INCREASING QUALITY OF LIFE FOR OLDER ADULTS LIVING IN COLLECTIVE DWELLINGS USING VIRTUAL REALITY: A FEASIBILITY STUDY

by

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Abstract

The number of older adults living in collective dwellings is increasing. It is important to research effective strategies to maintain and enhance quality of life for older adults living in collective dwellings. Meaningful leisure, such as the ability to travel, is associated with increases in quality of life for older adults. Unfortunately, many older adults, especially those living in collective dwellings, face barriers to travel. Virtual reality (VR) may help older adults living in collective dwellings overcome barriers to travel. The present study examined whether older adults living in collective dwellings tolerated and enjoyed immersive VR, and whether six weeks of virtual tourism affected their quality of life, social engagement, and loneliness. Fourteen older adults living in retirement homes in Toronto participated in this study. Results suggested that participants tolerated immersive VR without experiencing cybersickness, and that they were happier, more excited, and less anxious immediately following VR exposure. Levels of social engagement increased following the six-week virtual tourism program. These quantitative findings were further supported by qualitative interviews. No changes in quality of life or loneliness were found. Limitations include a lack of a control group and small sample size. Addressing these limitations will help to isolate the effects of the virtual tourism program on indices of well-being.

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The population is aging at an increasingly high rate. In 2016, 16.9% of the Canadian population was over the age of 65, the highest it has ever been (Statistics Canada, 2011a; Statistics Canada, 2017a). As the baby boomer generation ages, and with increases in life expectancy, the proportion of older adults in Canada is projected to increase to up to 25% by the year 2036, making one in every four people over the age of 65 (Statistics Canada, 2011c). From 2011 to 2016, the proportion of adults over the age of 85 grew almost four times faster than the rest of the Canadian population (Statistics Canada, 2017b). This trend is not limited to Canada. Worldwide, the proportion of adults over the age of 60 has increased by 48% from 2000 to 2015, with a projected increase of 56% by the year 2030 (United Nations, 2015). Just over 30 years from now, the number older adults in the world is expected to hit a record-setting 2.1 billion (United Nations, 2015). For the first time in history, the number of adults over the age of 65 is expected to be greater than the number of children (Statistics Canada, 2011a; United Nations, 2015).

An increase in the number of adults over the age of 65 means an increase in the number of adults entering collective dwellings (Statistics Canada, 2011b). The term *collective dwelling* encompasses such places as senior residences (i.e., retirement homes), nursing homes (i.e., long-term care facilities [LTCFs]), and facilities that offer multiple or mixed services (Statistics Canada, 2017b). Retirement homes provide support with activities of daily living for relatively independent older adults, whereas nursing homes and LTCFs provide medical and personal services to older adults who are no longer able to live independently (Centers for Disease Control and Prevention, 2017; Statistics Canada, 2017b). In 2016, 1.2% of the entire Canadian

population lived in a collective dwelling, a rate that increases with age; 29.6% of adults over the age of 85 live in a type of care facility (Statistics Canada, 2011b; Statistics Canada, 2017c). In assessing older adults' reasons for moving into nursing homes, Scocco, Rapattoni, and Fantoni (2006) found that less than 6% reported making the personal decision to move, with 26.5% reporting the necessity to move due to loneliness. The authors also reported that the majority of participants had a previous psychiatric diagnosis and were unable to live independently upon admission to a nursing home (Scocco et al., 2006).

The rise in the number of older adults living in collective dwellings poses many challenges for health care providers and psychologists alike. Moving into LTCFs is often associated with decreases in quality of life, well-being, and life satisfaction, as well as increases in levels of depression and loneliness (Borowiak & Kostka, 2004; Hedayati, Hadi, Mostafavi, Akbarzadeh, & Montazeri, 2014; Pinquart & Sörensen, 2001). While it is important to maintain quality of life throughout the lifespan, it is especially important to maintain quality of life for older adults, as they are at a higher risk for poor health outcomes (Brett et al., 2012). This review will include a discussion of quality of life and how it pertains to older adults, the differences in quality of life between community dwelling older adults and those in collective dwellings, and the challenges associated with improving quality of life for older adults living in these settings. It will finish with an introduction to virtual reality (VR), and how this new, innovative technology was used with a sample of older adults living in retirement homes.

Quality of Life, Well-Being, and Life Satisfaction

Quality of life is a multidimensional and subjective concept that has received much empirical attention in the last 50 years (Cella, 1994; Haas, 1999). The World Health Organization (1997) defines quality of life as:

> Individuals' perception of their position in life in the context of the culture and value system where they live and in relation to their goals, expectations, standards and concerns. It is a broad ranging concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, personal beliefs and their relationship to salient features of their environment (p. 1).

Although this is one definition of quality of life, there exists no single, agreed-upon definition of quality of life and its determinants in the psychological literature. Despite disagreement, Rapley (2003) points out that, at the very least, most researchers can agree that quality of life is an "individual psychological perception" (p. 50). Quality of life is commonly confused with concepts such as functional status, well-being, life satisfaction, and health-related quality of life, and, as a result, these concepts are used interchangeably (Haas, 1999; Karimi & Brazier, 2016). Based on their review of the literature, Moons, Budts, and De Geest (2006) argue that quality of life is best conceptualized through an understanding of life satisfaction; however, conceptualizations and definitions of quality of life may depend on the population in question (Rapley, 2003). Researchers often take a multidimensional approach to understanding quality of life, and include a variety of physical, functional, emotional, psychological, social and environmental domains (Brett et al., 2012; Cella, 1994; Haas, 1999). Van Malderen, Mets, and Gorus (2013) surmise that a lack of coherence within the literature may be due to the fact that although quality of life is a multidimensional construct, interventions aimed at enhancing it may only focus on one dimension at a time.

Many researchers agree that there is both an objective and subjective component to quality of life (e.g., Butler & Ciarrochi, 2007; Xavier et al., 2003;). Objective components include factors such as income, health, functional status, marital status, gender, and age (Butler

& Ciarrochi, 2007; Haas, 1999). Subjective components include factors such as life satisfaction and well-being (Haas, 1999). Xavier et al. (2003) reason that quality of life likely depends not only on internal and external factors within an older adult's environment, but also how the older adult conceives of his/her quality of life.

Determinants of quality of life may differ between younger and older adults (Paskulin, 2007). Determinants of a positive quality of life in a sample of Brazilian adults over the age of 80 were good health, positive relationships, and financial security (Xavier et al., 2003). In a qualitative study on quality of life in adults over the age of 65, Gabriel and Bowling (2004) found that most participants reported a better quality of life with better social resources. Participants also mentioned the need to stay busy, partake in social activities, and travel as contributing to their quality of life (Gabriel & Bowling, 2004). On the other hand, poor quality of life is commonly associated with poor health (Gabriel & Bowling, 2004; Xavier et al., 2003). Decreases in quality of life are associated with increased age, a greater need for support, and an inability to work (Butler & Ciarrochi, 2007; Xavier et al., 2003).

Loneliness is a factor that contributes to decreases in quality of life for older adults (Jakobsson & Hallberg, 2005). Loneliness can be defined as a negative subjective feeling due to a paucity in social relationships (Singh & Srivastava, 2014). Loneliness is common in older adulthood, with 20-43% of older adults reporting some degree of loneliness (Jakobsson & Hallberg, 2005; Perissinotto, Cenzer, & Covinsky, 2012). Risk factors for loneliness include age, gender, marital status, living in a special facility, and needing assistance with activities of daily living (Jakobsson & Hallberg, 2005; Pinquart & Sörensen, 2001). Not only are increases in loneliness associated with an increased risk of death and functional decline, they are also

associated with an increased likelihood of moving into long-term care (Perissinotto et al., 2012; Russell, Cutrona, De La Mora, & Wallace, 1997; Scocco et al., 2006).

Quality of Life in Collective Dwellings

It is important to maintain quality of life for older adults, as they are a part of the population susceptible to poor health outcomes (Brett et al., 2012). A recent rise in the number of older adults entering collective dwellings (Statistics Canada, 2011b) has prompted researchers to evaluate whether this change in dwelling is associated with enhancements, maintenance, or reductions in older adults' quality of life.

Quality of life has been shown to be significantly lower for older adults living in nursing homes compared to those living in the community (Hedayati et al., 2014). Frail older adults living in residential care in California reported a moderate level of life satisfaction, and a satisfactory quality of life (Mitchell & Kemp, 2000). Living in a LCTF was associated with greater depression scores on the Geriatric Depression Scale, and greater levels of loneliness, compared to older adults living in the community (Borowiak & Kostka, 2004; Pinquart & Sörensen, 2001). Factors associated with poor quality of life in LTCFs include lower health status, greater cognitive impairment, and a greater need for assistance with daily living (Kehyayan, Hirdes, Tyas, & Stolee, 2016).

Six months after moving into nursing homes, Scocco et al. (2006) found significant decreases in global cognition and activities of daily living, as well as significant increases in depression, in their sample of older adults. Furthermore, 33% of participants had died within the six-month intervening period (Scocco et al., 2006). Similar results have been reported elsewhere (e.g., Borowiak & Kostka, 2004). Using data from the Office of the Chief Medical Examiner in New York City, Mezuk, Prescott, Tardiff, Vlahov, and Galea (2008) found 47 suicides occurred

in LTCFs from 1990-2005. Although this is substantially less than the 1724 suicides that occurred in the general community in the same period of time, Mezuk et al. (2008) noted that there was no change in suicide rate over time in LTCFs compared to a general decrease in suicide rate in the community. To this end, it is clear from the research that quality of life substantially decreases for older adults after moving into long-term care, and that this may be due to a number of factors.

