographic. Older adults have reported using the internet to have a positive impact on their feelings of social belongingness, social connectivity, and self-esteem (Zheng, Spears, Luptak, & Wilby, 2015; Zhang & Kaufman, 2015). Using technology as a tool for communicating with others has also been found to have benefits for older adults' feelings of social connectedness and growing social networks (Chen & Schulz, 2016). Older adults have also been found to create their own social dynamics, different from younger users, that meet their social needs in online settings such as online discussion forums (Nimrod, 2011).The internet and communication technologies show promise in helping older adults maintain their social engagement as they get older.

Older adults' engagement with new technology spans beyond their internet usage. Researchers have identified older adults as prominent digital game players and have been evaluating the benefits they receive from engaging in digital games as a leisure activity. The number of older adults who play digital games increased from 9% in 1990 (Entertainment Software Association, 2007) to 34% in 2014 (Entertainment Software Association of Canada, 2014). As younger generations who grew up with digital games grow older, this number is expected to increase. Research in this area is in its early stages but studies are uncovering evidence to support various benefits associated with playing digital games (Kaufman, Sauve, Renaud, Sixsmith, & Mortenson, 2016).

Early research into the benefits of digital games focused on the cognitive benefits of arcade-style games such as Pong and Pac Man. Studies showed participants improved on tests of reaction time and processing speeds after playing arcade games (Goldstein, et al., 1997; Dustman, Emmerson, Seinhous, Shearer, & Dustman, 1992; Clark, Lanphear, & Riddick, 1987; Weisman, 1983). These findings are not surprising as

early games consisted of repeating the same task or motion. More recent research has found digital games to have the potential to improve task switching, working memory, visual short-term memory, and reasoning (Basak, Boot, Voss, & Kramer, 2008; Belchior, et al., 2013). In addition to improved performance on cognitive tasks, older adults frequently cite perceived cognitive stimulation as a motivating factor to playing digital games (De Schutter & Malliet, 2014; Delwiche & Henderson, 2013; De Schutter & Brown, 2016; Pearce, 2008).

Research investigating the impact of active games on older adults' social and cognitive well-being are yielding promising results. Studies have found games such as Wii Bowling can have positive impacts on older adults' perceptions of social well-being (Wollersheim, et al., 2010), alleviating symptoms of depression (Rosenberg, et al., 2010), mobility (Studenski, et al., 2010), and general cognitive functioning (Rosenberg, et al., 2010). While these findings are exciting, they are found under special circumstances. Researchers set up programs in retirement communities or assisted living facilities, provided the equipment, and trained participants to use the game, as well as created a social environment for the older adults to engage in. Without the support of researchers and other assistants, older adults may have not obtained the same benefit from the digital games or may not have engaged in the technology at all. The lack of resources available to learn new technology has been discussed by older adults as a barrier to learning new tools (Gatto & Tak, 2008; Nap, de Kort, & Ijsselsteijn, 2009; McLaughlin, Gandy, Allaire, & Witlock, 2012). When considering the growing demand for resources to support older adults in the aging process, these highly structured program are important. However low cost, easy to implement solutions are at least as important to consider.

A small but growing body of research is looking outside the laboratory setting and into the daily lives of older adults who are integrating digital games into their lives organically and without organisational support. Early literature has looked at defining the older adult gamer by reporting on the demographic and gameplay characteristics (Pearce, 2008; Allaire, et al., 2013; De Schutter, 2011). Findings vary from study to study in the amount of time they play, what platforms they play on, and what types of games they play. This suggests that older adults are diverse in all of these aspects and different findings may be attributed to sampling biases. Research has begun asking older adults about their perceived benefits to playing digital games. Older adults have

identified cognitive benefits such as improved memory and feeling sharper (Whitbourne, Ellenberg, & Akimoto, 2013), and social benefits such as feeling connected (Delwiche & Henderson, 2013; Allaire, et al., 2013) increased self-esteem (McLaughlin, Gandy, Allaire, & Witlock, 2012; Kaufman, Sauve, Renaud, Sixsmith, & Mortenson, 2016). Leisure activities that facilitate informal learning contain these same benefits as older adults have perceived when playing digital games. With older adults facing more barriers to formal education than younger generations (Larkin, Mullane, & Robinson, 2008), avenues that allow older adults to engage in informal learning should be explored as they are more flexible and accessible (Golding, Brown, & Foley, 2009).

As previously mentioned, certain demographic and lifestyle characteristic are shown to put some at higher risk of social isolation and cognitive decline later in life (Dykstra & de Jong Gierveld, 2004; Buchman, et al., 2010; Rosso, Taylor, Tabb, & Michael, 2013; Cohen-Mansfield, Hazan, Lerman, & Shalom, 2016). In the same way as identifying risk factors in the aging process has helped in the development of programs for certain populations, identifying which factors are associated with how older adults perceive the benefits of digital games can also help when creating interventions. A one-size-fits-all approach may not be the best strategy in looking at ways to leverage digital game technology in helping the older adult population. Being able to identify which of these factors are associated with one another can help in the development of successful interventions in different situations. Educational technologists can use this information to guide the development of new technologies and programs. In developing interventions to facilitate the challenges in the aging process, focus on the affordances of digital games can be tailored to suit the individual needs of the target population.

1.1 Purpose

The purpose of the present study is to identify associations between the demographic characteristics, the gameplay pattern characteristics, and the perceived socio-emotional and cognitive benefits of older adult gamers. Research in the area of older adults and their digital game playing characteristics is descriptive and looks at characteristics in isolation of one another, or at most in comparison with two or three other variables. Considering a larger set of digital play aspects will help gain a more thorough understanding of the unique sub-groups contained within the larger population

of older adult gamers. Additionally, considering the perceived socio-emotional and cognitive benefits of digital games within these unique groups will help in identifying the reciprocal associations of gameplay characteristics and outcomes. This will be important in helping to guide future research to target more specific problems and challenges within this demographic. Additionally, professionals looking to develop interventions to facilitate the challenges of the aging process will also benefit from this information.

1.2 Research Questions

1. What are the demographic characteristics of older adults who play digital games?
2. What are the gameplay patterns of older adults? What kinds of games are they playing, with whom are they playing, and how often are they playing?
3. Is there an association between demographic characteristics and gameplay patterns of older adults who play digital games?
4. Is there an association between demographic characteristics of older adults and their perceived benefits of playing digital games?
5. Is there an association between gameplay patterns of older adults and their perceived benefits of playing digital games?

2.0 Literature Review

2.1 Aging Population

The older adult demographic is the fastest growing population in the world. There are currently 841 million people over the age of 60 in the world's population today, and this number is expected to grow to over two-billion by 2050. This will mark the first time in history the older adult population will outnumber the children population. This rapid increase in the aging population is due to longer life expectancy and lower fertility rates in the developed world. (United Nations, Department of Economic and Social Affairs, Population Division, 2013). The Baby Boomer generation in Canada consists of anyone born between the years 1946 to 1961, which constitutes a total of 3 in 10 Canadians. Today, Baby Boomers are between the ages of 55 and 71 and because of their large numbers, are quickly increasing the average age in the country (Statistics Canada, 2015). The changing needs of an aging population provide challenges and opportunities for policy makers to improve and develop social supports and services available to these individuals. The Canadian government has identified the importance of ensuring older adults have access to resources to maintain their financial autonomy, have access to resources to manage their personal health, and are provided with quality home and ongoing care services (Carstairs & Keon, 2009). In addition to the actions government bodies will need to pursue in order to develop the best resources possible, individuals enduring the aging process will need to address challenges themselves.

2.2 Aging Well

There is a large body of research surrounding the question, what does it mean to age well? One widely regarded theory, established by Rowe and Khan (1997), defines aging well as being free or mostly free of disease, cognitively and physically active, and socially active in their environments. They consider these three components to be related with one another and all three must be accomplished to fulfill their definition of

successful aging. However, these criteria are not comprehensive and the model has come under criticism. Some researchers have attempted to widen the model's scope to include aspects of spirituality (Crowther, Parker, Achenbaum, Larimore, & Koenig, 2002), and others have reconsidered the model to represent aging as more dynamic and see it as an ongoing process instead of a static stage of life (Stowe & Cooney, 2015; Nimrod & Ben-Shem, 2015). Despite the abundant research in this area, there is still no universal definition for what it means for someone to age well.

To gain more insight into the question of aging well, researchers have aimed to understand the process through self-reported data collected by individuals experiencing process (Laditka, et al., 2009; Strawbridge, Wallhagen, & Cohen, 2002; Reichstadt, Sengupta, Depp, & Palinkas, 2010; Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007; Tate, Swift, & Bayomi, 2013; von Faber, et al., 2001; Duay & Bryan, 2006). In the current situation where it has been difficult to identify universality, it is important to widen the scope of investigation to further understanding of challenges of aging. By consulting the demographic under question to help define the concept of aging well, this offers a comparison point for researcher-derived paradigms. It could provide guidance to researchers in formulating their own definitions and criteria for aging well. It may also help the public gain a better understanding of what seniors themselves consider to be important in the aging process, and serve as a guide to policy makers for developing various care initiatives (Phelan, Anderson, LaCroix, & Larson, 2004).

Qualitative research centring around having older adults define what successful aging means to them, asks questions such as How would you define successful aging? and what are the necessary components of successful aging? (Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007; Reichstadt, Sengupta, Depp, & Palinkas, 2010; Tate, Swift, & Bayomi, 2013) "what is most important to you in your life right now", and "what do you think it means to age unsuccessfully" (Duay & Bryan, 2006). Out of all participant responses across studies, between three and twenty-one themes were identified as areas participants considered factors to aging well. The most common themes pertaining to aging well are social engagement (Duay & Bryan, 2006; Reichstadt, Sengupta, Depp, & Palinkas, 2010; Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007; Tate, Swift, & Bayomi, 2013; Laditka, et al., 2009; von Faber, et al., 2001) adaption/openness to change (Duay & Bryan, 2006; Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007; Tate, Swift, & Bayomi, 2013; von Faber, et al., 2001), cognitive health (Laditka, et al., 2009;

Duay & Bryan, 2006), and physical health (Laditka, et al., 2009; Duay & Bryan, 2006; Reichstadt, Depp, Palinkas, Folsom, & Jeste, 2007).

2.2.1 Social and Emotional Challenges of Aging

As previously mentioned, social engagement is an important facet in the process of successful aging. One way researchers measure social engagement is in the context of social isolation and loneliness. Loneliness is a subjective personal account of the quality of social engagement, and social isolation is a quantifiable construct (Petersen, et al., 2015). The increased risk of experiencing loneliness with age is caused by various factors such as spouses dying (Dykstra & de Jong Gierveld, 2004) and decline in physical health (Buchman, et al., 2010; Rosso, Taylor, Tabb, & Michael, 2013) In a review of over 38 articles investigating aging and loneliness, a number of socio-demographic factors were found to be correlated with increased feelings of loneliness, such as non-married status, older age, gender (females experiencing more loneliness than males), and living in a nursing home (Cohen-Mansfield, Hazan, Lerman, & Shalom, 2016). Loneliness and social isolation are multifaceted, complex and able to manifest itself in a number of different ways. These are detrimental to the well-being of older adults and can negatively impact physical and mental health of older adults in areas such as sleep quality (Hawkley, Preacher, & Cacioppo, 2010), mobility (Buchman, et al., 2010; Rosso, Taylor, Tabb, & Michael, 2013), morbidity and mortality (Cacioppo & Hawkley, 2003), depression (Heikkinen & Kauppinen, 2004), and cognitive decline (Taylor, Repetti, & Seeman, 1997; Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004).

The size of social networks is one of many ways researchers look to further understand loneliness in older adults. Recent decades have seen a shift in the size of social support that individuals, across all ages, receive from friends, family and especially community. Older adults have the smallest number of social support systems of any other age group today (McPherson, Smith-Lovin, & Brashears, 2006). Although these diminishing support circles may seem alarming at first, researchers have found that social networks are more complex than strictly the size of the network. Factors such as quality of support received by individuals (Fiori, Antonucci, & Cortina, 2006; Stephens, Alpass, Towers, & Stevenson, 2011), family structure (Fuller-Iglesias,

Webster, & Antonucci, 2015), and type of social network (Stephens, Alpass, Towers, & Stevenson, 2011; Fiori, Antonucci, & Cortina, 2006) may be more valuable when considering measures of social isolation. Understanding how social interactions influence perceptions of loneliness in older adults is complex and not fully understood. However, most studies seem to emphasize the importance of a diverse circle of support, including friends and family, to contribute for the most fulfilling social circles.

Fiori et al. (2006) found symptoms of depression were highest in older adults over the age of 60 with non-friend networks, social networks defined by low contact with friends, low involvement in religious services, and low attendance in social meetings. Symptoms of depression were lowest for those with diverse networks, defined by high attendance in religious services, high meeting attendance, and above sample average contact with friends, and contact with children. They also found those in non-friend networks had higher levels of depression symptomology than those with non-family networks, networks defined by low marriage rates, few children, and low contact with children. This implies that networks containing mainly friends might be more beneficial than networks containing mainly family. Previous research has also found this to be true and attributed the pattern to the autonomy associated with friendships, versus the obligatory nature of families (Antonucci & Akiyama, 1987). Fuller-Iglesias et al. (2015) looked specifically at the nuances within familial support throughout the lifespan. Depressive symptoms were found to decrease for older adults who had a larger number of family members in their support network, but only if family negativity was low. Without considering the quality of familial relationships, depressive symptoms were found to increase with more familial relationships in the network. This study helps emphasize the earlier discussion point that size of social circle is not the only determining factor in the quality of social engagement, and quality and type of the relationships are also important factors to consider.

2.2.2 Cognitive Challenges of Aging

The decline of cognitive abilities with age has been extensively researched for decades. Some cognitive abilities have been found to remain relatively stable over time, such as verbal ability (Park, et al., 2002; Hultsch, Hertzog, Dixon, & Small, 1999; Schaie, 1996; Verhaegen, Steitz, Sliwinski, & Cerella, 2003) and numerical ability (Schaie, 1996;

Park & Reuter-Lorenz, 2009), while other abilities such as processing speed (Park, et al., 2002; Hultsch, Hertzog, Dixon, & Small, 1999; Schaie, 1996; Ball, Beard, Roenker, Miller, & Griggs, 1988), working memory (Park, et al., 2002; Hultsch, Hertzog, Dixon, & Small, 1999; Bopp & Verhaegen, 2005), spatial reasoning, and mental rotation (Schaie, 1996) are found to decline with age. Those abilities that are found to decline are considered fluid mental abilities, abilities that help in problem solving and are important in carrying out everyday activities. Conversely, crystalized abilities, those associated with more knowledge-based processes, have been found to be more stable across ones lifespan (Kramer, Bherer, Colcombe, Dong, & Greenough, 2004). Severe decline in fluid cognitive abilities can have an impact in the quality of life (Deary, et al., 2009). With cognitive engagement being an important factor to older adults in the process of aging well, it is important to find ways to mitigate these declines. However, contrary to these commonly held beliefs about fluid and crystalized abilities, in a 20-year longitudinal study of over 6203 adults, Ghisletta and colleagues (2015) found cognitive decline in crystalized abilities, previously thought to be resilient to aging. Cognitive decline was found in areas of fluid intelligence, vocabulary, memory (episodic, visuo-spatial, semantic), and perceptual speed. (Ghisletta, Rabbit, Lunn, & Lindenberger, 2012).

2.2.3 Association Between Social Well-Being and Cognitive Functioning

Cognitive functioning and social well-being do not exist in isolation and have been theorized to be reciprocally associated (Lawton, 1983). There is still controversy as to whether cognitive decline impacts social well-being (Gerstorf, Lovden, Rocke, Smith, & Lindenberger, 2007) or vice versa (Boyle, Buchman, & Bennett, 2010). The complexity of this association may be, in part, due to the complex nature of cognitive function and well-being. Each of these overarching areas contain a number of specific functions and facets, some of which may be dependent on one another (Wilson, et al., 2013). For example, James et al. (2011) conducted a study of 1138 older adults and measured their cognitive decline and engagement in social activities over the course of 12 years. They found increases in social activity were associated to slower decreases in cognitive decline. However, this does not provide enough evidence to identify whether the cognitive decline was caused by the lack of social engagement or vice versa. Wilson et al. (2013) also conducted a large-scale study on 1049 participants over the course of 5 years. They found rapid cognitive decline was associated with various measures of well-

being. With this complicated association not yet identified, when considering ways to improve the social well-being of older adults, it is important to also consider ways to improve cognitive well-being.

2.2.4 Education and Learning for Aging Well

With the social, emotional, and cognitive challenges of aging being complex and interrelated, it is important to look at ways to engage older adults in activities that will improve both of these aspects of well-being. Researchers have been able to identify activities and characteristics that contribute to social and cognitive well-being in older adults. Examples include having a sense of purpose in life (Windsor, Curtis, & Luszcz, 2015), engaging in leisure activities (Menec, 2003; Hutchinson & Nimrod, 2012), maintaining an intellectually stimulating lifestyle (Hertzog, Kramer, Wilson, & Lindenberger, 2008), and pursuing educational and learning opportunities (Field, 2009).

Education and continued learning are considered an important part of aging well (Moody, 2004). Education can take place in formal, non-formal, and informal settings. Formal education takes place in structured environments, such as in educational institutions, where the purpose is to learn knowledge and how to apply it in new settings. There is a mandatory aspect of formal learning with usually requires students to attend lectures or obtain a certain level of proficiency in order to be recognized. Non-formal learning gives the learner more choice in how they obtain knowledge. This could take the form of workshops, self-directed learning resources, and additional courses. Informal learning is not confined to a specific setting and learning objectives are not clearly identified. The boundaries of what constitutes a specific type of learning are not clear cut and certain situations and activities can contain any combination of formal, informal, or non-formal components (Callanan, Cervanters, & Loomis, 2011)

Formal education for older adults, such as certifications, degrees, diplomas, and coursework, is of interest to many policy makers who see the importance of making learning accessible throughout the life-course (World Health Organization (WHO), 2002). Motivations for pursuing education are different for older adults than for younger adults. Older adults less frequently enroll in full-time degrees or diplomas and typically enroll in coursework to improve their skills from a professional perspective (DiSilvestro, 2013). While policy and government agencies are working toward providing formal education,

researchers and organisations should also consider the importance of informal learning. The advantage to informal learning over formal learning is the flexibility. Learning is not confined to specific schedules and lectures, rather it takes place in day-to-day life. Developmental psychologists have investigated the impact of play and exploration on learning in children for decades (Vygotsky, 1978; Piaget, 1955). In the past fifteen years, researchers have applied this same theory to older adult populations by investigating the impact of leisure activities on well-being. They have found overwhelming support for recreational activities promoting learning and improving social and cognitive aspects of well-being (Dench & Regan, 2000; MacKean & Abbot-Chapman, 2011; Falk & Storksdieck, 2010; Merriam & Kee, 2014). Recent literature has even implied leisure activities may be more beneficial than formal education in improving perceptions of social well-being (Jenkins & Mostafa, 2015).