In 2002, the World Health Organization created the concept of "Active Ageing," and outlined seven determinants of quality of life in their policy framework; culture and gender, health and social services, behaviour, personal factors, physical environment, social environment, and economics (World Health Organization, 2002). To enhance quality of life as much as possible, researchers should consider all seven of these determinants of quality of life when formulating intervention strategies (Van Malderen et al., 2013). The most common intervention strategy aimed at enhancing quality of life for older adults in LTCFs is lifestyle improvement, typically in the form of physical activity (Van Malderen et al., 2013). Physical activity intervention strategies have been shown to successfully enhance quality of life and well-being for older adults living in the community, however the results are less consistent when considering older adults living in collective dwellings (Netz, Wu, Becker, & Tenenbaum, 2005; Park, Han, & Kang, 2014; Paw, Van Poppel, Twisk, & Van Mechelen, 2004; Van Malderen et al., 2013).

Only six studies in a systematic review of 35 studies looked at interventions aimed at the social environment determinant to improve quality of life for older adults living in LTCFs (Van Malderen et al., 2013). Within these six, only three looked at "meaningful leisure" intervention strategies. All three of these studies resulted in improvements in quality of life (Van Malderen et

al., 2013). Meaningful leisure is important for healthy aging, and includes participation in leisure activities (Silverstein & Parker, 2002). An increase in activity participation over a 10-year period was associated with improvements in quality of life, especially for older adults who were widowed, low in social contact, and showing declines in functional status (Silverstein & Parker, 2002). In another study, social activity participation was positively associated with life satisfaction, and negatively associated with depressive symptomology (Mitchell & Kemp, 2000). Perhaps, then, meaningful leisure within the social environment is a promising determinant of quality of life for older adults living in collective dwellings that should continue to be studied further. One form of meaningful leisure for older adults is the ability to travel.

Travel and Quality of Life

Milman (1998) defines "tourism" and "travel" as pertaining to a time when an individual isn't engaged in his/her everyday routine, and is away from home. The word "travel" encompasses many different experiences, ranging from commuter trips to holidays and vacations (e.g., De Vos, Schwanen, Van Acker, & Witlox 2013). Travel and tourism can impact a wide variety of life domains, including social life, leisure, and recreation domains, and has been qualitatively reported by older adults as contributing to their quality of life (Gabriel & Bowling, 2004; Sirgy, Kruger, Lee, & Yu, 2011). In a literature review of 29 studies investigating the effects of travel on mental and physical health and well-being, Chen and Petrick (2013) found that vacations had a positive effect on quality of life, happiness, and feelings of health, and led to decreases in stress. In most studies, travelling leads to increases in well-being, positive feelings, and life satisfaction, however, more research is needed to understand the long-term benefits of travel (Chen & Petrick, 2013; De Vos et al., 2013; Uysal, Sirgy, Woo, & Kim, 2016). The direction of the effect of travel on quality of life is not necessarily the same for everyone, it can

be positive or negative, and it may depend on individual characteristics as well as the length of stay in a destination (Chen & Petrick, 2013; Neal, Uysal, & Sirgy, 2007; Uysal et al., 2016). Despite these positive findings, Milman (1998) did not find that travel increased psychological well-being, a component of quality of life. It could be that the variation in results is due to the fact that there is disagreement regarding how to best quantify quality of life, and that different researchers measure quality of life either objectively or subjectively (Uysal et al., 2016).

The mechanism by which travel may influence quality of life and life satisfaction has been understood in terms of the "bottom-up spillover theory" (Neal et al., 2007; Sirgy, 2010). This theory posits that life satisfaction and subjective well-being are influenced by satisfaction in various life domains, for example, the leisure domain. Experiences within these life domains, such as a satisfying travel experience, positively influences the domain to which the experience belongs (i.e., the leisure domain). This satisfaction then "spills over" and influences general life satisfaction (Neal et al., 2007; Sirgy, 2010). Life satisfaction can be enhanced through experiences while travelling, and psychological well-being and happiness may be positively associated with the degree of activity participation while travelling (Milman, 1998; Neal, Sirgy, & Uysal, 1999; Wei & Milman, 2002). Sirgy (2010) proposes that tourists make choices that promote the achievement of their "leisure travel goals" (p. 247) in order to increase feelings of subjective well-being, life satisfaction, and happiness.

The benefits of travel may transcend demographic borders. Social tourism involves travel for disadvantaged individuals who are, as a result, at risk for lower levels of well-being (McCabe & Johnson, 2012; Morgan, Pritchard, & Sedgley, 2015). Although social tourists may not have as many opportunities to travel as other, more advantaged individuals, it is these disadvantaged individuals that can benefit greatly from travel (Chen & Petrick, 2013). McCabe and Johnson

(2012) found that when given a holiday, most families on welfare reported increases in quality of life, happiness, and optimism. The holiday even improved over 30% of tourists' health (McCabe & Johnson, 2012). Morgan et al. (2015) found similar results in a sample of social tourists aged 68 to 85 years old. A holiday increased subjective well-being, social engagement, self-esteem, and confidence (Morgan et al., 2015). However, only three of the aforementioned studies explicitly investigated the effects of travel on quality of life in samples of older adults (Chen & Petrick, 2013; Milman, 1998; Morgan et al., 2015). Nevertheless, this paucity of research does not mean that older adults do not derive satisfaction from travel; 93-94% of older adults reported feeling satisfied or very satisfied with a tourism experience (Milman, 1998; Wei & Milman, 2002). Chen and Petrick (2013) discuss the need for more research to understand how older adults may benefit from travel. It is especially important to understand how tourism experiences affect older adults' quality of life in light of the rapidly aging population. Older adults may have a unique set of motivations for travel including nostalgia, friendship, learning, escapism, thinking, status enhancement, and physical stimulation (Cleaver & Muller, 2002).

Despite older adults' desire to travel, many may face more barriers to travel than other age groups. Adults over the age of 65 are less likely to travel the older and less mobile they are (Zimmer, Brayley, & Searle, 1995). Other travel predictors include health and chronic health conditions, income, money-handling skills, and the desire to spend money on travel (Zimmer et al., 1995). Kazeminia, Del Chiappa, and Jafari (2013) found that health problems were the biggest barrier to travel, followed by interpersonal barriers, such as not having someone to travel with, and, finally, financial barriers. These older adults coped with these challenges by choosing destinations appropriate for their abilities, and joining organized tour groups (Kazeminia et al., 2013). These constraints come from samples of community-dwelling older adults, however, one

can speculate that the constraints to travel for older adults living in collective dwellings may be even greater than those in the community, as it may also be more difficult for older adults living in collective dwellings to leave their facility for travel purposes. Consequently, virtual reality (VR) may help older adults living in collective dwellings overcome some of these travel constraints.

Virtual Reality

Virtual reality (VR) technology is defined "as a computer-simulated environment that can provide the sensation of physical presence in places representing real or imagined worlds" (Benoit et al., 2015, p. 558). Depending on the way in which VR is used, it can appear in the form of helmet-mounted displays (HMD), projections of computer images on large screens, and even computerized simulations on computers and tablets (e.g., Baños et al., 2012; Raghav et al., 2016; Zygouris et al., 2017). These configurations fall along a continuum of immersion, with HMDs considered the most immersive configuration. Ultimately, a high degree of immersion will increase *presence*, the subjective feeling of immersion in one environment despite being physically situated in another (Witmer & Singer, 1998). VR can bring the real and imagined world closer together (De Carvalho, Freire, & Nardi, 2010). This notion is relevant in a variety of contexts, and it is no wonder that psychologists have recently begun to take an interest.

The field of psychology has seen a surge of research using VR in the last fifteen years. Researchers have utilized VR technology to understand a variety of psychological phenomenon, and to enhance treatment options for individuals with various disorders. For example, VR has been used to enhance exposure therapy for specific phobias, now known as virtual reality exposure therapy (VRET) (Parsons & Rizzo, 2008). VRET, like traditional exposure therapy, often centres on exposing an individual to their feared stimulus in a hierarchical fashion until the

fear is diminished (Anderson et al., 2013; Wallach, Safir, & Bar-Zvi, 2011). The virtual environment in VRET can adapt to the motion of the user's head and body, making the experience feel more real (Parsons & Rizzo, 2008).

A meta-analysis conducted by Opris et al. (2012) revealed that the outcomes associated with "classical evidence-based interventions" (p. 86) that had been enhanced with VRET were significantly better than a wait-list control. They also found that the post-treatment results were comparable between the VRET-enhanced treatments and the classical evidenced-based interventions. Furthermore, there was no effect of treatment type on outcome at both 3-6 month, and 1-year follow-ups. In fact, there was a small, but significant effect size favouring the VRET-enhanced treatment over classical evidence-based treatments for fear of flying (Opris et al., 2012).

Turner and Casey (2014) arrived at similar conclusions in their meta-analysis investigating the use of VR to treat a variety of psychological disorders compared to more traditional interventions. Although most of the studies reviewed in this paper focused on the use of VR for treating specific phobias, some of the studies focused on the use of VR for treating other disorders, such as pain management (e.g., Hoffman et al., 2004). There was a large effect size for the efficacy of VR-based treatments over a wait-list control, and a moderate effect size for the efficacy of VR-based treatments over the traditional interventions. The number of VRET sessions, or other unknown moderators, may help explain these results, however, more research is needed (Opris et al., 2012; Turner & Casey, 2014).

The results of these meta-analyses suggest that VR is a promising technology for use in psychology. However, there are other domains and populations within the realm of psychology in which VR may be useful. For example, older adults are a subset of the population that have

received little empirical attention with respect to VR. Only a fraction of the published literature using VR in psychological contexts has done so with samples of older adults despite the possibilities for VR to impact health, well-being, and loneliness (see Hughes, Warren-Norton, & Tsotsos, 2017). Some of this literature will be reviewed next, along with considerations for future directions.

Benoit et al. (2015) wanted to ascertain whether older adults would be able to tolerate VR and virtual environments. Eighteen healthy older adults were exposed to the virtual environment for a maximum of 15 minutes at a time. The virtual environment was projected onto a 320cm x 240cm screen in front of which participants were seated 1 metre away, a configuration relatively low in immersion. As part of an autobiographical memory task, participants were exposed to either familiar or unfamiliar virtual environments, or two non-VR conditions. Benoit et al. (2015) measured participant emotion, motivation, security, fatigue, and familiarity in response to the VR, as well as individual levels of cybersickness and presence. *Cybersickness* is a form of motion sickness in response to virtual environments, and is characterized by symptoms such as nausea, eyestrain, vomiting, disorientation, headache, and drowsiness (Benoit et al., 2015; La Viola, 2000). These researchers found that there were no differences in feelings of security or fatigue across the four experimental conditions. Furthermore, participants did not report experiencing cybersickness in the VR conditions, and reported experiencing moderate levels of presence.

Baños at al. (2012) tried to induce positive mood states in older adults in two virtual environments. Participants, aged 58-79 years old, were virtually led through a park that was created to evoke feelings of joy or relaxation. In this study, the virtual environment was created using a 21” touch screen paired with built-in speakers and a keyboard. Following two of these

VR sessions over a two-week period, participants experienced decreased levels of anxiety and sadness, as well as increased levels of joy and relaxation in both experimental conditions. Both virtual environments led to increases in general mood following the two sessions, however these effects were only significant in the relaxation condition.

Few studies have used more immersive VR configurations that employ HMDs with samples of older adults. For example, Pacheco, Duarte, Rebelo, and Teles (2010) investigated whether immersive VR was a tool that could be used to help older adults select interior colouring. Twenty participants (M = 69.45, SD = 8.67) wore a HMD while completing the experimental task without experiencing cybersickness (Pacheco et al., 2010). In another study, Optale et al. (2010) examined whether immersive VR using a HMD would enhance a memory training intervention for older adults with memory deficits, however, this study did not include any measure of cybersickness. Optale et al. (2010) found that general cognitive functioning and verbal memory were enhanced for participants receiving virtual reality-based memory training.

Finally, a recent thesis from the Massachusetts Institute of Technology (MIT) by Lin in 2017 documented a study that investigated the ability for VR to improve well-being for older adults living in senior living communities. Facilities were block randomized into either the VR or TV group for content delivery. Content consisted of meditation, travel, culture, “memory lane,” and relaxation, however, no additional detail pertaining to the description of the content was provided. Participation took place over a two-week period wherein participants, as a group, were instructed to use the VR (or TV) each day for 20 minutes at a time. In the VR group, Lin (2017) saw significant improvements in perceived overall health, as measured by one question rated on a 5-point scale, and significant reductions in participants’ likelihood to get nervous, as measured by the short version of the Big Five personality inventory. Results also suggested that

content delivery in VR was superior to content delivery on TV. Limitations included a lack of standardized questionnaires used to measure the outcome variables of interest, as well as a disregard for measuring cybersickness in response to the VR (Lin, 2017). Understanding the parameters in which any participant, especially older adults due to the paucity in research, experiences symptoms of cybersickness is critical to research on the application of VR.

Taken together, the results of the previously reviewed literature suggest that older adults can tolerate VR and virtual environments, however, more research is needed to understand how older adults tolerate immersive VR. Methodological and procedural limitations in previous work warrant additional pilot testing of immersive HMDs in older adult samples. There appear to be numerous applications for VR with older adults, however, one area that has not been exclusively examined in a single study is travel.

Virtual Travel

One application for VR that has not previously been explored in the published literature is the use of VR to improve quality of life by means of allowing individuals to escape into virtual reality. One possibility is to use VR to transport individuals to different parts of the world. Given the notion that travel, be it social tourism, meaningful leisure, or vacationing, can enhance quality of life, subjective well-being, and life satisfaction, coupled with the fact that quality of life is often lacking in collective dwellings, it is reasonable to surmise that travel-related VR content may be a way to improve quality of life for older adults living in collective dwellings (e.g., Chen & Petrick, 2013; De Vos et al., 2013; Hedayati et al. 2014; McCabe & Johnson, 2012; Morgan et al., 2015; Uysal et al., 2016). Athough Lin (2017) investigated the utility of virtual travel in a similar context, virtual travel was one content category among many, including relaxation and “memory lane.” The unique contributions of each variety of content were not

examined individually (Lin, 2017). The present feasibility study is unique in focusing on VR content that is related specifically to travel and tourism with a strong theoretical foundation for doing so. To date, no published studies have investigated the utility of VR in this context. "Virtual tourism" is the term that will be used in this thesis to denote the use of travel-related content in VR, thereby allowing the user to virtually travel around the world.

Older adults, especially those living in collective dwellings, face many barriers to travel. These older adults may be limited by their financial resources, physical capabilities, or the fact that they are bound to stay in their respective collective dwelling (Kazeminia et al., 2013; Zimmer et al., 1995). The literature is suggestive of the fact that VR is an important and useful tool that can be used in psychological treatment contexts (Opris et al., 2012; Turner & Casey, 2014). The results of previous studies (e.g., Baños et al., 2015; Benoit et al., 2012; Pacheco et al., 2010; Optale et al., 2010) suggest that VR is a suitable technology to use with older adults, and that VR may produce positive benefits in samples of older adults. VR technology is becoming increasingly more accessible (Parsons & Rizzo, 2008). With this comes greater opportunity for VR to be used in real-world contexts, with the potential for it to improve individual lives.

The Present Study

Based on previous research, the primary objective of the present feasibility study was to determine whether a VR configuration that includes a HMD was suitable for a sample of older adults living in collective dwellings. It is necessary to determine whether the older adult population can tolerate immersive VR without experiencing cybersickness following increased accessibility and utility for VR in both recreational and scientific contexts. Furthermore, it is important to examine whether virtual tourism serves as an enjoyable pastime for older adults

living in collective dwellings, and whether it can produce short- and long-term effects on quality of life, social engagement, and loneliness. Accordingly, the objectives of this study are twofold:

The primary objective was to determine whether a HMD is a suitable VR configuration for relatively independent older adults living in collective dwellings. The primary outcome for this objective was self-reported cybersickness, which was assessed during every VR exposure session. Secondary outcomes that addressed this objective included immediate affect and self-reported presence associated with each VR exposure. I hypothesized that older adults would not experience significant levels of cybersickness in response to the VR exposure, and that they would report greater levels of happiness and excitement, and lower levels of anxiety immediately following VR exposure. Furthermore, I hypothesized that participants would experience presence in response to the virtual tourism.

The secondary objective was to assess whether a six-week virtual tourism intervention can improve social aspects of wellbeing, including self-reported quality of life, social engagement, and loneliness, among relatively independent older adults living in collective dwellings. I hypothesized that the virtual tourism intervention would increase quality of life and levels of social engagement, and that it would decrease levels of loneliness at the end of the program. I also hypothesized that these changes would persist at one-month follow-up.

Methods

Participants

A total of 20 participants were recruited from retirement homes across the GTA. Exclusion criteria included frequent migraines, proneness to motion sickness, and previous piloting experience, as these conditions are associated with an increased risk for cybersickness (Johnson, 2007; Ruddle, 2004). One participant had previous piloting experience, however, this

participant was a part of an earlier VR demonstration at the retirement residence and did not experience cybersickness. In consultation with the principle investigator, this individual was permitted to participate in the present feasibility study. Six participants dropped out or did not complete the entire study (i.e., attrition rate was 30%). Two participants dropped out for medical reasons, two participants dropped out because they no longer wanted to partake in the study, two participants dropped out because they found the VR apparatus uncomfortable or unpleasant, and one participant dropped out due to disappointment with the virtual content. The final sample consisted of 14 participants who completed the first four phases of the study (i.e., pre-T1, T1, exposure, and T2). Ten of the 14 participants additionally completed the optional one-month follow up (i.e., T3); four participants opted out of the follow-up session.

Measures (see Appendix A)

Pre- and post-testing.

Global cognitive function. Participants completed the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) to assess global cognitive function. It is not a diagnostic test (Tombaugh & McIntyre, 1992). The MMSE is a 30-item questionnaire that measures performance in a number of cognitive domains including orientation, memory, and attention (Folstein et al., 1975). Questions on the MMSE ask participants to remember words, draw a geometrical figure, and provide the date. Scores can range from 0-30. Scores <23 are typically considered to be indicative of cognitive impairment, although normative data suggests a relationship between factors such as age and education with total MMSE score (Crum, Anthony, Bassett, & Folstein, 1993; Tombaugh & McIntyre, 1992). The MMSE is a valid evaluation of cognition and has good test-retest reliability (r = .887) in the original sample of older adults (patients and healthy controls) (Folstein et al., 1975). For the purposes of the present study, the

MMSE was administered as a "fail-safe" to ensure that all participants were capable of providing informed consent.