One of the first studies in the area by Dench and Regan (2000) found older adults perceived learning as having improved their enjoyment in life, life satisfaction, and sense of self concept. MacKean and Abbot (2011) found similar findings in their survey of older, who also stated leisure activities as having a positive impact on their feelings of social connectedness, autonomy, and community involvement. Older adults also perceive cognitive benefits to leisure activities. Falk and Storksdieck (2007) found individuals who visited a science centre for fun had learned new material and felt cognitively engaged. In addition to these perceptions of the benefits of education, there is empirical evidence to support education is positively related to longer lifespan and better overall health (Hammond, 2002). Education and continued learning for older adults has been found to have a number of positive benefits community as a whole. Merriam and Kee (2014) argued that learning, whether formal or information, contributes to the well-being of a community since it enables older adults to give back and remain engaged with the initiatives around them

Although the benefits of learning and education for older adults are well researched, they also face a unique set of challenges when trying to access formal educational resources. These barriers include ageism within educational institutions (Cody-Connor, 2015), limited access to transportation (Cody-Connor, 2015; Purdie & Boulton-Lewis, 2003), disability and health complications (Cody-Connor, 2015; Purdie & Boulton-Lewis, 2003) restricted finances (Cody-Connor, 2015), and lack of knowledge with the relevant technology to access resources (Cody-Connor, 2015; Timmermann,

1998). Informal education provides an opportunity to overcome these barriers in that opportunities for learning are more diverse in informal settings.

2.3 Older Adults in the Digital Age

Older adults are using technology to accomplish a variety of tasks in their daily lives to day lives such as communication, health and medical research, entertainment, news, and personal banking. (McMurtrey, Zeltmann, Downey, & McGaughey, 2011). Research overwhelmingly rejects the stereotype that older adults are stuck in their ways and unwilling to learn new tools. Integration of a new technology is largely driven by an individual's perception of how it will benefit them day-to-day. If older adults are able to see that the positives outweigh the negatives, they are willing to learn and adopt the new technology (Heinz, et al., 2013; Mitzner, et al., 2010). There is a strong body of qualitative research that asks older adults to express why they do and do not use certain technologies. These types of studies have been beneficial in not only understanding factors that increase usage, but also in understanding the barriers this demographic faces in learning new technology.

Mitzner et al. (2010) found older adults had positive attitudes toward technology when technology had the ability to make tasks more convenient (i.e., word processors to speed up writing), support everyday activities (i.e., communication via email or phone to stay in touch), or carry out multiple functions (i.e., televisions ability to watch shows and record programs). Heinz et al (2013) had older adults openly discuss their opinions of technology and found technology was used when it was found to be easy to use, had the ability to provide entertainment, and assisted them in self-monitoring. Additionally, Gatto and Tak (2008) found older adults had positive attitudes toward technologies when the technologies provided them with a sense of connectedness, satisfaction, utility, and a positive learning experience. Conversely, negative attitudes toward technology arose when older adults felt there were usability limitations and frustrations, inconvenience and time barriers, and concerns about security and reliability (Heinz, et al., 2013; Mitzner, et al., 2010; Gatto & Tak, 2008). Older adults are able to reflect on their experiences with new technology. These self-reflections are valuable in helping to understand how technology is adopted within this demographic. It provides an understanding on how to best develop and implement technology based-solutions for this aging population.

2.3.1 Internet and Older Adults

When considering older adults in the context of an aging society, it is also important to consider how they are integrating every-day technology into their daily lives. A study by Shapria and colleagues (2007) found training older adults in how to use a personal computer and the internet, specifically email, web browsing, participating in forums and virtual communities, improved older adults' life satisfaction, self-control, and reduced feelings of depression and loneliness. Researchers speculated these feelings came from gaining a sense of autonomy and empowerment and improved ability to communicate with loved ones. The benefits and usage of the internet is one of the more researched areas with regard to older adults and technology, largely due to the number of capabilities afforded by the internet.

In 2005, 63.7% of all Canadians were using the Internet in their home and this number quickly grew to 75.1% by 2009 (Statistics Canada, 2010) As of 2014, over 86.6% of Canadians were connected to the internet (Canadian Internet Registration Authority, 2014). Although younger generations are the largest internet users (82.9% of Canadians under the age of 34 use the internet), 69.1% of Canadians between the ages of 55 – 64 and 65.9% of those over the age of 65 reported using the internet at least once a day (Statistics Canada, 2010). The internet is a very diverse tool, capable of accomplishing a variety of tasks. The most common activities for which Canadians use the internet for are email (93%), general browsing (77%), checking the weather (74.6%), general research (72.7%), health-related research (69.9%), and following the news and/or sports (67.7%). Other popular uses for the internet are playing video games, obtaining an education, planning travel, and paying bills/personal banking (Statistics Canada, 2010). Older adults are no different than the rest of the population in the diversity of their internet usage. For example, Wagner and colleagues (2010) found, through meta-analyses, the most common internet activities in older adults are communication and social support, leisure and entertainment, health research, and education Similarly, Zheng et al. (2015) found older adults commonly use the internet for social connectedness, self-efficacy, financial research, and health research. Knowing that older adults are active internet users, researchers can target their specific activities to understand why and how they are engaging in specific areas. They can also look for ways to carry these motivators to other internet based activities that may provide benefits. For example, Zhang and Kaufman (2015) further investigated how older adults'

social activities over the internet may be beneficial to their well-being and found these activities to be positively associated with belongingness, and self-esteem, as well as being negatively associated to feelings of loneliness.

2.3.2 Information Communication Technologies & Social Networks

To gain a better understanding of how older adults are using technology to develop social connections, we can turn to the available literature of older adults' interactions with information and communication technologies (ICT). Vroman and colleagues (2015) found older adults over the age of 65 were engaging in ICT to mitigate some of the previously discussed social and emotional challenges of aging. Some examples are using ICT to stay in touch with family members and friends, and engaging in activities that bring them enjoyment (i.e. playing games).

A meta-analysis of 30 studies by Chen and Schulz (2016), investigated the social benefits of ICT interventions in older adult populations. They found ICTs may reduce feelings of social isolation by allowing older adults to feel connected, gain social support, provide them with an opportunity to engage in activities of interest, and boost their self-confidence. However, these results were not obtained in naturally-occurring settings. Results were derived from laboratory experiments where older adults were provided with training and support to learn and utilize the technologies. These resources may not be available to older adults in everyday life. Studies also reported high levels of participant dropout, suggesting ICTs may not be for everyone, and each individual has different motivators influencing which platforms will work best for them. (Chen & Schulz, 2016). Findings of this meta-analysis do provide evidence that under the right circumstances, older adult populations are able to integrate modern technologies into their lives in order to mitigate some of the social challenges that come with aging. A specific classification of ICT are social networks. As previously mentioned, social networks occur in everyone's face-to-face lives (Stephens, Alpass, Towers, & Stevenson, 2011; Fiori, Antonucci, & Cortina, 2006) and have a significant impact on how older adults perceive their social and emotional quality. With the internet has come the digitization of these in person social networks. Examples of these include Facebook, Twitter, and Instagram. These platforms provide an interesting opportunity to understand communication methods in a digital age.

As previously discussed, older adults face many challenges in maintaining social connectivity in their everyday lives due to a variety of factors such as decline in physical health and fewer opportunity to develop new relationships (Fiori, Antonucci, & Cortina, 2006). Social networks allow for individuals to communicate with each other across the world from portable devices such as mobile phones and laptops. Understanding the potential benefits of social networks for older adults, online communities have been developed and targeted specifically for this demographic (i.e., www.buzz50.com and www.seniorforums.com). Research in this area is still in its early stages and studies are mostly descriptive in nature. For example, Nimrod (2011) found older adults who engage in online senior's communities used them mainly to interact in digital games with one another or to discuss varying topics (i.e., grand-parenting and politics). An extensive literature survey by Coelho & Duarte (2016) looked at over 38 papers investigating older adults' behaviours on social networking sites. They found the most common motivator for older adults in adopting the use of a social networking site was to stay connected with family and make new social connections.

2.3.3 Leisure in the Digital Age

Technology has brought about new avenues for engaging in leisure activities and older adults are conforming to this trend. Research so far has not shown that activity in digital leisure activities is less beneficial than non-digital pursuits, as long as older adults feel engaged and socially stimulated in what they are doing (Lee & Payne, 2015). As previously mentioned, older adults are actively using the internet in their daily lives for both practical and leisure purposes in the form of research, communication, and gaming (Statistics Canada, 2010). A survey by Heo et al. (2011) found older adults found those who actively use the internet as part of their daily lives see it as a source of leisure that contributes to their well-being. They found older adults perceived their well-being on a number of dimensions including social connectedness and educational stimulation. In addition to the use of the internet and ICT for leisure, studies have also found older adults are actively engaging in digital games in their spare time (Heinz, et al., 2013; Mitzner, et al., 2010; Wagner, Hassanein, & Head, 2010; Nimrod, 2011, Pearce, 2008).

2.4 Digital Games and Older Adults

The study of older adults and their interactions with digital games is not a new field and has been investigated since the early 1990's. However, within the context of aging populations and digital games, research has primarily focused on how to design digital games specifically for older adults from a usability perspective to make games more accessible (Marston, 2013; Vasconcelos, Silva, Caseiro, Nunes, & Teixeira, 2012; Al Mahmud, Mubin, Shahid, & Martens, 2010; IJsselsteijn, Nap, de Kort, & Poels, 2007). While this is a valuable area of research for companies looking to develop games specifically for a senior audience, or researchers looking to develop a game to train a specific cognitive skills, it is outside of the scope of this study that aims to look at how older adults are engaging with commercially available digital games as a form of leisure activity.

The number of older adults engaging in digital games is rapidly increasing. In 1990 only 9% of adults over the age of 50 reported playing digital games (Entertainment Software Association, 2007). This number grew in 2014 to 34% of Canadians over the age of 55 reporting playing a digital game in the past 4 weeks (Entertainment Software Association of Canada, 2014). Of those who do play, 32% reported playing digital games every day (Entertainment Software Association of Canada, 2012). Research into the impact of digital games in younger populations has garnered attention for decades because of the prevalence of this activity in their daily lives. With the increase in popularity of digital games in older adult populations, there is cause for investigating how this form of leisure activity may also be benefiting this older generation.

2.4.1 Types of Digital Games

Different generations favour different game genres. Children between the ages of 6-12 years favour role-playing games and adventure games. Teens between the ages of 13-17 years play mostly arcade and shooter games, and adults between the ages of 18-35 play mostly shooter, role-playing, and educational/word/puzzle games (Entertainment Software Association of Canada, 2014). Older adults most frequently play digital games in the word, puzzle, and card genres (Pearce, 2008; Entertainment Software Association of Canada, 2014; De Schutter, 2011; Allaire, et al., 2013; Nap, de Kort, & Ijsselsteijn, 2009), while tending to dislike fighting, shooting, and sports games (De Schutter, 2011;

Pearce, 2008). McKay and Maki (2010) found support for older adults disliking shooter games. Older adults' favourability toward word, puzzle and card games makes sense as non-digital games older adults play (i.e. solitaire, bridge, mah-jong) are being converted into digital games, enabling them to play traditional games in new environments.

2.4.2 Role-Playing and Massive Multiplayer Online Games

Role-playing games (RPGs) have the player engage in the game from the perspective of a fictional character or role. RPGs are typically single-player or small multiplayer (i.e., groups of 4). Massive multiplayer online games (MMOPG) are similar to role-playing games in that player assumes the role of a character, but are played online with large numbers of other players. There are elements of cooperation, competition, and person-to-person interaction. Both RPGs and MMOPGs have a storyline or strong narrative for the player to follow. Research has shown older adults do not engage heavily in RPG and MMOPGs. For example, De Schutter (2011) found older adults seldom or never played these types of games and Lenhart, Jones and MacGill (2008) reported only 9% of adults over the age of 50 played massive multiplayer online games. In contrast, Pearce (2008) found MMOPGs to be one of the most common genres played by adults over the age of 40. Pearce's anomalous finding might be due, in part, to recruiting methods since participants were acquired through online forums. Although De Schutter and Lenhart et al. may be correct in finding that these game genres are not popular in older adult populations, Pearce's study at least brings to attention the fact that older adults, even if in lower numbers, are still engaging in RPGs and MMOPGs. Delwechie and Henderson furthered these findings when they found over 8% of those who play Wizard101 (an MMOPG) are over the age of 50. These games can be very complex in their gameplay and installation, which may be discouraging for novice game-play users who may not have the resources necessary to assist them in the learning process.

2.4.3 Time Spent Playing Digital Games

Researchers typically make an attempt to quantify the amount of time older adults spend playing digital games. However, results have been shown to vary widely, possibly due to inconsistencies in units of measuring time spent playing games. Pearce (2008) found that of older adults over the age of 40, 8% of played 2-4 hours per week,

17% played 5-9 hours per week, 25% played 10-14 hours per week, 18% played 15-19 hours per week, and 18% played 20-29 hours per week. De Schutter (2008) found older adults over the age of 45 played, on average, 1.45 hours of digital games per day. Allaire et. Al (2013) found 17.1% of older adults between the ages of 63 and 92 played digital games every day, 13.6% played several times a week, 30% played once a week or less, and only 39% had never played digital games. Lenhart, Jones and MacGill (2008) found similar game play frequency in adults over the age of 65, with 36% playing every day, 28% playing a few times per week, 17% playing a few times a month, and the remaining 14% playing less than a few times per month. However, in adults between the ages of 50 and 65, Lenhart et al. (2008) found only 19% played every day, 30% played a few times a week, 25% a few times a month, and the remaining 21% played less often than a few times a month.

There are also age differences in each of the studies. Some research included adults as young as 45 in their samples, while others included only those over the age of 65. With the current data presented by the previous aforementioned studies, there is no conclusive measure of how much time older adults are spending playing digital games. However, some older adults are playing digital games as often as every day, and some are playing more than an hour each day. These general estimates are enough to provide evidence that older adults are indeed integrating digital games into their daily lives to varying degrees. There may also be factors other than age attributing to these inconsistent findings, Delwiche and Henderson found older adults over the age of 50 spent 24.65 hours per week on average playing Wizard 101, a MMOPG. This average seems very high, but Pearce's (2008) findings also provide support for the possibility that game genre plays an impact in time spent playing digital games since her sample consisted of mostly RPG players and 18% of older adults reported between 20-29 hours of game play per week.

2.4.4 Gender Differences

Data has suggested that there are more females playing digital games than males. However, the exact breakdown of this varies and could largely be due to sampling biases instead of actual demographic representation. De Schutter (2011) recruited 124 digital gamers between the ages of 45 and 85 for an online survey

advertised through online communities and found 58% of respondents were women. Pearce (2008) recruited 271 participants for a survey, through online gamer communities targeted at older adult digital gamers between the ages of 38 and 68, and found 57% of respondents were female. Allaire et al (2013) recruited 140 older adult gamers between the ages of 63 and 92 through senior centres, religious communities, and senior living complexes and found 70% of participants were females. Delwiche and Henderson (2013) administered a survey to over 2600 older adults through a specific online game called Wizard101 and found 62% of the players over 50 were female. With the proportion of females ranging from 57% to 70%, and the age cut-off being as low as 38 and as high as 63, these findings are too inconsistent to say there are more-older adult females playing digital games than their male counterparts. In two recent studies conducted by our team, 81% were females in a Wii bowling tournament (Schell & Hausknecht, 2016) and 74% were females in a digital Bingo study (Seah & Kaufman, 2016).

2.4.5 Reasons for Playing Digital Games

Researchers have identified a number of different motivating factors for why older adults play digital games, such as fun and relaxation (Nap, de Kort, & Ijsselsteijn, 2009; De Schutter & Malliet, 2014; De Schutter & Brown, 2016; Pearce, 2008), challenge (Nap, de Kort, & Ijsselsteijn, 2009; De Schutter, 2011; De Schutter & Brown, 2016), passing the time (Nap, de Kort, & Ijsselsteijn, 2009), nostalgia (Nap, de Kort, & Ijsselsteijn, 2009), social enjoyment and connection (Nap, de Kort, & Ijsselsteijn, 2009; De Schutter & Malliet, 2014; Pearce, 2008), positive sense of self (De Schutter & Malliet, 2014; Delwiche & Henderson, 2013; De Schutter & Brown, 2016), and cognitive stimulation (De Schutter & Malliet, 2014; Delwiche & Henderson, 2013; De Schutter & Brown, 2016; De Schutter & Brown; Pearce, 2008). These motivators are quite diverse, but seem to fall into two categories. Social enjoyment and connection and positive sense of self can both be considered social and emotional motivators to playing digital games. Cognitive stimulation and challenge can both be considered cognitive motivators for playing digital games. As previously discussed, remaining cognitive and socially active are two important characteristics to what older adults consider in their definitions of aging well. Motivators for playing digital games appear to share similarities with older adult's perspectives of experiencing the process of aging successfully. De Schutter and

Brown (2016) found evidence for this when they observed 75 older adults play digital games and had them think aloud as they played various digital games. During this session they were asked to speak about what digital games meant to them in their daily lives. Respondents over the age of 60 tended to speak about how playing digital games were a good use of their time because they felt it had various benefits to their well-being. Younger participants (49-59) were not as homogenous in their expression of playing digital games for productive purposes, they were more likely to express playing games a means to an end. The social and emotional benefits and cognitive benefits of playing digital games will be discussed in further detail.

2.5 Social and Emotional Benefits of Playing Digital Games

As previously mentioned, the aging process brings social and emotional issues to individuals enduring the process. Older adults report higher rates of loneliness in their lives and have decreased social interactions. Digital games provide an opportunity to combat some of the negative side-effects of aging through their advanced features. Digital games can be played in online environments where there are opportunities for older adults to engage in social interactions (i.e., MMOPGs). Game consoles provide multiplayer functionality which allows older adults to play the same game together in the same room (i.e., Wii console games). Finally, some digital games provide a collaborative opportunity to allow people to work together to solve the same problems (i.e., puzzle and strategy games). As previously discussed, we know older adults are engaging in games on as a leisure activity, and the types of games they are engaging in range across a number of genres, from card games to RPG games. Research has associated this organic game playing with a number of social benefits. However, most of this research has been conducted in the context of self-reported measures instead of actual measures.

Allaire et al. (2013) compared older adult gamers and non-gamers on measures of well-being, negative affect and loneliness. Findings showed, occasional (once a month) and regular (once a week or more) older adult gamers had higher scores of well-being and lower scores of negative affect than non-gamer counterparts. In addition, regular gamers reported lower levels of depression than non-gamers. This study is

unique in its design because it investigates older adults playing digital games, and shows promise for the social benefits of older adults who play digital games.