Absorption. Participants completed the Tellegen Absorption Scale (TAS; Tellegen & Atkinson, 1974) prior to beginning the exposure phase of this study. The TAS is a 34-item self-report scale that measures individual levels of hypnotic susceptibility. Examples of questions on this scale include, "Sometimes I experience things as if they were doubly real" and "When listening to organ music or other powerful music I sometimes feel as if I am being lifted into the air." Participants were instructed to indicate how often they experienced each item on a 4-point Likert-type scale ranging from "never" to "always." Scores were summed such that a higher total score indicated greater levels of absorption. Total scores can range from 34 to 136. This scale has good reliability, with Cronbach's α ranging from .48 to .80 in the two original samples of female undergraduate students (Tellegen & Atkinson, 1974).

Loneliness. The revised UCLA Loneliness scale (UCLA-R; Russell, Peplau, & Cutrona, 1980) was used to measure loneliness. This is a 20-item self-report questionnaire that assesses individual feelings of loneliness and social isolation. Participants were instructed to indicate how often they related to each item on the scale. Responses are on a 4-point scale ranging from "never" to "often." Items 1, 4, 5, 6, 9, 10, 15, 16, 19, 20 are reverse coded. After reverse coding these items, scores were summed so that higher total scores indicated greater feelings of loneliness and social isolation. Total scores can range from 20 to 80 (Hawkley, Thisted, Masi, & Cacioppo, 2010). Examples of items on this scale are "There is no one I can turn to" and "I feel isolated from others." This scale has good internal consistency (Cronbach's $\alpha = .94$), however, this study was originally conducted in a sample of undergraduate students (Russell et al., 1980). In a sample of middle-aged and older adults over a 5-year period, the reliability of the UCLA-R

was comparable to the scale's original sample (Cronbach's α = .91) (Hawkley et al., 2010).

Quality of life. Quality of life was measured using the Older People's Quality of Life Questionnaire (OPQOL-35; Bowling, 2009). The OPQOL-35 is a 35-item self-report questionnaire that assesses participants' levels of satisfaction with their quality of life in various domains including life overall, health, social relationships, independence and control, home and neighbourhood, psychological and emotional well-being, finances, leisure, and religion. Responses were made on a 5-point scale ranging from "strongly agree" to "strongly disagree." After reverse coding positive items, items were summed and totaled, with possible total scores ranging from 35 to 175. Higher total scores are indicative of a greater quality of life. This scale is valid and has good reliability, with Cronbach's α ranging from .75 to .88 (Bowling, 2009).

Social engagement. Participants completed the Social Engagement Scale (SES) which consisted of five questions assessing levels of social engagement in the last two weeks. These questions were adapted from Krueger et al. (2009). Participants indicated how many times they have participated in activities outside of the residence with family or friends, engaged in church or religious activities, engaged in sports or physical activity, and engaged in other recreational activities, such as bingo. Participants indicated the frequency with which they engaged in each of the aforementioned activities in the past two weeks on a 4-point scale with the following four response options: zero times, one to two times, three times, or four to five times. Finally, participants were asked an open-ended question: "Have you engaged in the usual amount of activities in the past two weeks? If not, have you been more or less active than usual?" Less activity than usual was coded as "0" and more activity than usual was coded as "1." Scores were summed so that higher scores indicated greater levels of social engagement, ranging from 0 to 13.

VR exposure.

Cybersickness. A modified version of the Simulator Sickness Questionnaire (SSQ; Kennedy, Lane, Berbaum, & Lilienthal, 1993) was used to assess levels of cybersickness immediately prior to and following the VR exposure. The SSQ is a 16-item questionnaire that assesses the degree to which participants are experiencing various symptoms of simulation sickness, including, but not limited to, difficulty focusing, sweating, vertigo, blurred vision, headache, fatigue, eye strain, and nausea. Participants indicated whether they are experiencing any of these symptoms on the following 4-point rating scale: "none," "slight," "moderate," and "severe." Scores on each item can range from 0 to 3. Total scores can range from 0 to approximately 300, based on the original weighting procedure outlined by Kennedy et al (1993) (Kennedy et al., 2001). Scores were summed such that higher total scores indicated a greater amount of simulator sickness. Cronbach's $\alpha = .86$ in a sample of adults (Bouchard, Robillard, Renaud, & Bernier, 2011).

For the purposes of this study, we adapted a modified version of this scale that only assessed general discomfort, nausea, fatigue, headache, eye strain, and dizziness. If participants indicated the presence of any of these selected symptoms, they were asked follow-up questions to assess whether they were experiencing any of the remaining symptoms included on the original SSQ (e.g., difficulty focusing/concentrating, salivation increasing, sweating, "fullness of the head," blurred vision, vertigo, "stomach awareness," and burping). The experimenter noted down the presence of any of these additional symptoms. The modified SSQ used in the present study consisted of 6 items, each scored on a 4-point scale ranging from 0 to 3. Total scores ranged from 0 to 18. Modification of this scale was based on earlier piloting of the scale in a sample of 15 older adults to determine the appropriateness of the questions for this population.

Presence. The Presence Questionnaire (PQ; Witmer & Singer, 1998) was used to assess levels of subjective immersion and involvement in the VR material. The PQ is a 32 item self-report questionnaire that assesses participants' levels of *presence*, which is "the subjective experience of being in one place or environment, even when one is physically situated in another" (Witmer & Singer, 1998, p. 225). Participants respond on a 7-point scale that is anchored with relevant descriptors at both ends of the scale, as well as at the midpoint. Examples of items on this questionnaire include "How much did the visual aspects of the environment involve you?" and "How aware were you of events occurring in the real world around you?" Scores can range from 7 to 224, with higher scores indicating greater levels of presence. The original scale includes four subscales: involved/control, natural, interface quality, and resolution subscales. This scale has good reliability (Cronbach's $\alpha = .81$) and validity in the original student sample (Witmer & Singer, 1998). Reliability and validity estimates have not been calculated in samples of older adults, as this scale has not yet been used in these populations.

For the purposes of this study, we have adapted a modified version of the PQ to reflect the questions from the original scale that were most relevant to the present study. Specifically, items 5, 6, 8, 23, 26, 28, and 32 were taken from the original scale (Witmer & Singer, 1998). Total scores ranged from 7 to 49, with higher scores indicating greater levels of presence.

Visual Analog Scale (VAS). Participants completed a VAS before and after every VR exposure. The VAS assessed participants' happiness, excitement, and anxiety. Happiness was measured on a 100cm scale ranging from "very unhappy" to "very happy." Excitement was measured on a 100cm scale ranging from "very bored" to "very excited." Finally, anxiety was measured on a 100cm scale ranging from "very relaxed" to "very anxious." For each of the three dimensions, participants were asked to indicate, with a vertical line, where they felt they fall on

the 100cm horizontal line, given the relevant dimension. Mean pre- and post-VR scores on the VAS for each of the three dimensions were calculated such that higher mean scores indicated greater levels of happiness, excitement, and anxiety. At the end of the pre- and post-VR VAS, participants were asked to write down "one emotional word below that best represents how [they] feel right now."

Qualitative Interview

Participants completed two semi-structured, qualitative interviews; one immediately following the cessation of the virtual tourism program (T2; see Appendix E) and one at one-month follow-up (T3; see Appendix G). Qualitative interviews were conducted to assess any perceived benefits of the virtual tourism program from the participants' perspectives.

Immediately following cessation of the virtual tourism program, qualitative interviews consisted of questions pertaining to whether the program met participants' expectations; the best part of the virtual tourism program; whether participants noticed any changes in their outlook on life, social interactions, and physical or emotional well-being; whether participants felt that any changes were due to participating in the virtual tourism program; and, finally, whether participants had engaged in any travel-related activities in conjunction with the virtual tourism program.

At the one-month follow-up, qualitative interviews consisted of questions regarding participants' overall impression of the virtual tourism program and the most enjoyable aspect of the program; whether they had experienced any changes in their social interactions since completing the program and whether they felt that the changes were due to the program or something else; current feelings towards travel, and; any travel-related experiences participants may have had since completing the virtual tourism program.

Apparatus

The VR content was administered using Samsung Galaxy Note 7 mobile phones in combination with the Samsung Gear VR headset and Sony headphones. This apparatus was used to increase participants' levels of presence, as presence is affected by one's level of immersion (Witmer & Singer, 1998). Immersion occurs when one feels absorbed and captivated by incoming stimuli (Witmer & Singer, 1998). A helmet-mounted display with headphones, such as the one being used in the present study, helps users feel a sense of isolation from their physical environment, creating a greater sense of immersion and, ultimately, presence (Witmer & Singer, 1998).

Tourism content. In collaboration with the Transmedia Zone at Ryerson University and OwlFlix Films, we were able to curate our own virtual travel content. A total of 18 videos, each approximately 10 minutes long, were used in the present study. The destinations included: Amsterdam, Australia, Cancun, Canyon Walk, Elephants and Orangutans, Egypt, Far East, Greece, Hong Kong, the International Space Station, Ireland, Paris, Portugal, Prague, Morocco, Scuba Diving, Spain, and Turkey. All video files were saved in a .mp4 format and played in 360°. Videos were played through the Samsung VR folder in the Occulus application on each phone.

Procedure

This study took place in five phases. Trainees who conducted weekly VR exposures were different from the trainees who conducted pre- and post-testing (i.e., testing sessions 1, 2, 3, and 4).

Pre-Testing Session 1 (pre-T1): Approximately one week before beginning the VR exposure, participants met with the researcher to read and sign the consent form (see Appendix

B), complete the MMSE, answer two open-ended questions (see Appendix C), and complete a demographic interview (see Appendix D). Participants were given the opportunity to have any questions answered concerning the study at this time. After providing informed consent, participants were administered the MMSE. After, participants were asked two open-ended questions: "Do you have any previous experience with virtual reality?" and "What are your expectations from taking part in the VR tourism program?" The researcher recorded the answers to each question. Next, participants answered a number of questions assessing demographics, health status, collective dwelling characteristics, and prior travel experience. Finally, participants completed the TAS. This phase of the study took approximately 45 minutes per participant.