Most studies that have investigated the social and emotional benefits of digital games develop a form of intervention for older adults to engage in and measure aspects of social and emotional well-being before and after the intervention. A pilot study by Rosenber et al. (2010) looked at the impacts of playing Nintendo Wii Sports on older adults who have subsyndromal depression. They found, after 12 weeks of engaging in 35-minute play sessions, participants reported significant improvement in their depression symptoms, quality of life, and global cognitive function. A study by Studenski et al. (2010) found improvements in mental health, balance, and walking time in healthy older adults who played a dance video game for 24 half-hour sessions. Wollersheim et al. (2010) found in a pilot study of older adult women in a community, playing Wii Sports twice weekly improved their perceptions of social and psychological well-being. This is apparent from the previous examples, where intervention games typically are in the form of interactive and social digital games. Wii Bowling and Wii sports is a popular choice amongst researchers because it is already popular in the older adult community, it is easy to teach, and it allows for multiple people to play together (Wollersheim, et al., 2010). Interactive digital games involve physical activity in order to operate the game. For example, the Wii gaming console and Xbox Kinect use hand-held devices coupled with body motions in order to operate the game. Virtual reality and simulations are also considered to be interactive digital games. Commercialized games in this genre include Dance Dance Revolution, Wii Bowling, and Wii Sports. The use of these games is common in research looking at ways to develop programs to promote healthy activity in older adult populations who may be limited in their ability and/or accessibility to stay physically active. The implications of these types of studies in attenuating cognitive and social decline associated with age are well founded and continue to be a popular topic of research in the area of older adults and digital games (Wollersheim, et al., 2010; Rosenberg, et al., 2010; Bleakly, et al., 2015; Studenski, et al., 2010; Harley, Fitzpatrick, Axelrod, White, & McAllister, 2010).

More relevant research in the area of social and emotional benefits of playing digital games is turning to older adults perceptions of these benefits. By actively having older adults express how playing digital games improves their social well-being, we can

understand the benefits they may be receiving by playing digital games in their daily lives.

2.5.1 Perceived Socio-emotional benefits of playing digital games

De Schutter and Malliet (2014) found older adults identify a number of social and emotional motivators for playing digital games. Respondents thought digital games gave them opportunities to fulfill their affective needs such as, allowing them to feel emotions like excitement and suspense, or giving them an opportunity to feel nostalgic. Older adults also identify digital games as allowing them to feel as sense of connectedness, mainly to family relationships. One respondent identified the main reason she began playing digital games was because of her grandchildren's' interest in them, another individual played digital games online because of the social community that existed in this domain. Finally, older adults identified individuality as a benefit they felt they received from playing digital games. Older felt they were able to develop positive self-esteem and autonomy through playing digital games. Another study by De Schutter and Brown (2016) found older adults expressed similar perceived social benefits to playing digital games, with respondents describing them as a way to distract themselves from feeling of loneliness and using them as a means to connect with younger generations.

During observations of older adults engaging in digital games, McLaughlin et al. (2012) reported older adults expressed a number of social and emotional benefits while playing these games. This included expressions of social interaction, increases in self-esteem, positive emotions, and well-being. Nap et al. (2009) held focus groups with ten older adult gamers and engaged in a conversation about their game play habits and opinions on digital games. Participants expressed social benefits to playing digital games, such as providing an opportunity to engage in social connections online and relieve stress. When explicitly asked how they felt about playing digital games with others, their responses were mixed. Some mentioned they preferred to engage in games alone, while others reported using it as a source of entertainment with their significant other or family members. However, these preferences to play digital games alone did not take away from other positive benefits they felt they received from playing digital games.

2.6 Cognitive Benefits of Playing Digital Games

An important factor in maintaining cognitive ability is the active engagement in stimulating activities**.** In older adult populations, physical challenges and lifestyle changes makes the accessing stimulating activities more difficult**.** As previously discussed, older adults are already integrating digital games into their daily lives. Due to the accessibility, affordability, and variety in the types of digital games available for common purchase, this form of leisure activity is worth investigating in detail to see if older adults are able to maintain the cognitive stimulation required to offset age-related decline by playing digital games. Present literature investigating the cognitive benefits of digital games for older adults can be divided into two areas. The first looks at what cognitive benefits existing digital games may have, and the second focuses on how to develop digital games to train desired cognitive abilities. Both of these areas are important in understanding how digital games can best be used to mitigate age-related cognitive decline.

Looking at digital games designed for the purpose of developing cognitive abilities is valuable in helping us understand certain digital mechanisms that may promote the gain of certain cognitive abilities. An early example of this type of game is the Colorado Neuropsychology Test (CNT) (Davis, Bajszar, & Squire, 1994) which consisted of a series of cognitive tasks in a single software program. Rasmusson et al. (1999) and Rebok et al. (1996) found individuals who engaged in memory games in the CNT showed significant improvements on the memory tasks compared to control groups. A more recent digital game designed for the purpose of improving cognitive functioning is InSight, developed by Posit Science in 2012 (Brain HQ, 2016).Berry et al. (2010) had older adults play 10 hours of an InSight module, Sweep Seeker, a perceptual training game. Those who played Sweep Seeker outperformed participants in the control group on post-test measures of visual perception and working memory. Another recent study by Peretz et al. (2011) looked at the cognitive benefits in older adults who played Cognifit Personal Coach, versus the cognitive benefits of older adults who played commercialized digital games such as Tetris, Snake, and X-O's. Cognifit Personal Coach is a cognitive training game developed by CogniFit, a healthcare company founded by professor Shlomo Brenitz in 1999 (CogniFit, 2016). The digital games were chosen for their similar graphics and functionality found in the CogniFit tasks.

Participants were enrolled in the CogniFit or digital games category and played three, 20- to 30-minute sessions every week for three months. Results showed those who played CogniFit improved on measures of focused attention, sustained attention, memory recognition, memory recall, visual spatial learning, visual spatial working memory, executive functioning, and mental flexibility. Those who played the digital games improved on measures of focused attention, sustained attention, memory recognition, and mental flexibility.

While the above research shows cognitive training can be accomplished through the use of digital-tasks, there is a concern surrounding the accessibly and entertainment value of these developed games. The CNT was not commercially available, was only used in lab-settings (Davis, Bajszar, & Squire, 1994), and is no longer being developed today. BrainHQ's InSight comes with a monthly subscription fee ranging from $10.00 to $17.00 CAD per month (Brain HQ, 2016) and CogniFit ranges from $17.99 to $19.99 USD per month (CogniFit, 2016). These fees are barriers to the games' accessibility, whereas digital games such as Tetris, Scrabble, Snake, and Solitarie, can all be found for free online, and as Peretz et al. (2011) showed, there are cognitive benefits found in playing these more accessible digital games.

Research into the cognitive benefits for older adults who play commercially available digital games has been conducted since the early 1980's when Atari consoles were becoming household forms of entertainment. Early studies on the cognitive benefits of digital games for older adults found improvements mainly in the areas of reaction time and processing speeds (Goldstein, et al., 1997; Dustman, Emmerson, Seinhous, Shearer, & Dustman, 1992; Clark, Lanphear, & Riddick, 1987; Weisman, 1983). Evidence for digital games' potential to increase more complex cognitive abilities was not found during this era. This could be due, in part, to the limited functionality and simplistic gameplay of digital games (i.e. Tetris, Pac Man, Frogger) of this time (Zelinski & Davis, 2009).

Today, research investigating the impact of casual digital game playing on older adults is still limited. There are only a handful of studies done in the past decade looking at how older adults' benefit from playing digital games. One study by Basak and colleagues (2008) found older adults who played over 20 hours of a strategy digital game improved in their cognitive ability of task switching, working memory, visual short-

term memory, and reasoning compared to participants in control groups. Another study by Belchior et al. (2013) looked at the impact of digital games on improving useful field of view, a measure of processing speed and visual attention, in older adults, which has shown to decline with age (Ball, Beard, Roenker, Miller, & Griggs, 1988). Older adults either played a control game (Tetris), a first person shooter (Medal of Honour), a clinical training program, or received no training. Participants in all of the treatment groups, including the control, performed significantly better on measures of selective visual attention than individuals in the no training group. As the researchers noted, the game Tetris was chosen as a control in this study since it has been found to be unrelated to selective visual processing in younger populations (Green & Bavelier, 2003), but had an effect in older adult populations. The study did not consider factors such as motivation or level of enjoyment in playing the game, and these factors could have therefore influenced how invested the individual was in playing the game. As previously mentioned, older adults do not rate shooting games among their favourite genres and have little to no experience playing them, compared to Tetris which can be considered a puzzle game and rates high on older adults' favourite genre of games (McKay & Maki, 2010) (De Schutter, 2011; Pearce, 2008).

The limited amount of research in the area of older adults and cognitive benefits provides a challenge in fully understanding which of these studies are most accurate in their findings. Research designs tend to address only one factor at a time, mainly type of game played and the benefit associated with that genre (Basak, Boot, Voss, & Kramer, 2008; Belchior, et al., 2013; Green & Bavelier, 2003). However, research is highly developed in the area of the benefits of digital games in younger populations and cognitive benefits have found to be much more complex than simply type of game played. For example, amount of time spent playing digital games has also been shown to influence the degree of cognitive benefit of playing digital games. Studies that have compared non-gamer to gamers have found those who play digital games outperform their non-gaming peers in areas such as object tracking, short-term visual memory, switching between tasks, and decision-making response times (Boot, Kramer, Simons, Fabiani, & Gratton, 2008).

The research on older adults' cognitive benefits still has a lot of room for investigation. An adjunct area of literature looks at the cognitive benefits older adults perceive from playing certain digital games. As previously discussed, older adults have

identified they adopt new technology when they perceive the benefits to outweigh the negatives (Heinz, et al., 2013; Mitzner, et al., 2010). These motivations may be a mediating factor in which digital games are cognitively beneficial to older adults and could help explain some of the discrepancies in literature between young and old populations.

2.6.1 Perceived Cognitive Benefits of Playing Digital Games

Older adults have identified a number of perceived cognitive benefits to playing digital games. For example, in a sample of older adults who played the digital game Bejeweled, 43% reported the game made them feel sharper, 10.5% indicated it improved their memory, 18.6% thought it improved their ability to see patterns, and 23.4% felt it improved their reaction time (Whitbourne, Ellenberg, & Akimoto, 2013). De Schutter and Malliet (2014) found older adults identified cognitive needs as reasons for playing digital games. These needs included basic exercise of cognitive abilities (i.e., improving memory while playing a puzzle game) and being able to imagine complex situations (i.e., developing a business plan while playing a simulation game). In an observation setting De Schutter and Brown (2016) had older adults describe their perceived benefits of playing digital games as they played their favourite games. Older adults consistently identified mental fitness and cognitive exercise as one of the reasons why they played digital games. In participants who did not mention this as a primary benefit or motivator still identified it as a positive side effect to their engagement of digital games.

In another study by Boot et al. (2013) participants were asked to rate whether or not they were receiving cognitive benefits from playing a specific genre of digital game. Older adults (54+) who played an action digital game were less likely than older adults who played a brain training game to perceive the game as having everyday task benefits (i.e. driving a car, remembering dates, managing finances). No participants thought that engaging in digital games of either genre would improve their vision, reaction time, memory, hand-eye coordination, reasoning ability, or multi-tasking ability. Self-reported perceptions were in line with the results of cognitive tasks that participants completed at pre- and post-intervention, which found no improvement on any of the cognitive tasks. The study also measured the level of compliance in older adult's engagement with the

games and found many associations between the individual's perceived benefits, type of game played, and overall compliance to play the digital games. This research confirms the value of asking older adults about their perceived benefits when understanding their digital game playing habits. Respondents were accurate in their self-reflections how they thought they were cognitively benefitting from playing certain games.

The findings from these studies show that older adults' perceived the benefits of playing digital games may influence how likely they are to invest time into playing a certain game This, in turn, is beneficial for researchers looking to develop interventions reliant on active participants' active engagement in various types of games. If older adults are not perceiving any value in investing time into playing digital games, they may be less likely to adopt them into their daily routines (Boot, et al., 2013).

2.8 Areas for Investigation

Technology use in older adult populations continues to grow, both in daily usage and in diversity of applications. Digital games are becoming increasingly popular within this demographic, both in how much time is spent playing these games and the diversity in the type of games that are being played. We can assume the popularity of digital games will continue to grow as generations who grew up with digital games continue to age. Therefore, it is important that we continue our efforts to understanding how we can best help this demographic leverage the most from this type of activity.

Studies that have looked at the process of aging well have uncovered a number of lifestyle and demographic characteristics that put certain people at risk for social isolation and cognitive decline (Dykstra & de Jong Gierveld, 2004; Buchman, et al., 2010; Rosso, Taylor, Tabb, & Michael, 2013; Coelho & Duarte, 2016). Aging takes a different course for everyone and it is important to understand what factors increase risks so we are better prepared to combat them. Research looking specifically at older adults and digital games is limited, but is gaining momentum in the academic community. There have been a handful of studies that are descriptive in nature, aiming to identify a profile of older adult gamers (De Schutter, 2011; Pearce, 2008; Allaire, et al., 2013; Delwiche & Henderson, 2013; Nap, de Kort, & Ijsselsteijn, 2009). While these studies have looked at various characteristics of the older adult gamers, such as gender,

type of game played, time spent playing games, age, and education, these characteristics are investigated in isolation of one another. Further investigation into the associations between these characteristics is needed. In order to gain a better understanding of the complexity of the characteristics of older adults, demographic factors and game-play characteristics should be looked at together. This will allow us to identify the nuances in the older adult gamer and help in the development of new programs, technologies, and social initiatives for specific groups.

3.0 Methodology

3.1 Research Instrument

The research instrument is a print-based questionnaire asking for respondent information on demographic information (e.g., age, sex, education), patterns of gameplay (e.g., time spent playing digital games, with whom they play digital games), and perceived benefits of playing digital games. The majority of the questions were close-ended 'multiple choice' or 'select all that apply', with a few partially-open ended questions. The questionnaire was developed in 2012-13 by a large team led by Dr. David Kaufman, including co-investigators and research assistants. The instrument was reviewed by approximately ten people and went through five drafts before being finalized. The questions were developed from existing surveys, research standards, and group discussions. Table 1 provides a summary of the sources used in the development of some of the survey questions. The final questionnaire was written in both English and French to allow for delivery to both English-speaking and French-speaking Canadians (See Appendix A for final English questionnaire).

Table 1. Questionnaire development sources

Background Information	*Questions were influenced by survey questions.*
Patterns of Use	*Pew (2008), Video Games: Adults are Players Too*
Playing with others	*Pew (2008) – Teens, Video Games and Civics*
Social/Psychological	*Eldergames (2006), Wollersheim et al. (2010), Khoo & Cheok (2008), Jung et al. (2009), De Schutter (2011)*
Cognitive	*Gamberini et al. (2006), Buiza et al. (2009), Gamberini et al. (2008), Wollersheim et al. (2010)*
Educational/Skills	*Gamberini et al. (2008), Wollersheim et al. (2010)*

3.2 Respondents

A total of 1211 older adults (55 years and older) completed the survey. Only those who indicated they had played digital games in the past year were included in the analyses (n = 590). This included 218 males (36.9%), 363 females (61.5%), and nine (1.5%) respondents who chose not to disclose their gender. All respondents were 55 years and older with 234 (39.7%) between the ages of 55-64, 223 (37.8%) between the ages of 65-74, and 112 (19%) aged 75 and older. Twenty-one (3.6%) respondents chose not to disclose their age.

3.3 Procedures

The survey was administered to individuals over the age of 55 in shopping centres in Greater Vancouver, Ottawa, Quebec City, and Montreal. Participants were also recruited from older adults' independent and assisted living centres, local community centres, and seniors' centres. Permission from management was gained to publically solicit participants. Potential organisations were contacted via email and given a recruitment letter asking management to respond if they agreed to participate. As compensation for their participation, respondents were given a $5 gift card.

3.4 Data Analyses

The data were collected and coded into two different data sets: one for English speakers and another for the French speakers. Both data sets were coded into an SPSS format, and SPSS 21 was used to carry out all of the statistical work. Frequencies were run on the demographics between the groups to ensure the two samples were homogeneous. Once it was determined that the samples collected were similar in demographic characteristics, the data sets were combined. This involved cross-referencing coding schemes between the individual files and ensuring there were no errors. Only respondents who indicated having played digital games in the past year (n=590) were included in subsequent data analyses.

The final data set contained over 150 variables. All variables associated with questions 1 – 7 on the questionnaire were eliminated. These questions address non-

digital gaming patterns of older adults and are considered outside of the scope of the present research. Frequencies were run on all of the remaining variables for questions 8-36. This allowed for identification of data errors, variables irrelevant to the research questions, unequal group sizes, and the need for new variables to be created. The following questions were eliminated from future analyses because of poor data collection or lack of relevance to the research questions:

- Question 16: Which of the following devices did you use to play digital games? (select all that apply)
- Question 21: With whom have you played digital games (select all that apply)
- Question 23: What are your main difficulties in playing digital games? (select all that apply)
- Question 26: In your opinion has playing digiral games increased or decreased the following [Technological Skills]: Computer Skills, Internet Skills, Digital game-playing skills
- Question 29: Primary Language
- Question 30: Country
- Question 31: What is your ethnic group?

A number of variables contained response categories with highly unequal group sizes. Table 2 shows a summary of the variables that were recoded to contain different categories than originally stated on the questionnaire.

Table 2. Recoded variables.

Question	Response Categories		
Question 13. What is your skill level in playing digital games?	Beginner	Intermediate	Expert
Question 13. Recoded.	Beginner	Intermediate & Expert	
Question 14. What is your skill level in using computer technology/internet?	Beginner	Intermediate	Expert
Question 14. Recoded.	Beginner	Intermediate & Expert	
Question 17. Have you played role-playing games online with other	Yes	No	Don’t know

players? (e.g., World of Warcraft, Everquest).						Don't know what that is
Question 17. Recoded.	Yes		No			Eliminated
Question 18. Have you played social games online with other players? (e.g., bridge, chess, scrabble, Facebook games).	Yes		No			Don't know what that is
Question 18. Recoded.	Yes		No			Eliminated
Question 20. Have you played digital games? (select all that apply).	Alone		With others who are in the same room with you			With others online through the internet
Question 20. Recoded.*	Alone		With others			
Question 28. Age.	55-59	60-64	65-69	70-74	80-89	90+
Question 28. Recoded.	55-64		65-74		75+	
Question 32. Living Arrangement.	Alone		In a couple		With Family	With Others
Question 32. Recoded.	Alone		In a couple		With family/others	
Question 33. Where do you live?	Home		Assisted living facility		Nursing home	Others
Question 33. Recoded.	Home		Assisted living/other			
Question 34. Level of education completed	More than 8 categories					
Question 34. Recoded_1	High school or <		Post Secondary			Post Graduate
Question 34. Recoded_2	High school or <		Above high school			
Question 35. Are you retired?	Yes		No			Never worked
Question 35. Recoded.	Yes		No			Eliminated

*These questions had respondents select all options that applied to them. In the recoded variable, respondents were categorized as alone if they didn't select any of the other options. If they selected at least one of the other categories, they were included in the "with others" category (even if they also selected alone)

In addition to the recoding of these variables, three new variables were created. Two of these variables are the measures of perceived benefits of digital games: cognitive and socio-emotional. The third variable aggregated the data from question 11 (during the past month, how many days per week on average have you played digital games?) and question 12 (during the past month, when you played digital games, how many hours per day on average did you play) to create a variable measuring the average hours per week spent playing digital games.

Once the final set of variables were established, a combination of cross-tabulations and non-parametric comparison of means were conducted to answer the research questions. Chi-squared tests, Mann-Whitney, and Kruskall-Wallace tests were calculated for statistical significance. The criteria for significance was set at $p = .05$.

3.4.1 Development of Dependent Variables

The perceived benefits of playing digital games were collected from two categories, socio-emotional and cognitive benefits, which asked “In your opinion, has playing digital games increased or decreased the following:” followed by a list of items respondents could respond either Increased, No Difference, or Decreased. Very few respondents selected ‘Decreased’ in any of the categories. All of the measures were recoded into Increased and No Difference/Decreased, giving binary measures for each response. Respondents were coded as either a 1 or 0 in each of the categories, 1 if they responded ‘Increase’, and 0 if they responded ‘Decrease’ or ‘No Change’. The sum of the scores in each of the three benefits category provided a ratio measure for socio-emotional benefits and cognitive benefits (i.e., those who reported an increase on two of the socio-emotional measures can be stated to have reported half the number of benefits as someone who reported an increase on 4 of the socio-emotional measures). These two variables are used as the dependent measures of perceived socio-emotional benefits to playing digital games and perceived cognitive benefits to playing digital games.

Social & Emotional Dependent Variable

Table 3 shows the frequency of responses for each of the items in the perceived socio-emotional benefits category. The 'No Difference' and 'Decreased' categories were combined to create two response categories: 'Increased' and 'No Difference/Decreased'.

Table 3. Frequencies of recoded responses for perceived socio-emotional benefits of playing digital games.

	Increased	Decrease/ No Change	Total
Developing new friendships	128 (23%)	417 (77%)	545
Connecting with current friends	134 (25%)	394 (75%)	528
Connecting with family	163 (31%)	366 (69%)	529
Connecting with various age groups	129 (25%)	387 (75%)	516
Developing self-confidence	237 (44%)	301 (56%)	538
Dealing with loneliness	150 (29%)	376 (71%)	526
Dealing with depression	107 (21%)	402 (79%)	509

Note. Survey question: "In your opinion, has playing digital games increased or decreased the following"

Respondents were coded 1 if they responded Increase and 0 if they responded 'Decrease' or 'No Change'. The sum of these seven scores was taken to create an aggregate measure of perceived socio-emotional benefits, creating a variable with a range of 0-7 (N=483, M = 1.7607, SD = 1.214; see table 4).

Table 4. Frequency table for perceived socio-emotional benefits score

Score (Range: 0-7)	Frequency	Percent (%)
0	129	35.0
1	101	20.9
2	65	13.5
3	52	10.8
4	35	7.2
5	23	4.8
6	11	2.3
7	27	5.6
Total	483	100.0

Cognitive Dependent Variable

Table 5 shows the frequency of responses for each of the items in the perceived cognitive benefits category. The No Difference and Decreased categories were combined to create two response categories: Increased and No Difference or Decreased.

Table 5. Frequencies of recoded responses for perceived cognitive benefits of playing digital games.

	Increased	Decrease/No Change	Total
Focusing attention	397 (71%)	165 (29%)	562
Memory	389 (69%)	175 (31%)	564
Reasoning	313 (58%)	230 (42%)	543
Problem Solving	320 (58%)	229 (42%)	549
Speed in reacting/responding	352 (64%)	198 (36%)	550

Respondents were coded 1 if they responded Increase and 0 if they responded 'Decrease' or 'No Change'. The sum of these five scores was taken to create an aggregate measure of perceived cognitive benefits, creating a variable with a range of 0-5 (N=525, M = 3.162, SD = 1.802; see table 6).

Table 6. Frequencies table for perceived cognitive benefits of playing digital games score

Score (Range: 0-5)	Frequency	Percent (%)
0	73	14.2
1	39	7.6
2	65	12.6
3	71	13.8
4	88	17.1
5	179	34.8
Total	515	100.0

3.4.2 Categorizing Digital games

Respondents were given space on the survey to write up to three digital games they play (Q15. “Which digital games have you played, wither along or with others?”). There were a total of 1056 responses, with an average of 1.96 games listed by the respondent (178 respondents listed 3 games, 161 listed 2 games, 200 listed 1 game). All responses were coded into two variables: a string variable that was a transcription of the participant’s answer and a category variable that assigned each of the games into a category. Researchers individually assessed the nature of each game the participants listed and assigned it to a category. A total of 14 game categories were identified (see Table 7). Fourteen individual game category variables were created and the respondent was assigned a 0 or 1 for each of these variables. A ‘0’ was assigned if none of their listed games fell into the category, and a ‘1’ was assigned if any of their listed games fell within that category (i.e., if a respondent wrote down 1 puzzle game and 2 strategy games, they were given a 1 in the puzzle category and a 1 in the strategy category. All other categories received a 0). Game categories with at least 20 responses were used in the data analysis procedures. The final selection of game categories consisted of: Arcade (n=81), Strategy (n=75), Puzzle (n=228), Word (n=66), Sports (n=25), and Card (n=234). The “Other” category had a total of 112 responses, but due to it’s ambiguity, was eliminated from analyses (see Table 7).

Table 7. Digital Game Categories

Game Category	Frequency (n)	Percentage (%)
Arcade*	**81**	**9.22**
Adventure	16	1.82
Fighter	1	0.11
Shooter	16	1.82
Simulation	8	0.91
Role Playing	5	0.57
Strategy*	**75**	**8.53**
Puzzle*	**228**	**25.94**
Word*	**66**	**7.51**

Trivia	5	0.57
Sports*	**25**	**2.84**
Educational	7	0.80
Card/Board/Tile*	**234**	**26.62**
Other	112	12.74
Total	**879**	**100**

***Only these game categories are included in the final data analyses**

4.0 Results

4.1 Overview of Analyses for each Research Question

The goal of this research was to answer five questions about patterns of older adults' digital gameplay. The research questions and a summary of the analyses conducted are presented below.

1. **What are the demographic characteristics of older adults who play digital games?**

Frequencies and descriptive statics were run on the demographic variables to describe the characteristics of older adults who play digital games. This included the following characteristics: age, sex, living arrangement, living situation, education, retirement status, and current working/volunteering situation.

2. **What are the gameplay patterns of older adults? What kinds of games are they playing, how are they playing these games, and how often are they playing?**

Frequencies and descriptive statistics were run on the gameplay pattern variables to get a sense of how older adults are playing their digital games. Variables addressing the kinds of games that are being played are whether or not they play any of the six categories of games: word, puzzle, strategy, arcade, sport, card/board/tile. As mentioned above, these categories were selected because they were the largest game categories indicated on the questionnaire. Variables that describe how older adults are playing digital games are: hours per week spent playing digital games, skill level in playing digital games, skill level with computer technology and internet, playing role playing games, playing social games online with others, meeting new people playing social games online, and playing alone or with others.

3. **Is there an association between demographic characteristics and gameplay patterns of older adults who play digital games?**

Cross-tabulations were run between the demographic characteristic variables (as mentioned in the first research question) and the gameplay pattern variables (as mentioned in the second research question). For any significant associations, the column proportions were compared using a z-test to identify which categories were responsible for the significant association. P-values were adjusted using the Bonferroni method to account for the large number of comparisons being made and to reduce the chance of a type 1 error.

4. **Is there an association between demographic characteristics of older adults and their perceived benefits of playing digital games?**

Non-parametric comparison of means, independent-samples Kruskall-Wallis and Mann-Whitney-U tests, were conducted between the demographic variables (listed in the first research question) and the perceived benefits of digital games variables, socio-emotional and cognitive. Explanation for the non-parametric approach will be provided in the next section.

5. **Is there an association between gameplay patterns of older adults and their perceived benefits of playing digital games?**

Non-parametric comparison of means, independent-samples Kruskall-Wallis & Mann-Whitney-U tests, were conducted between the gameplay pattern variables (listed in the second research question) and the perceived benefits of digital games variables, socio-emotional and cognitive. Table 8 shows a summary of all the variables used in the data analyses for answering the research questions.

Table 8. Summary of Variables Included in Final Data Set

INDEPENDENT VARIABLES	DEPENDENT VARIABLES
DEMOGRAPHICS	**SOCIAL & EMOTIONAL**
Q27 – Sex	Q24A – Developing new friendships
Q28 – Age	Q24B – Connecting with current friends
Q32 – Living arrangement	Q24C – Connecting with family

Q33 – Living situation	Q24D – Connecting with various age groups
Q34 – Education	Q24E – Developing self-confidence
Q35 – Retirement status	Q24F – Dealing with loneliness
Q36 – Present Working Situation	Q24G – Dealing with depression
GAMEPLAY PATTERNS	Total Social Emotional Benefits Count
Q11x12RECODE – Hours/Week	**COGNITIVE**
Q13 – Skill level playing digital games	Q25A – Focusing attention
Q14 – Skill level with computer technology/internet	Q25B – Memory
Q17 – Role-Play Gamers	Q25C – Reasoning
Q18 – Social game players	Q25D – Problem Solving
Q19 – Met People Online	Q25E – Speed in reacting/responding
Q20 – Playing alone or with others	Total Cognitive Benefits Count
TYPE OF GAME PLAYED	
Q15 – Arcade	
Q15 – Strategy	
Q15 – Puzzle	
Q15 – Word	
Q15 – Sport	
Q15 – Card/Board/Tile	

4.2 Non-Parametric Approach

In testing the data for normality, graphs and statistics indicated significantly non-normally distributed variable. To test for normality, histograms of the two dependent variables (socio-emotional and cognitive) were generated and the Shapiro-Wilks test was used to statistically test for normality. Histograms showed significantly non-normal

distributions and all three Shapiro-Wilks tests showed $p < .000$. See Figure 1 for the distribution of the perceived socio-emotional benefits of playing digital games dependent variable and Figure 2 for the distribution of the cognitive benefits of playing digital games dependent variable.

Figure 1. Frequency histogram of older adults perceived socio-emotional benefits of playing digital games

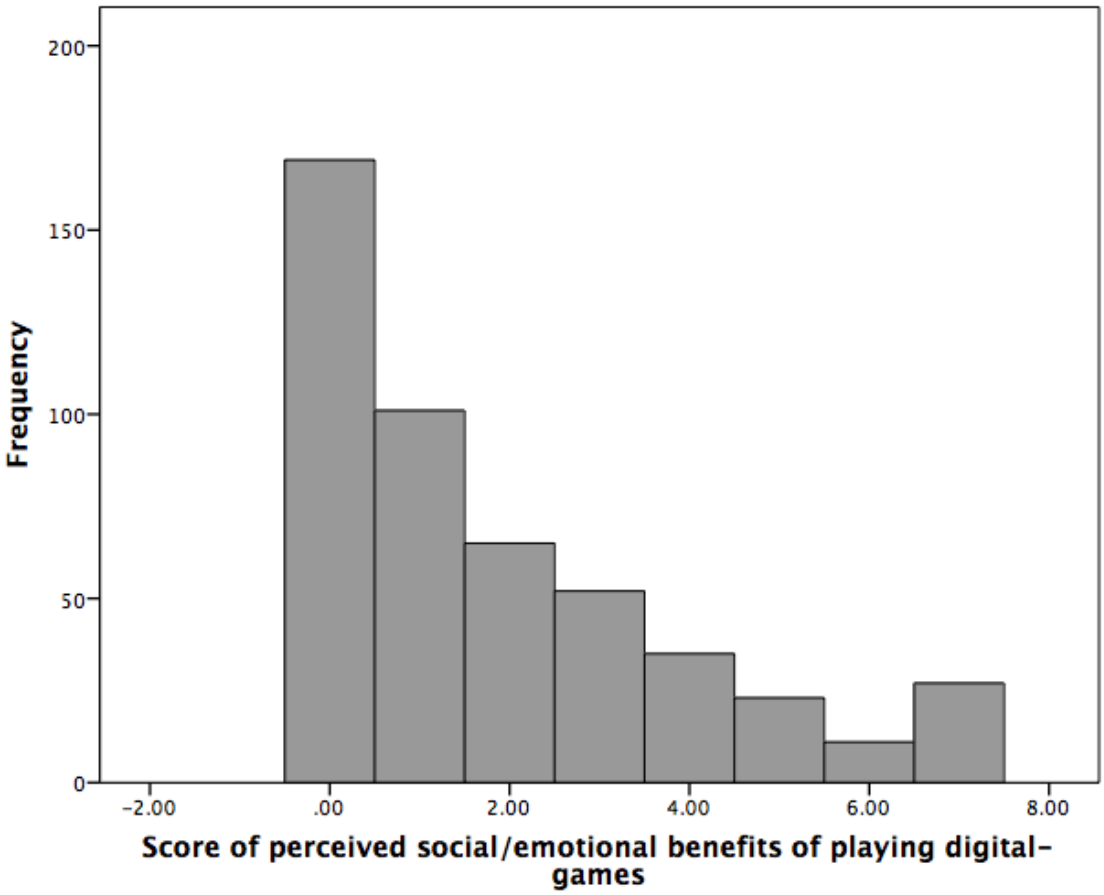
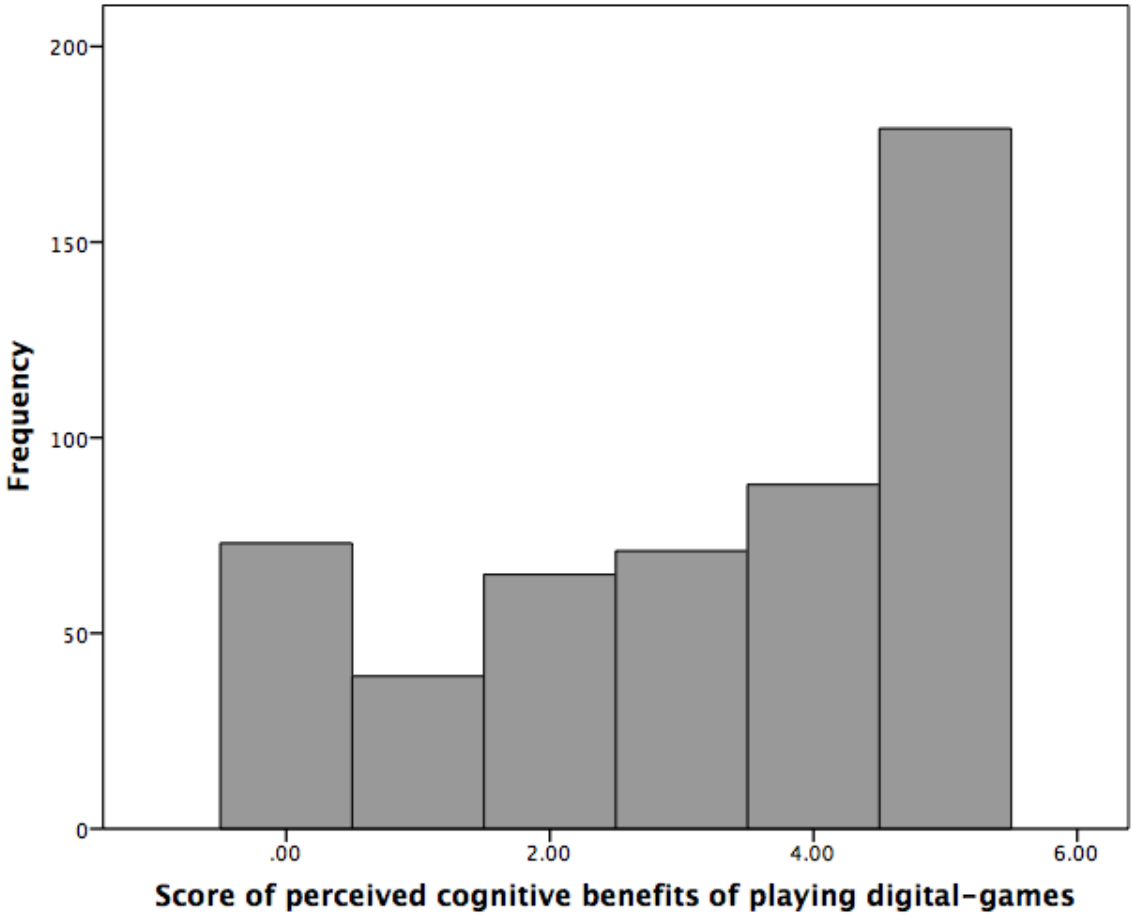


Figure 2. Frequency histogram of older adults perceived cognitive benefits of playing digital games



The distributions of each dependent variable and independent variable category were also tested for normality. These combinations included:

- Dependent variables (x2) vs. demographic characteristics (7); 14 comparisons
- Dependent variables (x2) vs. gameplay patterns (13); 26 comparisons

Significance threshold was set to p=0.05. All comparisons had a Shapiro-Wilks score significant at p<.000. Data were considered to be significantly non-normal and therefore a non-parametric approach to analyzing the data was adopted. All future associations are also at the significance level of p=0.05

4.3 Research Question 1: What are the demographic characteristics of older adults who play digital games?

Frequencies were run on the demographic variables contained within the questionnaire. Table 9 shows the frequencies of these demographic characteristics of the older adults who responded to the survey.

Table 9. Demographic characteristics of older adults who reported playing digital games

Demographics	Category	Frequency (n)	Percentage (%)
Sex	Female	363	62.5
	Male	218	37.5
	Total	581	100.0
Age	55-64	234	41.1
	65-74	223	39.2
	75+	112	19.7
	Total	569	100.0
Living Arrangement	Alone	220	37.9
	In a couple	222	38.2
	With family/others	139	23.9
	Total	581	100.0
Living Situation	Home	485	83.9
	Assisted Living/Other	93	16.1

	Total	578	100.0
Education	High school or less	176	30.3
	Post Secondary	298	51.4
	Post Graduate	106	18.3
	Total	580	100.0
Retired	No	120	20.9
	Yes	453	79.1
	Total	573	100.0
Working Status	Not working	340	60.1
	Part-time	158	27.9
	Full-time	68	12.0
	Total	566	100.0

Nearly two-thirds of all participants were females (females = 62.5%, males = 37.5%). There were approximately equal number of participants between the ages of 55-64 (n=234, 41%) and 65-75 (n=223, 39.2%), but a lower number of those 75 years and older (n=112, 19.7%).

The majority of the participants lived either alone (n=220, 37.9%) or in a couple (n=222, 38.2). Most lived in their own homes (n=485, 83.9%), but there were a small number of respondents who reported living in an assisted living or a nursing home (n=93, 16.1%). Table 10 shows a detailed cross tabulation frequencies and proportions of the living situation of the respondents. Most respondents reported living with a partner in their own home (n=207, 35.9%) or alone in their own homes (n=152, 26.3%). Those who live in assisted living or other reported living alone (n=66 11.4%) in a couple (n=14, 2.4%), or with family/others (n=92, 15.9%).

Table 10. Where respondents live and with whom they live

	Where respondents live		
Who they live with	**Home**	**Assisted Living/Other**	**Total**
Alone	152 (26.3%)	66 (11.4%)	218 (37.8%)
In a couple	207 (35.9%)	14 (2.4%)	221 (38.3%)
With Family/Others	126 (12%)	12 (2.1%)	138 (23.9%)
Total	485 (84.1%)	92 (15.9%)	577 (100.0%)

Note. Percentages indicate the proportion of the total sample that fall into the

cross-sectional category.

Approximately half of the respondents had a post-secondary education (n=298, 51.4%), 30.3% had a high-school education (n=121, 20.9%) or less, (n=55, 9.5%), and 18.3% reported having a post-graduate education, which included 2-year degrees (n=71, 12.2%), 4-year degrees (n=107, 18.4%), master's degrees (n=46, 7.9%), doctoral degrees (n=9, 1.6%), and professional designations (n=51, 8.8%).