Testing Session 1 (T1): A few days following pre-T1, participants completed a battery of questionnaires, of which OPQOL-35, UCLA-R, and SES are relevant to this thesis.[1] This phase of the study took approximately 30 minutes per participant.

Exposure: The week following the completion of pre-T1 and T1, participants began the exposure phase of the study. The exposure phase consisted of three VR sessions per week, each for approximately 10 minutes at a time, for a total duration of six consecutive weeks. Prior to each exposure, participants completed the pre-VR modified SSQ to assess the presence of any symptoms that may lead to discomfort during the VR exposure. Participants who expressed flu-like symptoms were not exposed to the VR system until their symptoms had subsided so as not to increase their risk of cybersickness (Johnson, 2007; La Voila, 2000). If a participant felt too ill to participate at any one session, they were given the opportunity to reschedule with the experimenter to ensure that they completed the entire six-week intervention program. Participants then completed the pre-VR VAS.

[1] There were occasions where timing did not allow for pre-T1 and T1 to take place on separate days. Some participants completed both phases on the same day, or on two days in a row. Together, these two phases took approximately 60-75 minutes per participant.

After completing the pre-VR modified SSQ and the pre-VR VAS, participants chose the destination to which they wanted to virtually travel. Participants were able to choose any destination they would like, including destinations to which they had previously travelled. The experimenter loaded the video through the Occulus application and then fitted the participant to the gear-VR headset. It was important to ensure all participants were comfortable in the VR configuration so as to ensure that any discomfort did not distract participants from attending to the VR content, thereby maximizing presence (Witmer & Singer, 1998). Once the participant indicated that they were comfortable and able to see the VR content, they were fitted with the headphones and began watching the video they selected. Participants were told to inform the experimenter when the video had finished.

When the participant indicated that the video had finished, the experimenter helped to remove the headset and headphones. All equipment was cleaned after each use using rubbing alcohol wipes. When participants were ready, they were given the post-VR modified SSQ and post-VR VAS to complete. Finally, participants completed the modified PQ. Once finished, participants were able to leave the session and return to their day. Each exposure took approximately 20-30 minutes per participant.

Testing Session 2 (T2): Approximately one week following the cessation of the 6-week intervention, participants were asked to complete the OPQOL-35, UCLA-R, and SES. Participants further completed the first semi-structured qualitative interview. This testing session took approximately one hour per participant. Towards the end of T2, participants were asked if they would be willing to sign the consent form for a one-month follow-up interview (Testing Session 3; see Appendix F).

Testing Session 3 (T3): Participants who consented to this additional phase of the study completed a follow-up one month following T2. Participants completed the questionnaire battery, including the OPQOL-35, UCLA-R, and SES. Participants further completed the second semi-structured qualitative interview to assess any potential qualitative, long-term impacts of the six-week VR program. Following the completion of the interview and questionnaires, participants were thanked for their time and participation. This phase of the study took approximately one hour per participant.

Quantitative Data Analysis

Data was analyzed using SPSS version 23 (IBM, 2015). Data from all outcome measures was inspected for violations of normality (e.g., OPQOL-35, UCLA-R, SES, VAS, PQ, and SSQ). Data was considered to violate the assumption of normality if any of the following conditions were met: significant skew and kurtosis (i.e., *z* score of 1.96, or greater; Field, 2014), significant Kolmogorov-Smirnov test (i.e., $p < .05$; Field, 2014), multiple outliers and/or extreme cases, or boxplots and histograms that were visibly abnormal. For data used in the context of paired *t*-tests, normality of the differences between pairs was examined. When these indices suggested the data was not normally distributed, non-parametric tests were used (i.e., Sign Test in place of a paired *t*-test and Friedman's Test in place of a repeated measures ANOVA). Due to the small sample size, covariates were not included in any statistical models. Descriptive statistics were calculated for all variables included in the study at each phase of assessment (e.g., demographic variables, OPQOL-35, UCLA-R, SES, TAS, MMSE, VAS, SSQ, and PQ).

Objective 1: To determine whether an immersive VR configuration is suitable for older adults living in collective dwellings. Pre- and post-VR data from the modified SSQ was analyzed to investigate the acceptability and suitability of an immersive VR configuration with

older adults. Average pre- and post-VR modified SSQ scores from all 18 exposure sessions were calculated. A paired samples *t*-test was conducted to examine significant differences in the experience of cybersickness before and after VR exposures. Individual paired *t*-tests and Sign tests were conducted for each symptom on the modified SSQ to examine whether there were any changes in the average occurrence of specific symptoms pre- and post-VR across all 18 exposures. Average pre- and post- VR SSQ scores were calculated for each week (i.e., the average of the three sessions each week over a total of six weeks). Change scores were calculated by subtracting average weekly post-VR SSQ scores from average weekly pre-VR SSQ, resulting in a total of six change scores. These change scores were entered into a Friedman's Test to examine whether the experience of cybersickness changed over the course of the six-week program. This analysis had reduced power due to missing data, therefore individual paired *t*-tests and Sign tests were conducted to examine weekly changes on the modified SSQ pre- and post- VR using full power. Finally, pre- and post-VR SSQ scores were grouped by video. Change scores representing every time each video was watched were calculated by subtracting individual post-VR SSQ scores from the corresponding individual pre-VR SSQ score. The change scores associated with each video were entered into a bias-corrected and accelerated (BCa) one-way ANOVA with 1000 bootstrapped samples to determine whether the degree to which participants experienced cybersickness varied as a function of the video being watched.

To determine whether older adults experienced virtual tourism as an enjoyable leisure activity, pre- and post-VR VAS scores were analyzed. Due to formatting and printing irregularities, the VAS line was not always exactly 100cm in length (e.g., sometimes it was 96cm or 101cm). In these instances, the individual scale and corresponding score were mathematically

adjusted to 100cm. Mean pre- and post-VR VAS scores from all 18 exposure sessions were calculated for each of the three dimensions that were assessed: happiness, excitement, and anxiety. Individual paired-samples *t*-tests were conducted for each VAS subscale to examine whether mean levels of happiness, excitement, and anxiety were significantly different pre- and post-VR across all 18 exposures. Weekly average pre- and post-VR scores were also calculated for each subscale (i.e., the average of the three sessions each week over a total of six weeks). Change scores for each week and each subscale were calculated by subtracting average weekly post-VR VAS scores from pre-VR VAS scores, resulting in a total of 18 change scores (i.e., six change scores per week for each of the three subscales). These change scores were entered into a RM ANOVA to determine whether any significant changes in weekly VAS subscale scores occurred over the course of the six-week program. This analysis had reduced power due to missing data. To assess any changes over time using full power, individual paired *t*-tests and Sign tests were conducted comparing weekly average pre- and post-VR VAS scores for each subscale. If VAS data from a participant was missing due to missed exposures, averages were calculated from the total amount of existing data for that participant. Missing VAS data accounted for 3% of the total VAS data. With respect to the open-ended VAS question, two independent raters coded the qualitative responses pre- and post-VR and grouped them into thematically-related categories.

To determine whether participants felt involved and immersed in the VR content, scores from the modified PQ were analyzed. PQ data was only available for 10 participants due to the fact that this questionnaire was added as an amendment to the study after it began. Average scores were calculated and inspected to determine whether older adults experienced presence in the VR. Average PQ scores for each video (collapsed across participants) were also calculated

and entered into a one-way ANOVA to examine whether presence changed as a function of the VR content.

Occasionally, participants did not attend exposure sessions for various health and personal reasons. Whenever SSQ or PQ data was missing, averages were calculated from the total number of data available for each participant. Missing SSQ and PQ data accounted for 2.2% and 1% of the data, respectively.

Objective 2: To assess whether a six-week virtual tourism intervention can improve quality of life and social engagement, as well as remediate loneliness. Scores from the OPQOL-35, SES, and UCLA-R were analyzed at all three phases of administration (i.e., T1, T2, and T3). Three one-way repeated measures analyses of variance (RM ANOVAs) were conducted to examine whether mean levels of quality of life, social engagement, and loneliness were significantly different between baseline, post-exposure, and one-month follow-up. Due to participants who dropped out or did not complete the study, power was reduced for each RM ANOVA analyses (i.e., $n = 10$). As a result, individual paired *t*-tests were conducted comparing each outcome variable at T1 and T2, allowing for the exploration of possible significant effects using the full sample. Exploratory paired samples *t*-tests and Sign tests comparing each subscale at T1 and T2 were also conducted to examine potential changes in quality of life subscales from T1 to T2.

Whenever data was missing for individual questionnaire items at T1, T2, or T3, average values for each missing item were calculated and inputted using existing data. Altogether, inputted values of this nature accounted for less than 1% of the entire dataset.

Qualitative Data Analysis

Six of the available 14 qualitative interviews from T2 (i.e., immediately following the cessation of the virtual tourism program) were analyzed using content analysis. Each interview was transcribed, verbatim, by the primary researcher. Transcriptions were broken into meaning units, which were condensed and coded, and codes were grouped into categories and themes (Erlingsson & Brysiewicz, 2017). The codes, categories, and themes presented in this thesis were extracted from the interviews based on the primary and secondary research questions: the tolerance and enjoyment of immersive VR, and any perceived benefits of the virtual tourism program.