As to be expected with an older population, most of the respondents were retired (n=453, 79.1%). Despite being retired, some of these individuals were still working casually or on a volunteer basis, since only 340 (60.1%) reported to be currently not working at all, less than the indicated number of retirees. Twelve-percent (n=68) reported working or volunteering full-time and 27.9% (n=158) reported working or volunteering part-time. Table 11 shows the cross tabulation frequencies and proportions of respondents' retirement-status and current working-statue. From this table, we can see of the 453 who indicated they were retired, 104 (23.6%) were working or volunteering part-time and 11 (2.5%) were working or volunteering full-time.

Table 11. Retirement status and current working status

	Retirement Status		
Current work/volunteer status	**Not Retired**	**Retired**	**Total**
Not working or volunteering	12 (2.1%)	325 (58%)	337 (60.2%)
Part-time work or volunteer	51 (9.1%)	104 (18.6%)	155 (27.7%)
Full-time work or volunteer	57 (10.2%)	11 (2.0%)	68 (12.1%)
Total	120 (21.4%)	440 (78.6%)	560 (100%)

4.4 Research Question 2: What are the gameplay patterns of older adults?

Frequencies were run on the gameplay pattern variables contained within the questionnaire. Table 12 shows the frequencies of these gameplay characteristics of the older adults who responded to the survey.

There was an equal distribution of respondents across the categories of time spent playing digital games with 37.5% (n=215) playing less than 2 hours per week, 33.4% (n=193) playing 2 to 6 hours per week, and 29.4% (n=179) playing more than 6 hours per week. Over half of the sample rated themselves as being intermediate or advanced in their digital game skill level (n=357, 61.4%) and skill level with computer technology and the internet (n=368, 63.4%). Only a small number of older adults reported playing role-playing games (n=45, 7.6%), playing social games online with others (n=154 26.6%), and meeting new people online (n=84, 14.7%). Two thirds of the respondents play digital games alone (n=357, 61.3%) and the other third plays digital games with others in the same room as them or with others over the internet (n=225, 38.7%).

Table 12. Gameplay pattern of older adults who reported playing digital games

Gameplay Pattern	Category	Frequency	Percentage (%)
Time spent playing digital games (hours/week)	Less than 2 hours/week	215	37.5
	2-6 hours/week	193	33.4
	More than 6 hours/week	179	29.4
	Total	578	100.0
Skill level playing digital games	Beginner	224	38.6
	Intermediate /Advance	357	61.4
	Total	581	100.0
Skill level with computer technology/internet	Beginner	212	36.6
	Intermediate/ Advance	368	63.4
	Total	580	100.0
Played role-playing games online with others	Yes	45	7.6
	No	495	83.9
	Total	540	100.0
Played social games online with others	Yes	154	26.6
	No	425	73.4
	Total	579	100.0
Met new people playing online games	Yes	84	14.7

	No	487	85.3
	Total	571	100.0
Play digital games alone or with others	Alone	357	61.3
	With others	225	38.7
	Total	582	100.0

4.5 Research Question 3: Is there an association between demographic characteristics and gameplay patterns of older adults who play digital games?

Cross-tabulations were conducted to test for significant associations between demographic variables and game-play patterns. Chi-square was used to test for a significant association between the two variables. A z-test was used to compare proportion sizes of the categories to identify where the areas of difference were.

4.5.1 Sex vs. Gameplay Patterns

Table 13 shows which gameplay characteristics were significantly associated with sex. Hours per week playing digital games, playing RPG games, and meeting new people online showed significant associations with sex. Category proportions suggest that males spent less time per week playing digital games, with 44.4% (n=96) of males playing less than 2 hours a week compared to 32.6% (n=115) of female respondents playing this amount. There is approximately the same percentage of males and females in both the 2-6 hours per week category (females=36.0%, n=127; males 30.1%, n=65) and more than 6 hours per week category (females=31.4%, n=111; males=25.2%, n=55).

Males (12.5%, n=25) appeared to play more role-playing games than females (5.6%, n=19) and meet more people online, with 19.9% (n=42) of males indicating they've met new people online compared to only 11.4% (n=40) of females.

Table 13. Significant associations between sex and gameplay patterns

	Sex			Statistics	
Game-play pattern	**Female**	**Male**	**Total**	**χ^2**	**p**

Hours per week playing digital games	**< 2 hours**	115 (32.6%)$_a$	96 (44.4%)$_b$	211 (37.1%)	8.11	.017
	2-6 hours	127 (36.0%)$_a$	65 (30.1%)$_a$	192 (33.7%)		
	> 6 hours	111 (31.4%)$_a$	55 (25.5%)$_a$	166 (29.2%)		
	Total	353 (62.0%)	216 (38.0%)	569 (100%)		
Play RPG games	**No**	314 (94.6%)$_a$	175 (87.9%)$_b$	489 (92.1%)	7.53	.006
	Yes	18 (5.4%)$_a$	24 (12.1%)$_b$	42 (7.9%)		
	Total	332 (62.5%)	199 (37.5%)	531 (100%)		
Met new people playing online games	**No**	311 (88.6%)$_a$	169 (80.1%)$_b$	480 (85.4%)	7.66	.006
	Yes	40 (11.4%)$_a$	42 (19.9%)$_b$	82 (14.6%)		
	Total	351 (62.5%)	211 (37.5%)	562 (100%)		

Each letter subscript indicates column proportions that do not differ significantly from one another.

Gameplay pattern categories that were not found to have a significant association with sex are skill level in playing digital games, skill level with computer technology and the internet, playing social games online with others, and meeting new people while playing online games.

Table 14 shows the sex differences in types of games played. Based on the proportion of cells, males appear to play more strategy games and sports games, with 20.2% (n=44) of males indicating they play a strategy game compared to only 8.0% (n=29) of females, and 6.4% (n=14) of males indicating they play a sports games compared to only 2.8% (n=10) of females. Females appear to play more puzzle and word games, with 52.9% (n=171) of females indicating they play puzzle games compared to only 25.7% (n=56) of males, and 15.2% (n=55) females indicating they play word games, compared to the 5.0% (n=11) of males.

Table 14. Significant associations of sex and type of game played

		Sex			**Statistics**	

Digital game Category	Female	Male	Total	χ^2	p-value
Strategy	29 (8.0%)$_a$	44 (20.2%)$_b$	73 (12.6%)	18.44	<.000
Puzzles	171 (52.9%)$_a$	56 (25.7%)$_b$	227 (39.1%)	26.25	<.000
Word	55 (15.2%)$_a$	11 (5.0%)$_b$	66 (11.4%)	13.81	<.000
Sports	10 (2.8%)$_a$	14 (6.4%)$_b$	24 (4.1%)	4.63	.028

Note. Cell data indicates the number of respondents who played at least one game in the specified category. Each letter subscript indicated column proportions who do not differ significantly from one another.

Game categories that were not found to be significantly associated with gender are arcade and card/board/tile games.

4.5.2 Age vs. Gameplay patterns

Table 15 shows the significant associations between age and game-play patterns. Hours per week playing digital games, skill level with computer technology and the internet, meeting new people while playing online digital games, and play alone vs. with others, are all associated with age.

Table 15. Significant associations of age and gameplay patterns

		Age				Statistics	
Gameplay pattern		**55-64**	**65-74**	**75+**	**Total**	χ^2	**p**
Hours per week playing digital games	**<2 Hrs**	104 (45.2%)$_a$	76 (34.9%)$_{a,b}$	30 (27.3%)$_b$	210 (37.6%)	11.73	.019
	2-6 hrs	66 (28.7%)$_a$	79 (36.2%)$_a$	42 (38.2%)$_a$	187 (33.5%)		
	6 hrs	60 (26.1%)$_a$	63 (28.9%)$_a$	38 (34.5%)$_a$	161 (28.9%)		
	Total	230 (41.2%)	218 (39.1%)	110 (19.7%)	558 (100%)		
Skill level with computer tech/ internet	**Beg**	66 (28.3%)$_a$	88 (40.4%)$_b$	49 (45.4%)$_b$	203 (36.3%)	11.81	.003
	Int. /Adv.	167 (71.7%)$_a$	130 (59.6%)$_b$	59 (54.6%)$_b$	356 (63.7%)		
	Total	233 (41.7%)	218 (39.0%)	108 (19.3%)	559 (100%)		

Play digital games alone or with others	**Alone**	126 (54.3%)$_a$	145 (65.9%)$_b$	76 (69.1%)$_b$	347 (61.7%)	9.56	.008
	With others	106 (45.7%)$_a$	75 (34.1%)$_b$	34 (30.9%)$_b$	215 (38.3%)		
	Total	232 (41.3%)	220 (39.1%)	11 (19.6%)	562 (100%)		

Note. Each letter subscript indicated column proportions who do not differ significantly from one another.

The only significant difference found within the association of age and time spent playing digital games was within the less than two-hour category. The proportion of older adults aged 55 to 64 who play digital games less than two hours a week (45.2%, n=104) is greater than the proportion of older adults aged 75 and older who play digital games less than two hours a week (27.3%, n=210). There were no proportional differences between any of the age groups and the other two hours of game play categories, 2-6 hours per week and more than 6 hours per week.

Over half of all respondents indicated their skill level in playing digital games as either intermediate or advanced. However, those in the youngest age category appear to rate themselves highest in this category, with 71.7% (n=167) of 55-64 year olds rating themselves as intermediate or advanced internet users, compared to 59.6% (n=130) of 65 to 74 year olds and 54.6% (n=59) of those 75 and older.

The proportion of older adults aged 55 to 64 who reported playing digital games with others (45.7%, n=106) is greater than the proportion of older adults aged 65 to 74 (34.1%, n=75) and older adults 75 and older (30.9%, n=34) who reported playing digital games with others. Proportions of older adults aged 65 to 74 and older adults 75 and older who play digital games with others did not differ significantly.

Gameplay pattern categories that were not found to have a significant association with age are skill level in playing digital games, playing role-playing games, playing social games online with others, and meeting new people while playing online games.

Table 16 shows the age differences in types of games played. Only arcade games were found to be significantly associated with age. The proportion of older adults aged 55 to 64 and older adults aged 65-74 who play arcade games (20.1%, n=47;

13.5%, n=30 respectively) is greater than the proportion of older adults 75 years-old and older (1.8%, n=2).

Table 16. Significant association of age and type of game played

	Age				Statistics	
Digital game Category	**55-64**	**65-74**	**75+**	**Total**	**χ^2**	**p**
Arcade	47 (20.1%)$_a$	30 (13.5%)$_a$	2 (1.8%)$_b$	79 (13.9%)	21.27	<.000

Note. Numbers indicate the number of respondents who played at least one game in the specified category. Each letter subscript indicated column proportions that do not differ significantly from one another.

Digital game categories that were not found to be significantly associated with age are strategy, puzzle, word, sport, and card/board/tile games.

4.5.3 Living arrangement and Living Situation vs. Gameplay patterns

Table 17 shows the significant associations of living arrangement and gameplay patterns of older adults. The only significant association was found between living-arrangement and time spent playing-digital games. The proportion of older adults who live alone and played less than two hours per week of digital games (26.3%, n=56) is significantly lower than the proportion of older adults who live in a couple and play less than two hours of digital games per week (43.1%, n=59) and the proportion older adults who live with family/others and play less than two hours of digital games per week (43.1%, n=59). Older adults who live in a couple or in a family/others and play less than two hours of digital games per week did not proportionally differ from one another. There were no other significant differences in the proportion of older adults in any living situation who played 2-6 hours of digital games per week, or older adults in any living situation who played more than 6 hours per week.

Table 17. Significant associations of living arrangement and gameplay patterns

		Living arrangement				Statistics	
Game-play pattern		**Alone**	**In a Couple**	**Family or others**	**Total**	**χ^2**	**p**
Hours per	**< 2**	56	96	59	211	17.32	.002

week playing digital games	**hours**	(26.3%)$_a$	(43.6%)$_b$	(43.1%)$_b$	(37.0%)
	2-6 hours	81 (38.0%)$_a$	67 (30.5%)$_a$	44 (32.1%)$_a$	192 (33.7%)
	> 6 hours	76 (35.7%)$_a$	57 (25.9%)$_a$	34 (24.8%)$_a$	167 (29.3%)
	Total	213 (37.4%)	220 (38.6%)	137 (24.0%)	570 (100%)

Note. Each letter subscript indicated column proportions who do not differ significantly from one another.

Gameplay pattern categories that were not found to have a significant association with living arrangement are skill level in playing digital games, skill level with computer technology and the internet, playing role-playing games, playing social games online with others, meeting new people while playing online games, and playing alone or with others.

Table 18 shows the living arrangement differences in types of games played. Word games, sports games, and card/board/tile games were found to be associated with the living arrangement of an older adult. The proportion of older adults living with family or others (4.3%, n=6) who play word games is smaller than the proportion of older adults living alone or in a couple who play word games (15.5%, n=34; 11.7%, n=26 respectively). The proportion of older adults living in a couple who play sports games (2.7%, n=6) is less than the proportion of older adults living with family or others who play sports games (8.6%, n=12). The proportion of older adults living in a couple who play card/board/tile games (45.0%, n=100) is greater than older adults living with family or others who play card/board/tile games (30.9%, n=43).

Table 18. Significant associations of living arrangement and type of game played

	Living Arrangement				**Statistics**	
Digital game Category	**Alone**	**In a couple**	**Family/ Other**	**Total**	**χ^2**	**p**
Word	34 (15.5%)$_a$	26 (11.7%)$_a$	6 (4.3%)$_b$	66 (n=581)	10.54	.005
Sports	7 (3.2%)$_{a, b}$	6 (2.7%)$_b$	12 (8.6%)$_a$	25 (n=581)	8.38	.015
Card/Board/Tile	86 (39.1%)$_{a,b}$	100 (45.0%)$_b$	43 (30.9%)$_a$	229 (n=581)	7.14	.028

Note. Numbers indicate the number of respondents who played at least one game in the specified category. Each letter subscript indicates column proportions that do not differ significantly from one another.

Digital game categories that were not found to be significantly associated with age are strategy and puzzle games.

Table 19 shows the significant associations of living situation and gameplay patterns of older adults. The only significant association was found between living situation and skill level with computer technology and the internet. Over half of all respondents reported themselves as intermediate to advanced in their skill level with computer technology and the internet (63.6%, n=362). The proportion of older adults who live at home and reported intermediate or advanced skill level with computer technology and the internet (65.8%, n=315) was larger than the proportion of older adults who live in assisted living or other and reported intermediate or advanced skill level with computer technology and the internet (52.2%, n=47).

Table 19. Significant associations of living situation and game-play patterns

		Living situation			Statistics	
Game-play pattern		**Home**	**Assisted living/other**	**Total**	**χ^2**	**p**
Skill level with computer technology/internet	**Beginner**	164 (34.2%)$_a$	43 (47.8%)$_b$	207 (36.4%)	6.00	.017
	Intermediate /Advance	315 (65.8%)$_a$	47 (52.2%)$_b$	362 (63.6%)		
	Total	479 (84.2%)	90 (15.8%)	569 (100%)		

Note. Each letter subscript indicated column proportions that do not differ significantly from one another.

Gameplay pattern categories that were not found to have a significant association with living situation are time spent playing digital games, skill level in playing digital games, playing role-playing games, playing social games online with others, meeting new people while playing online games, and playing alone or with others. There were no significant associations found between type of digital game played and the living situation of older adults.

4.5.4 Education vs. Gameplay Patterns

Table 20 shows the significant associations between education and game-play patterns. Hours per week playing digital games, skill level playing digital games, skill level with computer technology and the internet, playing role playing games, and meeting new people while playing online digital games, are all associated with education.

The proportion of older adults who play less than two hours a week, and between 2-6 hours a week did not differ across all education levels. However, there is a larger proportion of older adults with a high-school education or less who play more than 6 hours per week (38.2%, n=65) than older adults with a post-secondary and post-graduate degree who played more than 6 hours per week (27.2%, n=80; 21.9%; n=23 respectively). This implies that those with a lower education spend more time playing digital games.

Education is associated to the digital game playing skill of older adults, with a higher education being associated with a higher self-rating of digital game playing skill. A greater proportion of older adults with a post-graduate degree rated themselves as intermediate/advanced digital game players (70.8%, n=75) than older adults with a high-school diploma or less (52.9%, n=90). Although the proportion of older adults with a post-secondary education who rated themselves as intermediate/advanced digital game players (63.7%, n=188) fell between older adults with a high-school education or less and older adults with a post-graduate degree, there was no significant difference in these proportions.

Older adults' self reported computer technology and internet skill showed the same pattern as above, with the exception of each education category being significantly larger than the next. Only 45.6% (n=78) of older adults with a high-school diploma or less rated themselves as intermediate/advanced in computer technology and internet skill, compared to older adults with a post-secondary education (66.6%, n=197), and older adults with a post-graduate education (84.6%, n=88). An increase in education is associated to an increase in self-reported computer technology and internet skill.

There is a smaller proportion of older adults with a post-secondary education who play role-playing games (5.9%,n=16) than older adults with a high school diploma or less who play role-playing games (12.8%, n=20). The proportion of older adults with a post-graduate degree who play role-playing games (7.8%, n=8) did not differ from older adults in the other two education categories

The proportion of older adults with a high school diploma or less who met new people online (42.7%, n=35) is greater than the proportion of older adults with a post-secondary education (12.2%, n=35). The proportion of older adults with a post-graduate degree who have met new people online (14.6%, n=12) did not differ from older adults in the other two education categories.

Table 20. Significant associations of education and game-play patterns

		Education				Statistics	
Game-play pattern		**HS or less**	**Post Second.**	**Post Grad**	**Total**	**χ^2**	**p**
Hours per week playing digital games	**<2 hours**	57 (33.5%)$_a$	113 (38.4%)$_a$	40 (38.1%)$_a$	210 (36.9%)	10.51	.033
	2-6 hours	48 (28.2%)$_a$	101 (34.4%)$_a$	42 (40.0%)$_a$	191 (33.6%)		
	6+ hours	65 (38.2%)$_a$	80 (27.2%)$_b$	23 (21.9%)$_b$	168 (29.5%)		
	Total	170 (29.9%)	294 (51.7%)	105 (18.5%)	569 (100%)		
Digital game playing skill	**Begin.**	80 (47.1%)$_a$	107 (49.1%)$_{a,b}$	31 (29.2%)$_b$	218 (38.2%)	9.72	.008
	Inter. /Adv.	90 (52.9%)$_a$	188 (63.7%)$_{a,b}$	75 (70.8%)$_b$	353 (61.8%)		
	Total	170 (29.8%)	295 (51.7%)	106 (18.6%)	571 (100%)		
Computer tech/ internet skill	**Begin.**	93 (54.4%)$_a$	99 (33.4%)$_b$	16 (15.4%)$_c$	208 (36.4%)	44.84	<.000
	Inter. /Adv.	78 (45.6%)$_a$	197 (66.6%)$_b$	88 (84.6%)$_c$	363 (63.6%)		
	Total	171	296	104	571		

		(29.9%)	(51.8%)	(18.2%)	(100%)		
Play RPG Games	**Yes**	20 $(12.8\%)_a$	16 $(5.9\%)_b$	8 $(7.8\%)_{a,b}$	44 (8.3%)	6.36	.042
	No	136 $(87.2\%)_a$	257 $(94.1\%)_b$	94 $(92.2\%)_{ab}$	487 (91.7%)		
	Total	156 (29.4%)	273 (51.4%)	102 (19.2%)	531 (100%)		
Met new people playing online games	**Yes**	35 $(20.7\%)_a$	35 $(12.2\%)_b$	12 $(14.6\%)_{a,b}$	82 (14.6%)	7.22	.027
	No	134 $(79.3\%)_a$	253 $(87.8\%)_b$	92 $(88.5\%)_{a,b}$	479 (85.4%)		
	Total	169 (30.1%)	288 (51.3%)	104 (18.5%)	561		

Note. Each letter subscript indicated column proportions that do not differ significantly from one another.

Gameplay pattern categories that were not found to have a significant association with education are playing social games online with others and playing digital games alone or with others.

Table 21 shows the educational differences in types of games played. Only word games were found to be associated to education level. The proportion of older adults with a post-secondary education (14.1%, n=42) or with a post-graduate education (14.2%, n=15) who play word games are higher than the proportion of older adults with a high-school diploma or less who play word games (5.1%, n=9). A higher education is associated to playing more word games.

Table 21. Significant associations of education and type of game played

	Education				Statistics	
Digital game Category	**High school or less**	**Post Secondary**	**Post Graduate**	**Total**	**χ^2**	**p**
Word	9 $(5.1\%)_a$	42 $(14.1\%)_b$	15 $(14.2\%)_b$	66 (n=580)	9.84	.007

Note. Numbers indicate the number of respondents who played at least one game in the specified category.

Digital game categories that were not found to be significantly associated with education are strategy, sports, card/board/tile, and puzzle games.

4.5.5 Retirement Status and Current Working Status vs. Gameplay Patterns

Table 22 shows the significant associations between retirement status and gameplay patterns. Hours per week playing digital games, skill level with computer technology and the internet, and playing alone or with others, are all associated with retirement status.

The proportion of retired older adults who play more than 6 hours of digital games per week (31.8%, n=142) is greater than the proportion of not retired older adults who play more than 6 hours of digital games per week (17.9%, n=21). Additionally, there's a higher portion of not retired older adults playing less than two hours of digital games per week (46.2%, n=56) than there are retired older adults playing less than two hours of digital games per week (34.8%, n=155). This suggests that older adults who are retired spend more time playing digital games than their not retired counterparts. There were no proportional differences between not retired and retired older adults who play between 2-6 hours of digital games per week.

There is a higher proportion of not retired older adults who rate themselves as intermediate to advanced users of computer technology and internet (74.8%, n=89) than retired older adults (60.4%, n=268). The proportion of not retired older adults who play digital games with others (47.1%, n=56) is greater than retired older adults who play digital games with others (36.3%, n=162).

Table 22. Significant associations of retirement status and game-play patterns

		Retirement Status			Statistics	
Game-play pattern		**Not Retired**	**Retired**	**Total**	**χ^2**	**p-value**
Hours per week playing digital	< 2 hours	54 (46.2%)$_a$	155 (34.8%)$_b$	209 (37.1%)	9.59	.008
	2-6 hours	42	149	191		

games		(35.9%)$_a$	(33.4%)$_a$	(33.9%)		
	> 6 hours	21 (17.9%)$_a$	142 (31.8%)$_b$	163 (29.0%)		
	Total	117 (20.8%)	446 (79.2%)	563		
Computer technology /internet skill	Beginner	30 (25.2%)$_a$	176 (39.6%)$_b$	206 (36.6%)	8.42	.004
	Intermediate +	89 (74.8%)$_a$	268 (60.4%)$_b$	357 (63.4%)		
	Total	119 (21.1%)	444 (78.9%)	563		
Play digital games alone or with others	Alone	63 (52.9%)$_a$	284 (63.7%)$_b$	347 (61.4%)	4.60	.033
	Others	56 (47.1%)$_a$	162 (36.3%)$_b$	218 (38.6%)		
	Total	119 (21.1%)	446 (78.9%)	565		

Gameplay pattern categories that were not found to have a significant association with retirement status are skill level in playing digital games, playing role-playing games, playing social games online with others, and meeting new people while playing online games. Retirement status is not significantly associated with any type of game played.

Table 23 shows the significant associations between current working/volunteering status and gameplay patterns. Hours per week playing digital games and skill level with computer technology and the internet are both associated with the current working/volunteering status of older adults.

The proportion of older adults who work full-time and play less than two hours of digital games per week (49.2%, n=32) is higher than older adults who work part-time and play less than two hours of digital games per week (28.2%, n=44). There is a greater proportion of older adults who work part-time and play between 2-6 hours of digital games per week (32.2%, n=21) than older adults who do not work and play between 2-6 hours of digital games per week (29.9%, n=100). There were no proportional differences between older adults who play more than 6 hours per week across any of the working/volunteering status categories.

The proportion of older adults who rated themselves and intermediate or advanced with computer technology and the internet, and who work/volunteer part-time (77.6%, n=121) and full time (80.3%, n=53), is greater than older adults who rated themselves as intermediate or advanced with computer technology and internet who are not working or volunteering (54.8%, n=183).

Table 23. Significant associations of current working/volunteering status and game-play patterns

		Current working/volunteering status				Statistics	
Game-play pattern		**Not working**	**Part-time**	**Full-time**	**Total**	**χ^2**	**p**
Hours per week playing digital games	**< 2 hours**	129 (38.6%)$_{a,b}$	44 (28.2%)$_{b}$	32 (49.2%)$_{a}$	205 (36.9%)	14.65	.005
	2-6 hours	100 (29.9%)$_{a}$	67 (42.9%)$_{b}$	21 (32.2%)$_{a,b}$	188 (33.9%)		
	> 6 hours	105 (31.4%)$_{a}$	45 (28.8%)$_{a}$	12 (18.5%)$_{a}$	162 (29.2%)		
	Total	334 (60.2%)	156 (28.1%)	65 (11.7%)	555		
Comp tech. /internet skill	**Beginner**	151 (45.2%)$_{a}$	35 (22.4%)$_{b}$	13 (19.7%)$_{b}$	199 (35.8%)	32.44	<.000
	Intermed /Advance	183 (54.8%)$_{a}$	121 (77.6%)$_{b}$	53 (80.3%)$_{b}$	357 (64.2%)		
	Total	344 (60.1%)	156 (28.1%)	66 (11.9%)	556		

Gameplay pattern categories that were not found to have a significant association with current working/volunteering status are skill level in playing digital games, playing role-playing games, playing social games online with others, meeting new people while playing online games, and playing digital games alone or with others. Current working/volunteering status is not significantly associated with any type of game played.

4.5.6 Summary of results

A total of 28 significant associations were found between demographic characteristics and gameplay patterns of older adults who play digital games. Figure 3 shows a summary of these significant associations. Further interpretation of these findings will be done in the discussion section below.

Demographic characteristics that showed the most assocations with gameplay patterns are sex (7 associations), age (4 associations), living arrangement (5 associations), and education (5 associations). Living situation, retirement status, and current working/volunteering status showed the fewest associations with digital gameplay patterns, with three or less significant associations.

Gameplay patterns that were most associated with demographic characteristics are time spent playing digital games (6 associations) and skill with computer technology and the internet (5 associations). Skill level in playing digital games, meeting new people online, playing role playing games, and playing alone or with others were all only associated to two demographic characteristics, while playing social games online with others was found not to be associated to any demographic characteristics.

Type of game played did not seem to be associated with many demographic characteristics, with all game categories having only one or two significant associations with demographic characteristics.

Figure 3. Summary of significant associations between demographic characteristics and digital gameplay patterns of older adults

	Demographic Characteristic							
Gameplay Pattern	**Sex**	**Age**	**Liv. Arrg**	**Liv. Sit.**	**Educ.**	**Retire Stat.**	**Work /Vol**	**Total Assn**
Time spent playing DG	X	X	X		X	X	X	**6**
Skill playing DG					X		X	**2**
Skill with comp tech/internet		X		X	X	X	X	**5**
Play RPG	X				X			**2**
Play online social games								**0**
Met new people online	X				X			**2**
Playing DG alone/others		X				X		**2**
Arcade DG		X						**1**
Strategy DG	X							**1**
Puzzle DG	X							**1**
Word DG	X		X		X			**3**
Sport DG	X		X					**2**
Card/board/tile DG			X					**1**
Total Associations	**7**	**4**	**4**	**1**	**6**	**3**	**3**	**28**

4.6 Research Question 4: Is there an assocation between demographic characteristics of older adults and their perceived benefits of playing digital games?

Descriptive statistics were conducted on the two demographic variables. Perceived socio-emotional benefits score has a range of 0-7 with a mean of 1.86 (N=483, SD=2.05). Perceived cognitive benefits score has a range of 0-5 with a mean of 3.16 (N=515, SD=1.80). A Pearson product-moment correlation coefficient was computed to assess the correlation between the perceived socio-emotional benefits and perceived cognitive benefits. There was a significant correlation between the two variables (r=0.41, n=483, p<.000).

4.6.1 Perceived Socio-emotional Benefits of Playing Digital Games vs. Demographics

Non-parametric independent tests of means were conducted using either a Kruskall-Wallis or Mann-Whitney U Test. Table 24 shows the significant assocations found between perceived socio-emotional benefits of playing digital games and demographic characteristics of the older adult respondents.

An independent-samples Mann Whitney U test was conducted to compare the association of gender with the perceived socio-emotional benefits of playing digital games. There was a significant difference (U=30.43, p=.006) between males (M=2.23, SD=2.21) and females (M=1.67, SD=1.92), with males reporting a higher number of benefits than females.

An independent-samples Kruskall-Wallis Test was conducted to compare the association of living arrangement with perceived socio-emotional benefits of playing digital games. There was a significant association at the p<.05 level for the three groups (H(2, 475) = 21.29, p<.000). Pairwise comparisons indicated the mean socio-emotional benefit score for respondents living alone (M=1.96, SD=1.91) was significantly different than respondents living in a couple (M=1.41, SD=1.89) and a significant difference was found between respondents living with family/others (M=2.45, SD=2.33) and those living

in a couple. There was no significant difference between those living alone and those living with family/others. Those living with family/others reported the highest level of social emotional benefits, followed by those living alone, and those living in a couple.

An independent-samples Mann Whitney U test was conducted to compare the association of living situation with the perceived socio-emotional benefit is playing digital games. Respondents who indicated they lived at home (M=1.76, SD = 2.04) reported significantly fewer socio-emotional benefits than those who lived in assisted living/other (M=2.48, SD=2.06), (U=18,338.5, p=.001).

An independent-samples Kruskall-Wallis Test was conducted to compare the association of education with perceived socio-emotional benefits of playing digital games. There was a significant association at the p<.05 level for the three groups (H(2, 473) = 6.86, p=.032). Pairwise comparisons did not reveal any significant differences between either of the three groups; postgraduate and postsecondary (p=1.0), post graduate and high school (p=.078), post secondary and high school (p=.06). However, the global test of independence suggests that education was associated with perceived socio-emotional benefits of playing digital games, with socio-emotional benefits decreasing as the level of education increases.

Table 24. Significant associations between demographic variables and perceived socio-emotional benefits from playing digital games (comparison of means).

		Descriptive Statistics		**Test Statistics**	
Demographic Characteristic	**Category**	**Mean (n)**	**SD**	**Test Stat**	**p**
Sex	Female	1.67 (307)	1.92	U=30426.5	.006
	Male	2.23 (173)	2.21		
Living arrangement	Alone	1.96 (178)	1.91	H=21.29	<.000
	In a couple	1.41 (180)	1.89		
	Family/others	2.45 (119)	2.33		
Living situation	Home	1.76 (398)	2.04	U=18338.5	.001
	Assist living/other	2.48 (75)	2.06		
Education	High school or	2.26 (133)	2.21	H=6.86	.032

	less		
	Post-secondary	1.73 (251)	1.96
	Post-graduate +	1.69 (91)	2.04

Demographic characteristics that were not found to be significantly associated with the perceived social-emotional benefits of digital games are age, retirement status, and current working/volunteering status.

4.6.2 Perceived Cognitive Benefits of Playing Digital Games

Sex is the only demographic characteristic found to be significantly associated to the perceived cognitive benefits of playing digital games. An independent samples Mann Whitney U test was conducted to compare the association of sex with the perceived cognitive benefit of playing digital games. Males (M=3.42, SD=1.86) reported perceiving more cognitive benefits to digital games than females (M=3.03, SD=1.67); U=33,543, p=.034.

Demographic characteristics that were not found to be significantly associated with the perceived cognitive benefits of digital games are age, living arrangement, living situation, education, retirement status, and current working/volunteering status.

4.6.3 Summary of findings

A total of four significant associations were found between demographic characteristics and perceived socio-emotional benefits of playing digital games (sex, living arrangement, living situation, and education), and one significant association was found between demographic characteristics and perceived cognitive benefits (sex). Figure 4 shows a summary of these significant associations. Further interpretation of these findings will be in the Discussion section below.

Figure 4. Summary of significant associations of demographic characteristics and perceived benefits of playing digital games

	Perceived Benefit		
Demographic characteristic	**Socio-emotional**	**Cognitive**	**Total associations**
Sex	X	X	**2**
Age			**0**
Living arrangement	X		**1**
Living situation	X		**1**
Education	X		**1**
Retirement status			**0**
Current work/volunteer status			**0**
Total associations	**4**	**1**	**5**

4.7 Research Question 5: Is there a assocation between gameplay patterns of older adults and their perceived benefits of playing digital games?

4.7.1 Perceived Socio-Emotional Benefits of Playing Digital Games vs. Gameplay Patterns

Non-parametric independent tests of means were conducted using Kruskall-Wallis or Mann-Whitney U Test to compare the assocations between gameplay patterns and perceived socio-emotional benefits of playing digital games. Table 25 shows significant associations found in doing these comparisons.

An independent-samples Kruskall-Wallis Test was conducted to compare the association of time spent playing digital games (hours per week) with perceived socio-emotional benefits of playing digital games. There was a significant association at the $p<.05$ level for the three groups ($H(2, 476) = 8.64$, $p=0.013$). Pairwise comparisons indicated the mean socio-emotional benefit score for respondents who play between 2-6 hours per week ($M=1.62$, $SD=1.85$) was significantly lower than respondents who play more than 6 hours per week ($M=2.27$, $SD=2.18$). Respondents who played digital games less than 2 hours per week ($M=1.75$, $SD=2.08$) had significantly lower perceived socio-emotional benefits scores than those who play more than 6 hours a week. There was no significant difference between those who play less than 2 hours per week and those who play between 2-6 hours per week.

Independent samples Mann-Whitney U tests showed significant associations of playing RPG games ($U(1, 540)=9\ 461.5$, $p=<.000$), playing social games online ($U(1,478)=26\ 575.50$, $p<.000$), meeting new people while playing social games online ($U(1, 470)=18\ 581.50$, $p<.000$), and playing alone or with others ($U(1, 482)=34\ 032.00$, $p=<.000$) with perceived socio-emotional benefits of playing digital games. Respondents who indicated playing RPGs ($M=3.73$, $SD=2.20$), social games online ($M=2.54$, $SD=2.18$), and those who met people online while playing social games ($M=3.45$, $SD=2.25$), reported significantly higher mean scores of perceived socio-emotional

benefits to playing digital games than their non-engaged counterparts; do not play RPG (M=1.76, SD=2.01), do not play online social games (M=1.65, SD=1.92), and have not met new people online while playing digital games (M=1.65, SD=1.92). Those who played alone (M=1.51, SD=1.97) reported significantly fewer socio-emotional benefits of playing digital games than those who played with others (M=2.33, SD=208).

Table 25. Significant assocations between gameplay patterns and perceived socio-emotional benefits to playing digital games (comparison of means).

		Perceived Socio-Emotional Benefits		Test Statistics	
Gameplay Pattern	**Category**	**Mean (n)**	**SD**	**Test Stat**	**p**
Time playing digital games (hours/week)	Less than 2 hrs/wk	1.75 (176)	2.08	H=8.637	.013
	2-6 hrs/wk	1.62 (159)	1.85		
	More than 6 hr/wk	2.27 (141)	2.18		
Play RPG	Yes	3.73 (30)	2.20	U=9461.5	<.000
	No	1.76 (421)	2.01		
Play Social Games Online	Yes	2.54 (117)	2.18	U=26757.5	<.000
	No	1.65 (361)	1.96		
Met new people while playing games online	Yes	3.45 (62)	2.25	U=18581.5	<.000
	No	1.65 (408)	1.92		
Play alone or with others	Alone	1.57 (298)	1.97	U=34032	<.000
	Others	2.33 (184)	2.08		

Gameplay patterns that were not significantly associated with perceived socio-emotional benefits of playing digital games are skill in playing digital games and skill using computer technology and the internet.

4.7.2 Perceived Socio-Emotional Benefits of Playing Digital Games vs. Type of Game Played

Non-parametric independent tests of means were conducted using Mann-Whitney U Test to test the associations between type of digital games played and perceived socio-emotional benefits of playing digital games. Table 26 shows the significant associations of these comparisons.

Independent samples Mann-Whitney U test showed a significant associations between perceived socio-emotional benefits of playing arcade games (U(1, 483)=17 750.50, p=.009), strategy games (U(1, 483)=14 291.00, p=.008), puzzle games (U(1, 483)=24 240.50, p=.006) and card/board/tile games (U(1, 483)=25 093.00, p=.029). Respondents who indicated playing at least one arcade game (M=2.44, SD=2.22) and/or strategy game (M=2.60, SD=2.25) perceived significantly greater socio-emotional benefits of playing digital games than older adults who did not report playing any arcade (M=1.75, SD=2.00) or strategy games (M=1.76, SD=2.00). Older adults who indicated playing at least one puzzle game (M=1.55, SD=1.86) and/or card/board/tile game (M=1.58, SD=2.83) perceived fewer socio-emotional benefits of playing digital games than older adults who did not report playing puzzle (M=2.07, SD=1.55) or card/board/tile games (M=2.06, SD=2.00). Types of digital games that were not found to be significantly associated with the perceived socio-emotional benefits of playing digital games are word games and sport games.

Table 26. Significant associations between type of game played and perceived socio-emotional benefits to playing digital games (comparison of means).

		Perceived Socio-emotional Benefits		Test Statistics	
Type of Game Played	**Category**	**Mean (n)**	**SD**	**Test Stat**	**p-value**
Arcade Games	Yes	2.44 (73)	2.22	U=17750.5	.009
	No	1.75 (410)	2.00		
Strategy Games	Yes	2.60 (55)	2.25	U=14291.0	.008
	No	1.76 (428)	2.00		
Puzzle Games	Yes	1.55 (199)	1.86	U=24240.5	.006

	No	2.07 (284)	2.14		
Card/Board/Tile Games	Yes	1.58 (200)	2.83	U=25093.0	.029
	No	2.06 (283)	2.00		

4.7.4 Perceived Cognitive Benefits of Playing Digital games vs. Gameplay Patterns

Non-parametric independent tests of means were conducted using Kurskall-Wallis or Mann-Whitney U Test to test the associations between perceived cognitive benefits of playng digital games and the gameplay patterns of older adults. Table 27 shows the significant associations of these comparisons.