Results

Participants

The final sample consisted of 14 participants (Age: $M = 82.43$, $SD = 6.54$), 57.1% of which were female (see Table 1). Dropouts were not significantly different from participants in terms of age, sex, years of education, length of stay in any retirement home, length of stay in current retirement home, and MMSE score. No participants had any known neurological conditions; one participant reported having "mild dementia," however, this participant scored a 27 on the MMSE. One participant experienced migraines in the past and another experienced infrequent migraines once or twice a year. English was the most common first language spoken (71.4%); other first languages included Dutch, Portuguese, Gujarti, and Polish. The sample was well-educated, with 57.1% achieving a graduate-level education. Most (64.3%) participants reported their health status as "good" or "very good."

Table 1. Sample Characteristics

Variable	*n*	*M*	*SD*
Age	14	82.43	6.54
Sex (% female)	8 (57.1)		
Years of Education	14	20.5	9.12

Length in any residential setting (months)	14	31.5	28.76
Length in current residence (months)	14	26.79	21.98
MMSE	12	27.83	1.34
TAS	14	71.29	14.13

Note. MMSE: Mini-Mental State Examination; TAS: Tellegen Absorption Scale;

On average, participants had lived in collective dwellings for about 2.5 years (M = 31.50, SD = 28.76, range = 5-96 months), and had spent an average of just over two years (M = 26.79, SD = 21.98, range = 5-84 months) in their current dwelling. Almost all participants (92.9%) had family that visited, with visitation frequency ranging from once a week to monthly, to "very occasionally." The majority of participants (78.6%) reported having friends in their residence. All participants indicated that their residence provided planned recreational programming for residents, and 85.7% of participants reported participating in these activities. The most common activities in which participants described taking part included movies, recreation and games, outings, exercise, and musical programming. Participants whom did not participate in recreational programming (n = 2) did so for health reasons, a lack of interest, or time constraints.

All participants reported enjoying travel; 92.9% of participants described themselves as "frequent travellers" in the past. However, all participants disclosed that they no longer travelled for various reasons including money and insurance (n = 5), changes associated with aging (n = 3), health (n = 2), companion-related concerns (n = 4), and mobility issues (n = 4). Health and mobility issues, a lack of a travel companion, money and insurance, and age were the most commonly reported barriers to travel for this sample of collective dwelling older adults. Four participants reported no barriers to travel.

Most participants took part in the present study for fun and enjoyment (n = 4*)*, knowledge and interest (n = 7), and to travel and see the world (n = 4). Three participants did not indicate any specific reason for taking part in the study, nor did they have any expectations. The majority

of participants (78.6%) had no prior experience with VR, other than the recruitment demo for some, and none were concerned or uncomfortable with trying new technology (n = 8 for this particular question). Average scores on the TAS were 71.29 (SD = 14.13), indicating intermediate levels of hypnotic susceptibility within the sample.

Objective 1: Determine suitability of immersive VR with present sample of older adults.

Cybersickness. The paired difference for SSQ total scores, as well as the paired differences for each symptom, were inspected for violations of normality. Total SSQ data was considered normal and was analyzed using a paired t-test. Data from each symptom (with the exception of "fatigue" and "discomfort" that were analyzed with parametric paired t-tests) violated assumptions of normality and was analyzed using individual Sign Tests.

A paired t-test using the average pre-VR SSQ score (M = .54, SD = .73) and post-VR SSQ score (M = .44, SD = .76) revealed no significant increase in cybersickness following VR exposure, $t(13) = -1.384$, 95% CI [-.248, .054], p = .190 Cohen's d = .367. In fact, trends in the data suggest that average levels of cybersickness decreased following exposure to VR. This pattern appears to be driven by the "fatigue" symptom of the SSQ. Pre-VR fatigue (M = .30, SD = .45) was significantly greater than post-VR fatigue (M = .16, SD = .35), $t(13) = -3.742$, 95% CI [-.214, -.057], p = .002, Cohen's d = .311. There were no other significant differences in SSQ symptoms pre- and post-VR (see Table 2).

Table 2. Descriptive statistics for average total SSQ and individual symptoms pre- and post-VR.

	Pre-VR		Post-VR			
Variable	M	SD	M	SD	Change	*Sig.*
Total	0.54	0.73	0.44	0.76	-0.10	0.19
Discomfort	0.07	0.12	0.04	0.07	-0.03	0.19
Nausea[a]	0.00	0.01	0.02	0.06	0.02	0.625
Fatigue	0.30	0.45	0.16	0.35	-0.14	**0.002**
Headache[a]	0.02	0.04	0.03	0.09	0.01	1.00

Eyestrain[a]	0.06	0.12	0.07	0.13	0.01	1.00
Dizziness[a]	0.09	0.25	0.10	0.22	0.01	1.00

[a]Significance value derived from Sign Test.

Average pre- and post-VR SSQ scores for each week were inspected for violations of normality. All variables violated assumptions of normality, therefore, individual Sign tests were conducted for each week. Friedman's test revealed no main effect of week on average SSQ change scores, $\chi^2(5) = 2.509$, $p = .775$. Similarly, Sign tests revealed no significant differences in average SSQ scores before and after VR exposure for each week. These results suggest that levels of cybersickness did not change over time (see Table 3).

Table 3. Average weekly pre- and post-VR SSQ scores.

	Pre-VR		Post-VR			
Variable	M	SD	M	SD	Change	*Sig.*
Week 1	0.62	0.80	0.44	0.70	-0.18	1.00
Week 2	0.45	0.64	0.36	0.58	-0.09	0.25
Week 3	0.64	0.98	0.48	0.87	-0.17	0.38
Week 4	0.38	0.61	0.36	0.75	-0.02	1.00
Week 5	0.52	1.15	0.45	0.87	-0.07	0.69
Week 6[a]	0.53	1.23	0.50	1.25	-0.03	1.00

Note. All significance values derived from Sign Test.
[a]Week 6 values derived from $n = 12$.

Finally, SSQ change scores for each video violated assumptions of normality. A BCa one-way ANOVA with 1000 bootstrapped samples comparing SSQ change scores for each video revealed no main effect of video on SSQ score, $F(1, 17) = .840$, $p = .646$, Cohen's $d = .527$. Pairwise comparisons with a Bonferroni correction revealed no significant differences in SSQ score between videos, suggesting that levels of cybersickness did not change as a function of the video being watched (data not shown; see Table 4 for descriptive SSQ information related to each video).

Table 4. Average SSQ scores pre- and post-VR for each video.

	Pre-VR		Post-VR			
Video	*M*	*SD*	*M*	*SD*	Change	*n*[a]
Amsterdam	0.55	0.82	0.36	0.92	-0.19	11
Australia	1.07	1.44	0.53	1.25	-0.54	15
Cancun	0.07	0.27	0.00	0.00	-0.07	14
Canyon Walk	0.38	1.12	0.38	1.12	0.00	13
Egypt	0.54	0.97	0.46	0.78	-0.08	13
Elephants	0.53	1.60	0.13	0.35	-0.40	15
Far East	0.25	0.87	0.17	0.39	-0.08	12
Greece	0.55	0.93	0.27	0.65	-0.28	11
Hong Kong	0.54	1.33	0.69	1.03	0.15	13
Ireland	0.92	1.32	0.69	1.25	-0.23	13
International Space Station	0.58	1.00	0.25	0.62	-0.33	12
Morocco	0.50	1.17	0.50	1.17	0.00	12
Paris	0.45	1.04	0.36	0.92	-0.09	11
Portugal	0.50	1.34	0.50	1.34	0.00	14
Prague	0.30	0.48	0.50	0.85	0.20	10
Scuba Diving	0.54	1.13	0.62	1.45	0.08	13
Spain	0.62	1.19	0.69	1.80	0.07	13
Turkey	0.20	0.42	0.00	0.00	-0.20	10

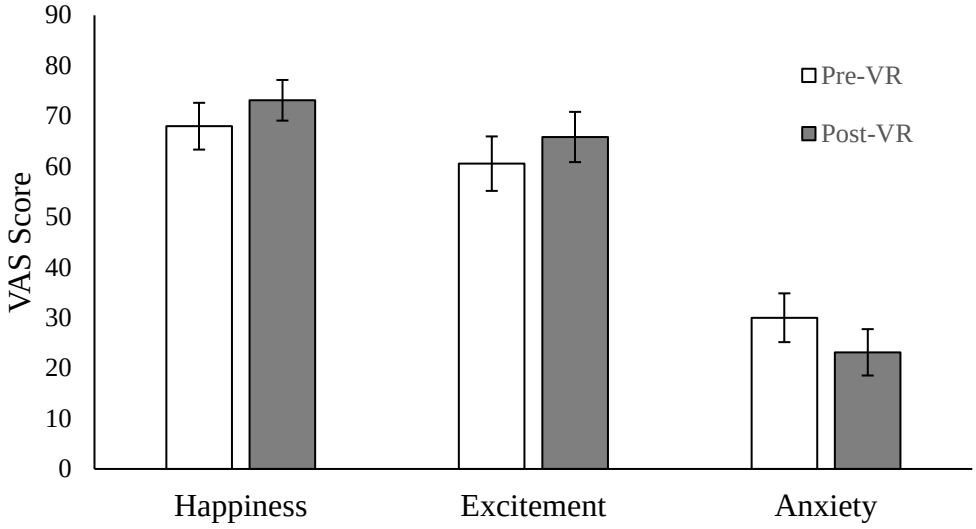
[a]*n* represents the number of times each video was watched.

Visual Analog Scale. Each paired difference variable was explored for violations of normality assumptions. All data was considered normal, therefore, paired *t*-tests were conducted.