An independent-samples Kruskall-Wallis Test was conducted to compare the association of time spent playing digital games (hours per week) with perceived cognitive benefits of playing digital games. There was a significant association at the $p<.05$ level for the three groups ($H(2, 507) = 7.47$, $p=.024$). Pairwise comparisons indicated the mean perceived cognitive benefit score for respondents who play between less than two hours per week (M=2.94, SD=1.79) was significantly lower than respondents who play more than 6 hours per week (M=3.43, SD=1.73). There were no significant differences between respondents who played digital games between 2-6 hours per week (M=3.23, SD=1.825) and those who play less than two hours per week or those who played more than 6 hours per week.

Independent samples Mann-Whitney U tests showed significant associations of digital game playing skill ($U(1, 508)=37\ 711.50$), playing social games online ($U(1,508)=29\ 192.50$, $p=.001$), meeting new people while playing social games online ($U(1, 500)=18\ 277.00$, $p=.003$), with playing alone or with others ($U(1, 513)=34\ 252.00$, $p=.040$) on perceived cognitive benefits of playing digital games. Older adults who rated themselves as intermediate to advanced in their digital game-playing skill (M=3.46, SD=1.73) reported significantly higher scores of perceived cognitive benefits of playing digital games than those who rated themselves as beginners (M=2.75, SD=1.81).

Respondents who indicated playing social games online (M=3.59, SD=1.67), meeting new people online while playing social games (M=3.71, SD=1.68), and play

digital games with others (M=3.36, SD=1.76) reported significantly higher mean scores of perceived cognitive benefits to playing digital games than their non-engaged counterparts.

Table 27. Significant associations between gameplay patterns and perceived cognitive benefits to playing digital games.

		Perceived Cognitive Benefits		Test Statistics	
Gameplay Pattern	**Category**	**Mean (n)**	**SD**	**Test Stat**	**p-value**
Time playing digital games (hours/week)	Less than 2 hrs/wk	2.94 (188)	1.79	H=7.471	.024
	2-6 hrs/wk	3.23 (169)	1.83		
	More than 6 hr/wk	3.43 (150)	1.73		
Skill level playing digital games	Beginner	2.75 (196)	1.81	U=37311.5	<.000
	Intermediate+	3.46 (312)	1.73		
Play Social Games Online	Yes	3.59 (130)	1.67	U=29192.5	.001
	No	3.02 (378)	1.83		
Met new people while playing games online	Yes	3.71 (70)	1.68	U=18277	.003
	No	3.11 (430)	1.79		
Playing alone or with others	Alone	3.05 (318)	1.81	U=34252.5	.040
	Others	3.36 (195)	1.76		

4.7.5 Perceived Cognitive Benefits of Playing Digital game vs. Type of Game Played

Non-parametric independent tests of means were conducted Mann-Whitney U Test to test the associations between type of digital games played and perceived cognitive benefits of playing digital games. Arcade games were found to be the only game category that was significantly associated to the perceived cognitive benefits (U(1, 483)=19487, p=.016). Game categories that were not found to be associated with

perceived cognitive benefits are strategy games, puzzle games, word games, sport games, and card/board/tile games.

4.7.6 Summary of Findings

A total of five significant associations were found between gameplay patterns and perceived social-emotional benefits of playing digital games (time spent playing digital games, playing RPG games, playing social games online, meeting new people online, playing with others) and four game categories were found to be associated with the perceived socio-emotional benefits of playing digital games (arcade, strategy, puzzle, card/board/tile).

A total of five significant associations were found between gameplay patterns and perceived cognitive benefits of playing digital games (time spent paying digital games, digital game playing skill, playing social games online, meeting new people while playing games online, and playing with others). Only arcade games were found to be significantly associated with perceived cognitive benefits, no other game categories were found to be significantly associated. Figure 5 shows a summary of these significant associations. Further interpretation of these findings will be done in the Discussion section.

Figure 5. Summary of significant associations of gameplay patterns and perceived benefits of playing digital games

	Perceived Benefits		
Gameplay Pattern	**Socio-emotional**	**Cognitive**	**Total Associations**
Time playing digital games (hours/week)	X	X	**2**
Digital game playing skill		X	**1**
Computer tech/ internet skill			**0**
Play RPG	X		**1**
Play Social Games Online	X	X	**2**
Met new people while playing games online	X	X	**2**
Play alone or with others	X	X	**2**
Total Associations	**5**	**5**	**10**
Type of Game Played	**Socio-emotional**	**Cognitive**	**Total Associations**
Arcade	X	X	**2**
Strategy	X		**1**
Puzzle	X		**1**
Word			**0**
Sport			**0**
Card/board/tile	X		**1**
Total Associations	**4**	**1**	**5**

5.0 Discussion and Conclusion

5.1 Summary

As the world population continues to age, it is important to understand how older adults are adapting to the world around them to successfully navigate this aging process. Many older adults have positive attitudes toward technology and have integrated widespread technological tools, such as the internet, into their daily lives. Interaction with these tools tends to revolve around engaging in activities that help mitigate the socio-emotional and cognitive challenges of the aging process.. Older adults are also increasingly using technology to play digital games. Digital games can be considered a leisure activity that may help facilitate opportunities for informal learning, an important aspect of aging well.

Motivations for engaging in digital games revolve around improvement of social and emotional well-being and cognitive functioning, which is what researcher have found to be the benefits of informal learning. While research is limited in the area of benefits for older adults playing commercially available digital games, the few studies that have investigated this area have found older adults perceive digital games to have a variety of social and cognitive benefits. Many of the studies that have found social and emotional benefits to playing digital games in older adults have been in the context of physical games as part of a social program, such as playing Wii Sports in retirement communities (Studenski, et al., 2010; Wollersheim, et al., 2010). More relevant research has found older adults to perceive digital games as having social benefits such as distracting from feelings of loneliness (De Schutter & Brown, 2016), staying connected with family (De Schutter & Malliet, 2014; Nap, de Kort, & Ijsselsteijn, 2009), and providing a way to stay socially connected (De Schutter & Malliet, 2014; McLaughlin, Gandy, Allaire, & Witlock, 2012). Early research investigated the cognitive benefits of playing arcade games in older adult populations and found arcade games played on the Atari system has some

cognitive benefits such as improved reaction time and processing speed (Goldstein, et al., 1997; Dustman, Emmerson, Seinhous, Shearer, & Dustman, 1992; Clark, Lanphear, & Riddick, 1987; Weisman, 1983). Digital games today have been found to be associated with cognitive benefits such as selective visual attention (Belchior, et al., 2013). Although the research into direct measurement of cognitive improvement in older adults who play digital games is very under researched, a few other studies have found older adults perceive digital games to have general cognitive benefits (Whitbourne, Ellenberg, & Akimoto, 2013).

The current study aimed to gain a better understanding of the gaming profile of older adults living in Canada, by looking at demographic characteristics and various aspects of gameplay, including types of game played and time spent playing digital games. The research also investigated the amount of socio-emotional and cognitive benefits older adults perceived from playing digital games, and what demographic and gameplay factors were associated with higher perceived benefits in these areas. By gaining a more detailed understanding of who is playing digital games, how they are playing, and the related benefits, researchers and industry professionals can tailor future research to more accurately defined populations and develop tools to cater more effectively to older adults.

Data were collected from older adults who were over the age of 55. Complete survey data were collected from older adults who identified themselves as having played digital games, and demographic information as well as a few other questions about leisure actives were collected from older adults who did not play digital games. Only data from the older adults who play digital games is used in the current study. Cross tabulations were run between demographic and gameplay patterns to identify any associations. Non-parametric comparison of means was conducted with socio-emotional benefits and cognitive benefits as dependent variables and demographic characteristics and gameplay patterns as the independent variables to identify significant associations.

5.1.1 Key Findings

1. Gameplay pattern variables and demographic characteristics showed a large number of associations. Sex, living arrangement, and education are the demographic variables with the most associations, and time spent playing digital games and skill level with computer technology and the internet are the gameplay pattern variables with the most associations.
2. Perceived social and emotional benefits of digital games were associated with sex, living arrangement, living situation, and education whereas perceived cognitive benefits were only associated with sex.
3. Perceived social and emotional benefits and perceived cognitive benefits were associated with similar gameplay patterns variables; time spent playing digital games, playing social games online with others, meeting new people while playing social games online, and playing alone or with others.
4. Game genre has an impact on how older adults perceive the benefits of digital games. Older adults who played arcade games reported higher levels of perceived socio-emotional and cognitive benefits than those who did not. Older adults who played strategy games reported a higher number of perceived socio-emotional benefits than those who did not. Older adults who played puzzle games or card/board/tile games reported fewer socio-emotional benefits than those who did not.

5.2 Interpretation of Findings

Research in the area of understanding the nuanced details of older adult digital gamers is minimal but gaining popularity. The current study compared a large number of associations to help identify variables that are significant in mediating the various aspects of digital game play. Variables that were found to have a high number of associations can be considered factors all studies in the area should control for when looking to investigate various aspects of older adults' digital game play and outcomes such as perceived benefits.

The current analyses only help to show the potential benefits for older adults who are already engaging in digital games and results will be interpreted accordingly. Findings here do not imply digital games are more beneficial than other leisure activities, nor do they suggest forcing older adults to engage in digital games will yield the same results. With data showing older adults are increasingly engaging in digital games and society's growing concern of how to assist the aging population in the developmental process, identifying the benefits and related variables will help understand how to encourage and support this specific activity within this population. These findings may also be beneficial to game developers looking to target older adult audiences, specifically by highlighting what types of games this population engages in and their reasons for doing so. Additionally, as McKay and Maki (2010) suggested, understanding where older adults' interest lie will also help in the development of digital games intended to training cognitive skills. Shooter games are found to be effective in improving various cognitive abilities in young adults and these types of games are used for this demographic in cognitive training contexts. However, older adults are distinctly disinterested in this genre of game and therefore this should be considered when developing cognitive training resources in this demographic.

5.2.1 Demographics and digital gameplay patterns of older adults

A few studies have collected demographic and gameplay pattern data from older adult participants. Variables showing the highest number of associations will be discussed in the context of current literature to explain the implication of these findings. Demographic variables showing the highest number of associations are sex, living arrangement, and education. Gameplay patterns showing the highest number of associations are time spent playing digital games, skill with computer technology/internet, meeting new people online, and playing digital games alone or with others (e.g., friends, family, members of a club).

Sex differences in older adult digital gamers

Researchers have reported more female than male digital gamers, with proportion of females reported ranging from 57% to 70% (De Schutter, 2011; Allaire, et

al., 2013; Delwiche & Henderson, 2013; Pearce, 2008). The current sample of digital gamers consisted of 62.5% females, which at first glance looks to be in line with what previous research has found. These data were taken from a portion of larger data which were collected from older adult gamers and non-gamers. The entire data set contained 63.1% females. However, when looking at the gender breakdown of gamers and non gamers, males and females were actually found to be equally split, 50.7% of all males reported playing digital games and 49.4% of all females reported playing digital games. As previously discussed, the unbalanced gender findings in previous studies may be a result if sampling bias, and results of this study seem to confirm this notion. This gender equality in digital gaming is important to note since it places equal important on addressing needs, concerns and perceptions of both male and female audiences.

The current study found sex to be associated with a number of gameplay pattern variables and perceptions of socio-emotional and cognitive benefits. Males reported meeting more people online, playing more RPG, strategy, and puzzle games, playing fewer puzzle and word games, and perceived higher levels of social and cognitive benefits to playing digital games, compared to female respondents. The perceived benefits of digital games are most likely more complex than can be explained by one demographic variable, such as sex. Males experiencing more social and emotional benefits from playing games might have been further associated with the sex differences in meeting more people online, playing RPG games, and playing strategy games, all of which males reported as engaging in more frequently than females and are gameplay pattern variables that were found to be positively associated to social and emotional benefits. Additionally, females reported playing more puzzle games than males and these were found to be associated with lower levels of perceived social and emotional benefits.

Living arrangement & Education

Older adults' living arrangement showed the most associations to gameplay characteristics and perceived benefits, next to participants' sex, and was tied with education. Living arrangement was found to be associated with skill with computer technology and the internet, playing puzzle games, word games, sports games, card/board/tile games, and perceived socio-emotional benefits. This is an unexpected

but important finding, because it implies the environmental context of the older adult impacts their perceptions and engagements with digital games.

Older adults who were living in a couple perceived significantly more socio-emotional benefits than older adults living alone or with family or others. This sentiment was expressed be a participant in Nap's (2009) interviews of older adults who said playing digital games with her significant other was one of their favourite pastimes. These results seem to contradict research which has shown older adults have commonly expressed their grandchildren's interest in playing digital games as a reason they began engaging in digital games (Wollersheim, et al., 2010; Nap, de Kort, & Ijsselsteijn, 2009; Quandt, Grueninger, & Wimmer, 2009). However, it may be older adults don't associate the socio-emotional enjoyment as much to the digital game itself but rather to the social situation while engaging in digital games with family members. It may also be the only social benefits they perceive come from playing with those who interested them in the digital game and they are unable to experience the same benefits outside of these social contexts. These findings highlight the important of understanding motivators and perceived benefits as different facets of older adults' engagement in digital games. Within the current data, two dimensions in the socio-emotional benefits variable asked older adults whether or not digital games increased or decreased connections with family and connections with various age groups. In the future, these two socio-emotional dimensions could be extracted from the aggregated variable to test for significant differences between those living alone, in a couple, or with family to further understand how living arrangement moderates the perceived social benefits of playing digital games.

The studies that have investigated various associations of older adults' perceptions and motivations for playing digital games either collect educational data and only report it as a descriptor of the population, or do not collect the data at all. Crosstabs revealed education was significantly associated with five gameplay patterns, time spent playing digital games, skill in playing digital games, skill with computer technology/internet, playing RPG games, and, meeting new people online, and perceived socio-emotional benefits of playing digital games. Having such a large number of associations, future studies should be sure to control for education when interpreting their findings.

Time spent playing digital games

Time spent in playing digital games has been inconsistently measured. Some studies take it as a measure of number of days per week or month (Lenhart, Jones, & MacGill, 2008; Allaire, et al., 2013), while others take it as number of hours per week (De Schutter, 2011; Pearce, 2008; Delwiche & Henderson, 2013). These inconsistencies have made it difficult in understanding how time impacts older adults' perceptions of playing digital games. Unfortunately, this study adds another inconsistent measure of time since creating three different time categories, less than two hours, two to six hours, and more than six hours. Since time data were collected through two variables in the survey, number of days per week and number of hours per day as a range, there was no raw data indicating the exact hours per week older adults spent playing digital games. Previous research has also been inconsistent in its report on how much older adults are actually playing digital games and there is no strict benchmark with which to measure our data against.

Even with these limited categories, time was found to be associated with a number of demographic characteristics including sex, age, living arrangement, education, retirement status, and working/volunteering status. There were more males than females in the less than two hours per week category, but equal distribution of gender in the other two categories. Older age categories were associated with less time spent playing digital games, 75+ played the last, followed by 65 to 74 year olds, and finally 55 to 64 year olds played the most. Individuals with post-secondary or post graduate educations reported playing more than 6 hours per week less frequently than those in high school. Retired individuals played more than their non-retired counterparts, and those working part-time play more than those working full-time but about the same as those who are not working. Time invested in playing digital games is associated with a number of demographic variables and may, in turn, share associations with other gameplay characteristics. However, time was not compared against the other digital gameplay categories, and this should be considered in future investigations to understand if certain games or game interactions are associated with more time spent playing digital games.

More time playing digital games was associated with more perceived socio-emotional benefits and cognitive benefits. However, since time was measured as categories instead of exact amounts, details might have been lost in the actual impact of time on these benefits. Results showed only older adults who played more than 6 hours per week on digital games perceived significantly more socio-emotional and cognitive benefits to playing digital games than those who played fewer than 6 hours. These findings suggest there may be a minimum threshold that needs to be achieved in order for older adults to perceive the benefits of playing digital games.

5.2.2 Perceived benefits of playing digital games

There were a number of characteristics, both demographic and gameplay, related to the perceived socio-emotional and cognitive benefits of playing digital games in older adults. Respondents who perceived the most socio-emotional benefits to playing digital games are either males, living alone or in a family, at home, or with less than a high school education. Gameplay patterns with the highest number of perceived socio-emotional benefits are those who; play more than six hours per week, play RPG games or online social games, meet new people while playing games online, and play with others. Game genres with the highest perceived socio-emotional benefits are arcade games and strategy games, and those who played puzzle and card/board/tile games perceived fewer socio-emotional benefits than those who did not. Respondents who perceived the most cognitive benefits were males. Gameplay patterns with the highest number of perceived cognitive benefits are those who; play digital games more than six hours per week, consider themselves to be intermediate or advanced digital game players, play online social games, meet new people while playing games online, and play with others. Those who played arcade games perceived more cognitive benefits than those who did not.

In investigating the perceived socio-emotional and cognitive benefits of playing digital games, we hope to gain a better understanding of the types of factors that may influence the se perceptions. As previously discussed, social well-being and cognitive functionality in old age are found to be closely related to one another. Research has not yet been able to identify the casual association between these two broad areas,

probably in part due to the broad definition of both of these constructs (Lawton, 1983; James, Wilson, Barnes, & Bennett, 2011; Wilson, et al., 2013). In this study, increases in perceived socio-emotional benefits and perceived cognitive benefits were found to be significantly correlated with one another, similar to what the previously mentioned research has found in other aspects of older adults social well-being and cognitive benefits. When considering the significant associations found between perceived cognitive benefits and the demographic and gameplay pattern variables the actual associations may be more complicated than can be explained by one variable.

Older adults perceived a higher number of cognitive benefits from playing digital games than socio-emotional benefits. Respondents perceived an average of 3.16 out of a possible total of 7 cognitive benefits to playing digital games and perceived an average of 1.86 out of a possible total of 5 socio-emotional benefits. This difference may be explained by the types of games older adults were found to be playing. In the gameplay pattern variables that reflected social aspects of playing digital games (playing RPG online with others, playing social games online, meeting new people while playing digital games online, and playing with others), less than one third of participants responded yes to engaging in any one of these activities (7.1% play RPG games online with others, 26.6% play social games online, 14.7% met new people while playing online, and 38.7% play digital games with others). Older adults who were found to engage in these gameplay patterns had significantly higher scores of perceived socio-emotional benefits to playing digital games, implying a very strong association between these variables and perceived socio-emotional benefits. Cognitive benefits may have been more strongly perceived by the entire population because there are cognitive training aspects to all types of digital games, and this is not specific to whether or not individuals are engaging in the game socially. However, as previously discussed, social and emotional well-being are found to be correlated with cognitive functioning, and this pattern was again seen in results showing older adults who engaged in the social gameplay patterns also perceived significantly more cognitive benefits to the non-social gamers. The only social gameplay pattern which did not show an association with perceived cognitive benefit was playing RPG games online with others.

Age was not found to be significantly associated with perceived socio-emotional benefits or cognitive benefits to playing digital games. This contradicts with the findings of Whitebourne et al. (2013) that found adults between the ages of 50 and 59 differed in perceptions of cognitive benefits of playing a digital game, Bejeweled. These two age groups also expressed different motivations for playing this game. No other studies that could be found explicitly discussed the differences between older adults' perceptions of digital games within the overall age group. Findings of this study may indicate there are no differences between older adult age groups in their perceptions of benefits of digital games.

Socio-emotional benefits of playing digital games

Older adults living in assisted living or nursing homes perceived more socio-emotional benefits to playing digital games than participants who lived at home. Older adults who live in assisted living or nursing facilities have been found to be at greater risk for feelings of depression and loneliness (Cohen-Mansfield, Hazan, Lerman, & Shalom, 2016). Digital games may provide an opportunity to help mitigate this increased risk for social isolation since they are portable and accessible. As previously discussed, nursing homes and assisted living facilities have had success when implementing digital game based interventions (Wollersheim, et al., 2010; Rosenberg, et al., 2010). The current study emulates these findings from the perspective of naturally occurring gameplay compared to a trained intervention situation.

Socio-emotional benefits were positively associated with social gameplay patterns, including playing RPG games, playing social games online, meeting new people while playing games online, and playing with others. However, more than half of all respondents reported not engaging in these types of gameplay, only 30 respondents reported playing RPG games at all. These gameplay patterns showed the highest levels of perceived socio-emotional benefit, yet captured on a small portion of the same. It might be because these types of games and gameplay methods are more complex. Previous literature has a identified lack of support in learning new technology and inability to access resources to help them learn a new tool as deterrents to adoption (Nap, de Kort, & Ijsselsteijn, 2009; Delwiche & Henderson, 2013). Older adults might not be learning these types of games on their own because of the lack of resources

available to them. Individuals may not be gaining the most from digital games because they are limited to interacting with games that are simplistic or adaptions of what they already know, for example playing traditional card games in a digital setting.

It is promising to see that older adults who play social games online still see social benefits to engaging with them. Older adults who may be limited in their social interactions due to disabilities that prevent them from being mobile, or who may not have access to in-person social activities, can potentially increase their social well-being through online interactions with others. Digital games provide an activity for multiple people to collaborate in a fun environment in solving puzzles, learning new strategies, or becoming more comfortable using technology.

Cognitive benefits of playing digital games

Perceived cognitive benefits were found to be associated with only one type of game, arcade games. As previously discussed, the earliest literature on digital games looked at the cognitive benefits on arcade-type games and found them to be effective in improving cognitive functioning in areas such as spatial reasoning and reaction speed (Goldstein, et al., 1997; Dustman, Emmerson, Seinhous, Shearer, & Dustman, 1992; Clark, Lanphear, & Riddick, 1987; Weisman, 1983). Two of the cognitive dimensions included in the present study's definition of cognitive benefits included reasoning and reaction speed. In the future, more in-depth analyses could be conducted to see if these two cognitive skills were perceived more in those who played arcade games compared to those who did not.

Impact of game genre on perceived benefits of playing digital games

Older adults favour games of word, puzzle, and card genres (Pearce, 2008; Entertainment Software Association of Canada, 2014; De Schutter, 2011; Allaire, et al., 2013; Nap, de Kort, & Ijsselsteijn, 2009), while tending to dislike fighting, shooting, and sport games (De Schutter, 2011; Pearce, 2008). Findings of the current study partially confirmed previous research, with the most common genres being card/board/tile games and puzzle games. Arcade and strategy games were listed more frequently than word games, which is not in line with research. This may however be because previous

studies have not considered strategy and arcade games as genres in their analyses. Fighting and shooting genres both contained fewer than 20 responses out of all participants. Sport games also contained a small number of responses within the population.

Participants who played arcade games reported higher levels of perceived socio-emotional and cognitive benefits compared to those who did not. This was the only game genre that was associated with an increase in perceived cognitive benefit. As previously mentioned, early digital game research found arcade style games had some cognitive benefits (Goldstein, et al., 1997; Dustman, Emmerson, Seinhous, Shearer, & Dustman, 1992; Clark, Lanphear, & Riddick, 1987; Weisman, 1983). Whitbourne et al. (2013) found older adults perceived various cognitive benefits to playing *Bejeweled*, an arcade game. Research has shown support for the cognitive benefits of playing arcade games. The perceived socio-emotional benefits of arcade games remains a mystery. Arcade games were not found to be associated with any demographic characteristics associated with increased socio-emotional benefits. It may be arcade games are frequently played on devices where social networking is also embedded, i.e., playing *Bejeweled* on Facebook.

Puzzle games and card/board/tile games were both associated with lower levels of perceived socio-emotional benefits, that is, older adults who played puzzle and/or card/board/tile games reported fewer socio-emotional benefits than those who did not play these types of games. These two genres contained the largest number of participants with 41% of all respondents reporting having played puzzle games and/or card/board/tile games most frequently. Literature has not looked specifically at these genres in the context of socio-emotional or cognitive benefits. These games may be more single-player in nature and provide less opportunity to interact socially with others while playing them. For example, Solitaire, Mahjong, and Tetris are typically played alone. There may also be motivational factors influencing the perceived benefits of the games. Older adults might be playing them to pass the time or avoid completing other tasks instead of engaging in them purely for enjoyment.

These conflicting findings regarding game genres provides an opportunity to consider the value in categorizing games based on genre. The categorization of game

genres is difficult to achieve since there is overlap in many of the qualities some games may share. For example, *Tetris* is considered a puzzle game in this study, but has previously been categorized as an arcade game (Belchior, et al., 2013; Zelinski & Davis, 2009) and puzzle game (Pearce, 2008) in other studies. *Bejeweled* was categorized as an arcade game in accordance with previous research (Whitbourne, Ellenberg, & Akimoto, 2013), but shares some gameplay features with Tetris such as pattern recognition. Since genres in this study did show associations with a number of variables, there are implications that it is important to consider in the context of benefits perceived. Future studies could look at categorizing games based on shared features rather than general genres in order to better identify which aspects of gameplay are associated with specific benefits. Elements that digital games couple be categorized on include: multiplayer or single player games, repetitive motions (i.e., *Tetris, Angry Birds*), reflexive movements (i.e., sports games, fighting games), or vocabulary knowledge (i.e., *Scrabble, Boggle, Text Twist*).

5.3 Limitations

There were limitations to this study both from a design perspective and a data analysis perspective. Sampling was conducted in only in-person settings (i.e., shopping centres and retirement communities). Previous literature has been inconsistent in profiling older adult gamers, mainly because of varying sampling methods. As previous discussed, Pearce's (2008) found most of the older adult population played MMOPG games, where no other study found this to be the case because she sample was gathered from online forum, perhaps where older adults who play these type of games were more active. To gain a more diverse representation of the older adults playing digital games, different methods, such as online communities and game forums, should be targeted.

The association between benefits of playing digital games, gameplay patterns, and demographics appears to be a complex situation and more sophisticated analyses could have been performed to answer some of the peculiar findings. The data collected from this survey does provide the information needed to conduct more in-depth analyses and should be considered in future research.

The measurement of some variables can be improved in future surveys. Studies seem to vary widely in how they measure the amount of time playing digital games, with some studies interested in the number of days per week played and others documenting a range. Having participants document the number of hours in a given timeframe (i.e., week) will allow data analyses to be more accurate in evaluating the association of time on perceptual benefits. The grouping used in this study, less than two hours, 2 to 6 hours, and more than six hours per week were created from combining two variables (how many days a week do you play and how many hours per day do you play – measured as a range) then developing three categories based on these measures. By keeping time, a continuous variable, it might be more valuable in helping identify correlations and used in modeling factors that are relate to increases in time. This survey used age as a range instead of a discrete values as well and this also led the limitation of using age in more detailed correlational analyses and regression modelling.

5.4 Conclusion

Older adults are increasingly spending their time engaging in digital games for leisure. How they play digital games is diverse, ranging in the types of games they play and who they play these games with. There were a large number of associations found between demographics characteristics, gameplay patterns, and perceived benefits, both socio-emotional and cognitive. Identifying these associations provide two major insights. The first being older adults' perceptions of benefits from playing digital games are not homogenous and are rather complex. The second being older adults do find digital games to be a source of socio-emotional benefit and cognitive benefits. These insights can help guide various professionals who are looking to develop new digital games for older adults or organizations looking to develop social programs to promote digital gaming in specific communities. Findings can also help future researchers develop better collection methods and provide direction on which associations to investigate in similar areas of study.

This study shows how older adults demographic and gameplay characteristics are associated with their perceptions of the benefits of playing digital games. While previous research has focused on a few demographic characteristics such, as gender

and education, and a few gameplay patterns, such as genre and amount of time spent playing, no other study has looked at this many factors. With the number of significant associations found, it is evident that older adults are not homogenous in how they interact and perceive digital games. This advances our knowledge and understanding of how older adults adapt to changing technologies and identifies groups who may be adopting new technologies at a different rate. There may be a number of reasons for this such as lack of access to learning resources, lack of access to technology, or lack of understanding as to how these activities could benefit them. Researchers can use this information to see if these populations actually feel they do not benefit from playing digital games, or identify other barriers that may be preventing them from actively engaging in them as a form of leisure.

These promising results that digital games have social and cognitive benefits as a leisure activity also provide confidence in using them as a tool to facilitate learning opportunities. Learning through leisure has been found to be beneficial for older adults and finding ways to immerse older adults in learning opportunities is important when considering improvements to quality of life (Dench & Regan, 2000). Nearly 40% of the older adults in this study reported playing digital games with others which suggests a social motivation for engaging in these games and additionally provides an opportunity for older adults to learn from one another as they play digital games games. In knowing which groups of older adults benefit from which specific types of gameplay can help educational technologists facilitate learning environments that will provide the most benefit.

Findings from this study should also be taken into consideration to improve data collection and categorization methods used by future researchers. Since the area of literature investigating the perceived benefits of digital games casually played by older adults is limited and new, most studies have been descriptive in an attempt to gain a better understanding of the demographic as a “bigger picture”. Research is ready to move into more sophisticated stages to develop more in-depth understandings of how the various factors work together to yield the largest socio-emotional and cognitive gains.

Providing opportunities for older adults to remain socially and cognitively active throughout their lives are necessary components in the model of aging well (Rowe & Kahn, 1997). Education and learning facilitate both of these aspects of well being. Most of the older adults in the present study were able to identify at least one socio-emotional and one cognitive benefit to playing digital games. Digital games provided older adults with the opportunity to interact with others, learn new skills, improve their memory, and have fun. In a world where technology is becoming more present, older adults who did not grow up this these tools, are adapting to their environments. Gaining a better understanding of who and how older adults are playing digital games as a form of leisure activity provides the knowledge in how to successfully develop new programs and tools to assist in the aging process.

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Appendices

Appendix A.

Questionnaire – English Version

SFU SIMON FRASER UNIVERSITY
ENGAGING THE WORLD

FACULTY OF EDUCATION AND GERONTOLOGY RESEARCH CENTRE
SURVEY OF OLDER ADULTS AND GAME PLAYING

This survey is designed for adults aged 55 years and over.

1. What are your three main leisure activities?
   (for example, TV, movies, walking, sports, bingo, photography, internet, etc.)

   a) _____

   b) _____

   c) _____

Non-Digital Games refer to all types of games that don't require the use of digital devices to play. Some examples include social games such as Trivial Pursuit, Monopoly, Concentration, Clue, card games such as Patience, Bridge, Hearts, Crazy Eights, Checkers, and Chess. Casino games such as slot machines are considered as non-digital games since skill is not required.

2. Have you played non-digital games in the past year?
   ☐ Yes (**GO TO A**)
   ☐ No (**GO TO B**) WHY NOT? _____

A. NON-DIGITAL GAMES

3. When you have played games, how many hours on average did you play in a day?
   ☐ 1 hr or less ☐ 2-3 hrs ☐ 4-5 hrs ☐ 6-8 hrs ☐ More than 8 hrs

4. Which games have you played? (For example, card games, board games, other)?

   _____

5. With whom have you played non-digital games? (select all that apply)
   ☐ On my own
   ☐ Family members (e.g., partner, children, relatives)
   ☐ Friends
   ☐ With members of a club or association
   ☐ Other_____

6. Why do you play non-digital games? _____

7. What do you think are the benefits of playing non-digital games? (*select all that apply*)
   - ☐ Mental exercise
   - ☐ Social interaction
   - ☐ Enjoyment (fun)
   - ☐ Escape from daily life
   - ☐ Other _____

B. DIGITAL GAMES

Digital Games refer to all types of video games and computer games, whether played on computers, handheld devices, video game consoles or other means. Casino games that require skill such as poker or blackjack are considered as digital games.

8. Have you played digital games in the past year?
   - ☐ Yes (**GO TO Q. 9**)
   - ☐ No (**GO TO C**) Why not?_____

9. How many years have you been playing digital games?
   ☐ Less than 1 year ☐ 1-4 years ☐ 5-9 years ☐ 10 + years

10. Have you played digital games in the past month?
    - ☐ Yes
    - ☐ No Why not?_____

11. During the past **month**, how many **days per week on average** have you played digital games?
    ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

12. During the **past month**, when you played digital games, how many **hours per day on average** did you play?
    ☐ 1 hr or less ☐ 2-3 hrs ☐ 4-5 hrs ☐ 6-8 hrs ☐ More than 8 hrs

13. What is your skill level in playing digital games?
    ☐ Beginner (Low level) ☐ Intermediate (Middle level) ☐ Expert (High level)

14. What is your skill level in using computer technology/Internet?

☐ Beginner (Low level) ☐ Intermediate (Middle level) ☐ Expert (High level)

15. Which digital games have you played, either alone or with others?

1) _____

2) _____

3) _____

16. Which of the following devices did you use to play digital games? (*select all that apply*)

☐ A video game console (example: Xbox, Playstation, Wii)

☐ Portable device (example: Nintendo DS, Gameboy, Playstation PSP)

☐ Desktop or laptop computer

☐ Handheld device (example: iPhone, iPad, Android, Blackberry, other tablets)

☐ Digital game machine in a casino

17. Have you played role-playing games online with other players? (e.g., World of Warcraft, Everquest)

☐ Yes ☐ No ☐ Don't know what this is

18. Have you played social games online with other players? (e.g., bridge, chess, scrabble, Facebook games)

☐ Yes ☐ No ☐ Don't know what this is

19. Have you met new people while playing these online games?

☐ Yes ☐ No

20. Have you played digital games? (*select all that apply*)

☐ Alone

☐ With others who are in the same room with you

☐ With others online through the internet

21. With whom have you played digital games? (*select all that apply*)

- ☐ On my own
- ☐ Family members (e.g., partner, children, relatives)
- ☐ Friends
- ☐ Members of a club or association
- ☐ Others _____

22. What do you think are the greatest benefits of playing digital games? (*select all that apply*)

- ☐ Mental exercise
- ☐ Social interaction
- ☐ Enjoyment (fun)
- ☐ Escape from daily life
- ☐ Other _____

23. What are your main difficulties in playing digital games? (*select all that apply*)

- ☐ Difficult to see or hear
- ☐ Too complicated
- ☐ Privacy
- ☐ Difficult to use controller
- ☐ Limited or no access to technology
- ☐ Other _____
- ☐ None

24. In your opinion, has playing digital games increased or decreased the following:

Social & Emotional	Increased	No difference	Decreased
Developing new friendships	☐	☐	☐
Connecting with current friends	☐	☐	☐
Connecting with family	☐	☐	☐
Connecting with various age groups	☐	☐	☐
Developing self-confidence	☐	☐	☐
Dealing with loneliness	☐	☐	☐
Dealing with depression	☐	☐	☐

25. In your opinion, has playing digital games increased or decreased the following:

Cognitive	Increased	No difference	Decreased
Focussing attention	☐	☐	☐
Memory	☐	☐	☐
Reasoning	☐	☐	☐
Problem solving	☐	☐	☐
Speed in reacting/responding	☐	☐	☐

26. In your opinion has playing digital games increased or decreased the following:

Technological Skills	Increased	No change	Decreased
Computer skills	☐	☐	☐
Internet skills	☐	☐	☐
Digital game-playing skills	☐	☐	☐

C. BACKGROUND / DEMOGRAPHICS

27. Sex:

☐ Male ☐ Female

28. Age:

☐ 55-59 ☐ 60-64 ☐ 65-69 ☐ 70-74 ☐ 80-89 ☐ 90 +

29. Primary language

☐ English ☐ French ☐ Other_____

30. Country:

☐ In which country were you born?_____

☐ In which city do you live now?_____

31. What is your ethnic group?

☐ Caucasian ☐ Asian ☐ African-American ☐ Aboriginal ☐ Other_____

32. Living arrangement:

☐ Alone ☐ In a couple ☐ With family ☐ With others

33. Where do you live?

☐ Home ☐ Assisted-living facility ☐ Nursing home ☐ Other _____

34. Level of education completed:

☐ Less than High school

☐ High school or equivalent (such as GED)

☐ Some College/CEGEP

☐ 2-Year degree (associate, diploma)

☐ 4-Year degree (BA, BS)

☐ Professional designation (e.g., CA,CGA,CMA)

☐ Master's Degree

☐ Doctoral Degree (e.g., PhD, EdD, MD, JD)

35. Are you retired?

☐ Yes ☐ No ☐ Never worked

36. Describe your working situation at the present time:

☐ Not working

☐ Working part-time (paid or voluntary)

☐ Working full-time (paid or voluntary)

Thank you for completing this survey.

DRAW FOR $100. If you wish to become eligible for the lucky draw of three $100 cash prizes, please provide your contact information on the separate card provided.

Appendix B.

Code Book

Variable			Categories		
Demographics	**Range**	**0**	**1**	**2**	**3**
Q27-Sex	0, 1	Female	Male		
Q28-Age	1, 2, 3		55-64	65-76	75+
Q32-Live	1, 2, 3		Alone	Couple	Family/Other
Q33-Live	1, 2		Home	Assisted Living	
Q34-Educ	1, 2, 3		High School	Post Secondary	Post Grad
Q35-Retire	0, 1	No	Yes		
Q36-Work	1, 2, 3		Not working	Part time	Full time
Gameplay Pattern	**Range**	**0**	**1**	**2**	**3**
Q11x12	1, 2, 3		< 2 hr/wk	2-6 hr/wk	>6 hr/wk
Q13-Skill	1, 2, 3		Beginner	Intermediate	Advance
Q13-Recoded	1, 2		Beginner	Intermediate+	
Q14 - Skill	1, 2, 3		Beginner	Intermediate	Advance
Q14-Recoded	1, 2		Beginner	Intermediate+	
Q15-Arcade	0, 1	No	Yes		
Q15-Strategy	0, 1	No	Yes		
Q15-Puzzle	0, 1	No	Yes		
Q15-Word	0, 1	No	Yes		
Q15-Sports	0, 1	No	Yes		
Q15-Card	0, 1	No	Yes		
Q17-RPG	0, 1	No	Yes		
Q18-Soc	0, 1	No	Yes		
Q19-Soc	0, 1	No	Yes		
Q20-Who	0, 1	No	Yes		
Self-Reported Benefits	**Range**	**0**	**1**	**2**	**3**
Social_Emotional_Count	0-7				
Q24A	0, 1	No	Yes		
Q24B	0, 1	No	Yes		
Q24C	0, 1	No	Yes		
Q24D	0, 1	No	Yes		
Q24E	0, 1	No	Yes		
Q24F	0, 1	No	Yes		
Q24G	0, 1	No	Yes		
Cognitive_Count	0-5				
Q25A	0, 1	No	Yes		
Q25B	0, 1	No	Yes		
Q25C	0, 1	No	Yes		
Q25D	0, 1	No	Yes		
Q25E	0, 1	No	Yes		