Individual paired samples *t*-tests revealed significant increases in both happiness and excitement immediately following VR exposure. Post-VR happiness ($M = 73.14$, $SD = 15.10$) was significantly higher than pre-VR happiness ($M = 68.00$, SD, 17.37), $t(13) = 3.243$, 95% CI [1.717, 8.659], $p = .006$, Cohen's $d = .296$. Post-VR excitement ($M = 65.86$, $SD = 18.62$) was significantly greater than pre-VR excitement ($M = 60.57$, $SD = 20.22$), $t(13) = 2.408$, 95% CI [.544, 10.028], $p = .032$, Cohen's $d = .261$. An additional paired samples *t*-test revealed that post-VR anxiety ($M = 23.14$, $SD = 17.21$) was significantly lower than pre-VR anxiety ($M = 30.00$, $SD = 17.90$), $t(13) = -3.522$, 95% CI [-11.063, -2.652], $p = .004$, Cohen's $d = .383$. These results

suggest that older adults were happier, more excited, and less anxious immediately following virtual tourism exposure (see Figure 1 and Table 5).

Figure 1. Average VAS scores pre- and post-VR exposure.

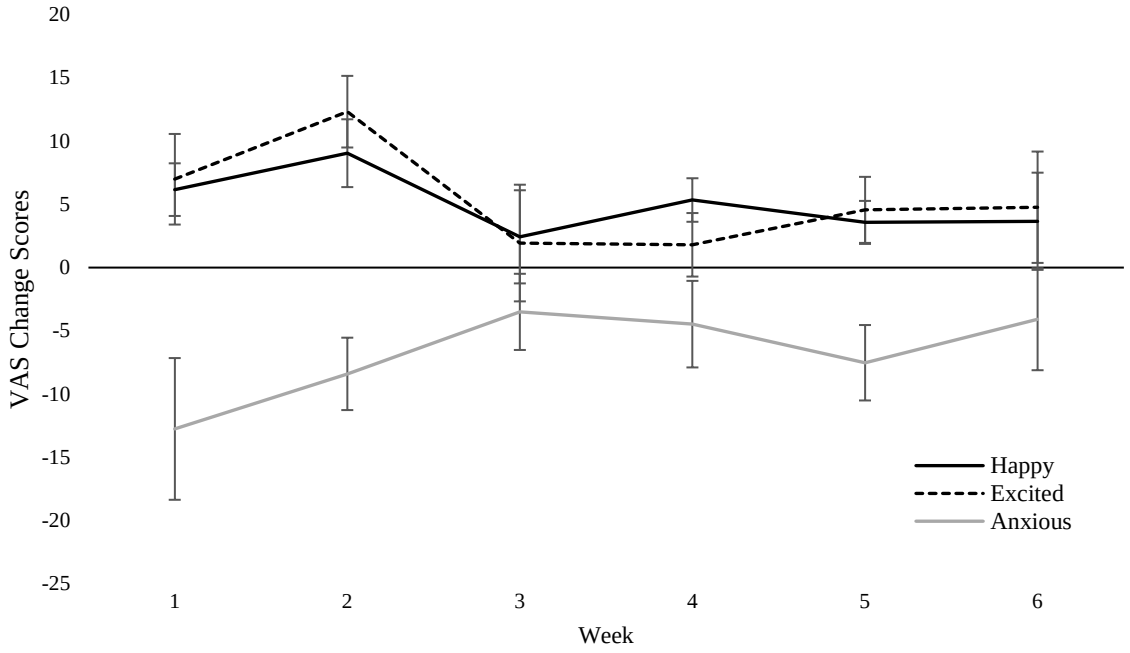


Note. Error bars represent standard error of the mean.

A 1 (VAS subscale: happy) x 6 (Week: 1, 2, 3, 4, 5, 6) RM ANOVA indicated no main effect of week on happiness change scores, $F(5,55) = 1.162$, $p = .339$, Cohen's $d = .652$. Individual paired *t*-tests revealed significant differences in average weekly happiness pre-VR and post-VR for week 1, $t(13) = 2.968$, 95% CI [1.677, 10.648], $p = .011$, Cohen's $d = .365$, and week 4, $t(13) = 3.112$, 95% CI [1.634, 9.053], $p = .008$, Cohen's $d = .265$ (see Table 5), and a Sign test revealed significant differences for week 2, $p = .003$. Another 1 (VAS subscale: excited) x 6 (Week: 1, 2, 3, 4, 5, 6) RM ANOVA revealed no main effect of week on excited change scores, $F(5, 55) = 1.373$, $p = .249$, Cohen's d = .707. Individual paired *t*-tests revealed significant differences in average weekly excitement pre- and post-VR for week 2 only, $t(13) = 4.352$, 95% CI [6.204, 18.433], $p = .001$, Cohen's $d = .689$ (see Table 5). A final 1 (VAS subscale: anxious) x 6 (Week: 1, 2, 3, 4, 5, 6) RM ANOVA revealed no main effect of week on anxious change scores (the assumption of sphericity was violated, therefore Greenhouse-Geisser

values are reported), $F(5, 55) = .953$, $p = .422$ (see Figure 2). Individual paired *t*-tests and Sign tests revealed significant differences in average weekly anxiety pre- and post-VR for week 1, $t(13) = -2.278$, 95% CI [-24.849, -.657] $p = .04$, Cohen's $d = .638$, week 2, $p = .003$, and week 5, $t(13) = -2.522$, 95% CI [-13.963, -1.079], $p = .025$, Cohen's $d = .350$. (see Table 5).

Figure 2. Average weekly change scores for VAS subscales.



Note. Error bars represent standard error of the mean.

Together, these results suggest that there were no significant changes across weeks for happiness, excitement, and anxiety in response to VR, however, the overall significant changes seen in the VAS subscales averaged across the entire study may be driven by a few weeks where changes in VAS subscales were significant.

Table 5. Descriptive VAS data for each subscale (total average and weekly averages).

	Pre-VR		Post-VR			
	M	*SD*	*M*	*SD*	Change	*p*
Happy (overall)	68.00	17.37	73.14	15.10	5.14	**0.006**
Week 1	67.78	16.88	73.94	14.79	6.16	**0.011**
Week 2	67.75	18.26	76.79	15.08	9.04	**.003**[a]
Week 3	67.00	16.70	69.43	16.51	2.43	.424[a]

Week 4	67.76	20.15	73.10	19.29	5.34	**0.008**
Week 5	69.09	18.19	72.63	17.47	3.57	0.061
Week 6[b]	69.33	21.23	73.00	18.96	3.66	0.361
Excited (overall)	60.57	20.22	65.86	18.64	5.27	**0.032**
Week 1	59.61	14.57	66.59	15.89	6.98	0.073
Week 2	57.37	17.87	69.69	20.08	12.32	**0.001**
Week 3	58.48	23.92	60.42	20.78	1.94	0.791[a]
Week 4	62.84	23.85	64.64	24.27	1.80	0.486
Week 5	62.60	24.83	67.20	20.33	4.56	0.102
Week 6[b]	61.40	26.79	66.18	21.79	4.77	0.301
Anxious (overall)	30.00	17.90	23.14	17.21	-6.80	0.004
Week 1	37.50	20.00	24.75	15.45	-12.75	**0.04**
Week 2	32.32	17.97	23.92	19.64	-8.40	**.003[a]**
Week 3	27.51	22.78	24.01	17.33	-3.50	.092[a]
Week 4	27.70	20.17	23.23	18.31	-4.47	1.00[a]
Week 5	28.70	21.44	21.18	20.90	-7.52	**0.025**
Week 6[b]	21.72	15.15	17.64	19.07	-4.08	1.00

[a]Values derived from Sign Test.
[b]Week 6 values derived from n = 12.

VAS Qualitative Analysis. Seven thematically-related categories emerged pre-VR. Categories were related to 1) positive emotions (e.g., “happy”), 2) neutrality and sameness (e.g., “normal” or “ok”), 3) peacefulness and calmness (e.g., “relaxed”), 4) negative emotions and boredom (e.g., “sad”), 5) positive arousal (e.g., “excited” or “anticipating”), 6) negative arousal (e.g., “frustrated,” “stressed,” or “anxious”), and 7) sleep and fatigue (e.g., “tired”).

Five thematically-related categories emerged post-VR. Categories were related to 1) positive emotions (e.g., “elated”), 2) positive arousal (e.g., “awe,” “excited,” or “impressed”), 3) relaxation and calmness (e.g., “peaceful”), 4) neutrality and sameness (e.g., “fine”), and 5) negative emotions and arousal (e.g., “disappointed” or “bored”).

Presence. Average level of presence across all 18 exposures was 35.69 (*SD* = 4.45, *range* = 7-49). Average levels of presence across the entire exposure phase ranged from 32.44 to 38.86. Average presence was the highest while watching Elephants and Orangutans (*M* = 40.25, *SD* =

7.94) and the lowest while watching the International Space Station (M = 32.13, SD = 8.11) (See Table 6). A one-way ANOVA indicated that presence did not significantly differ across destinations, $F(1, 17) = .771$, $p = .724$, Cohen's $d = .617$. Pairwise comparisons with a Bonferroni correction did not reveal any significant differences in presence between any destination (data not shown; see Table 6 for descriptive presence information related to each video).

Table 6. Average presence scores for each video.

Video	*M*	*SD*	*n*[a]
Amsterdam	36.13	5.36	8
Australia	37.09	9.88	11
Cancun	35.33	5.05	9
Canyon Walk	36.00	5.48	9
Egypt	37.80	6.73	10
Elephants & Orangutans	40.25	7.94	8
Far East	33.00	9.47	8
Greece	32.67	6.38	6
Hong Kong	33.30	5.96	10
Ireland	34.13	6.85	8
International Space Station	32.13	8.11	8
Morocco	35.89	7.23	9
Paris	33.56	4.04	9
Portugal	32.56	6.89	9
Prague	35.38	7.71	8
Scuba Diving	35.57	8.18	7
Spain	37.30	6.70	10
Turkey	34.38	7.41	8

[a]*n* represents the number of times each video was watched.

Objective 2: Evaluate impact of virtual tourism on quality of life, social engagement, and loneliness.

Quality of Life. Total OPQOL-35 scores and scores from each subscale at T1, T2, and T3 were inspected for violations of normality. A 1 (outcome: quality of life) x 3 (time point: T1, T2, T3) RM ANOVA was conducted to assess changes in total quality of life throughout the

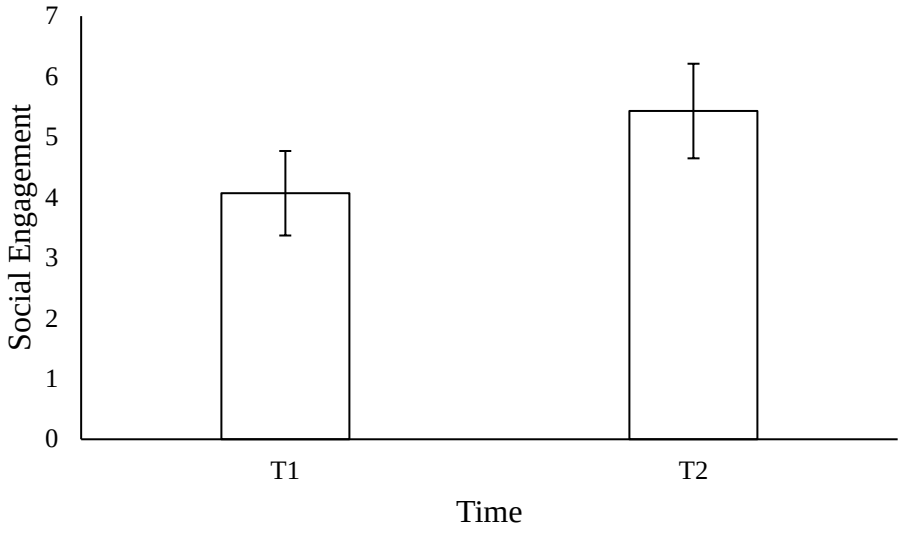
course of the study. Analyses revealed no significant main effect of time on quality of life, $F(2, 18) = .275$, $p = .763$, Cohen's $d = .352$.

Paired difference scores for total quality of life, as well as for each subscale, were examined for violations of normality. A follow-up paired *t*-test comparing total quality of life at T1 ($M = 121.93$, $SD = 11.56$) and T2 ($M = 123.57$, $SD = 14.15$) revealed no significant differences in quality of life between time points, $t(13) = .956$, 95% CI [-2.069, 5.355], $p = .356$, Cohen's $d = .142$. Follow-up paired *t*-tests were non-significant for life overall, health, independence, social relationships, finances, leisure, and psychological well-being, and religion subscales. The Sign test for the home and neighborhood subscale was non-significant as well (See Table 7).

Social Engagement. SES data from each time point was inspected for violations of normality. A 1 (outcome: social engagement) x 3 (time point: T1, T2, T3) repeated measures ANOVA was conducted to assess changes in social engagement throughout the course of the study. Analyses revealed no significant main effect of time on social engagement, $F(2, 18) = 1.483$, $p = .253$, Cohen's $d = .810$ (see Table 7). SES from T1, T2, and T3 was also analyzed using Friedman's test to account for the non-normal distribution of SES at T3. The results of this test were non-significant as well (data not shown).

Paired difference data for SES at T1 and T2 were inspected for violations of normality. A follow-up paired *t*-test revealed that social engagement was significantly higher at T2 ($M = 5.43$, $SD = 2.92$) compared to T1 ($M = 4.07$, $SD = 2.62$), $t(13) = 2.56$, 95% CI [.211, 2.50], $p = .024$, Cohen's $d = .518$ (see Figure 3 and Table 7).

Figure 3. SES scores at T1 and T2.



Note. Error bars represent standard error of the mean.

Loneliness. UCLA-R data from each time point was inspected for violations of normality. A 1 (outcome: loneliness) x 3 (time point: T1, T2, T3) repeated measures ANOVA was conducted to assess changes in loneliness throughout the course of the study. Analyses revealed no significant main effect of time on loneliness, $F(2, 18) = .195$, $p = .823$, Cohen's $d = .293$ (see Table 7).

Paired difference scores were inspected for violations of normality. A follow-up paired *t*-test comparing loneliness at T1 ($M = 45.93$, $SD = 10.55$) and T2 ($M = 44.93$, $SD = 9.55$) revealed no significant differences in loneliness between time points, $t(13) = -.725$, 95% CI [-3.98, 1.98], $p = .481$, Cohen's $d = .009$ (see Table 7).

Table 7. Descriptive statistics for OPQOL-35 (total and subscales), SES, and UCLA-R at T1 and T2 ($n = 14$) and T3 ($n = 10$).

	T1		T2		T3		
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	p^b
Total OPQOL-35	121.93	11.56	123.57	14.15	121.30	16.22	0.356
OPQOL-35 Subscales							
Life overall	14.79	2.00	14.86	2.18	15.20	2.66	0.89
Health	13.50	1.77	13.36	2.82	12.80	2.97	0.78
Social	15.57	3.18	16.00	3.64	15.30	3.77	0.29

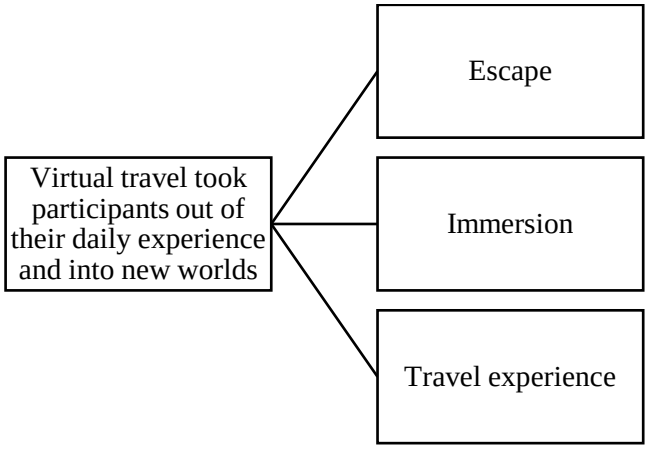
Independence	16.79	2.67	17.21	2.39	17.50	2.72	0.443
Finances	12.93	2.76	13.71	2.55	13.10	3.63	0.159
Leisure	10.86	1.75	11.00	2.25	10.80	1.93	0.738
Religion	6.86	2.03	6.93	1.73	7.10	1.60	0.836
Home[a]	14.79	1.58	15.00	2.00	14.20	1.93	0.344
Psychological	15.86	1.66	15.50	1.87	15.30	1.25	0.292
UCLA-R	45.93	10.55	44.93	9.55	45.70	9.07	0.481
SES	4.07	2.62	5.43	2.93	4.70	2.67	**0.024**

[a]Significance for home subscale derived from Sign Test.
[b]Significance values represent paired *t*-tests between T1 and T2.

Qualitative Analysis. Eighty-two condensed meaning units related to the research objectives were extracted from six qualitative interviews. Fourteen categories and five themes emerged.

Theme 1: Virtual travel took participants out of their daily experience and into new worlds. Categories within this theme related to escape, immersion, and travel experience. Participants discussed the ability for VR to create a feeling of escapism and transportation to new places. One participant said, “I didn’t feel… as much aware of my pain” with respect to watching the virtual content, and that this reduction in awareness persisted beyond the exposure period. Participants felt absorbed and immersed in the content, and felt as though it was highly realistic; one participant reported that it was “almost like being there in many cases,” and another commented that they were “really absorbed in a lot of it.” Participants reflected on the ways in which virtual tourism reminded them of, and added another layer to, previous travel experiences (see Figure 4).

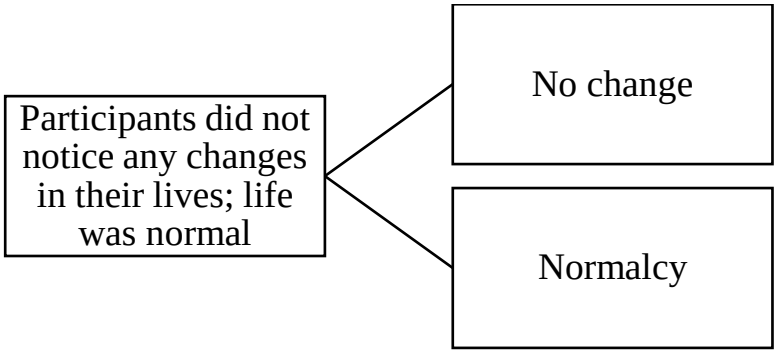
Figure 4. Theme 1 and corresponding categories.



Theme 2: Participants did not notice any changes in their lives; life was normal.

Categories within this theme related to the normalcy of participants' lives throughout the duration of the program. During the interview, many participants alluded to the fact that they could not think of any significant changes, positive or negative, that occurred in their outlook on life, or physical or emotional well-being. One participant "didn't recall any *great* changes" throughout the duration of the study, and another mentioned that everything had been "quite normal" (see Figure 5).

Figure 5. Theme 2 and corresponding categories.

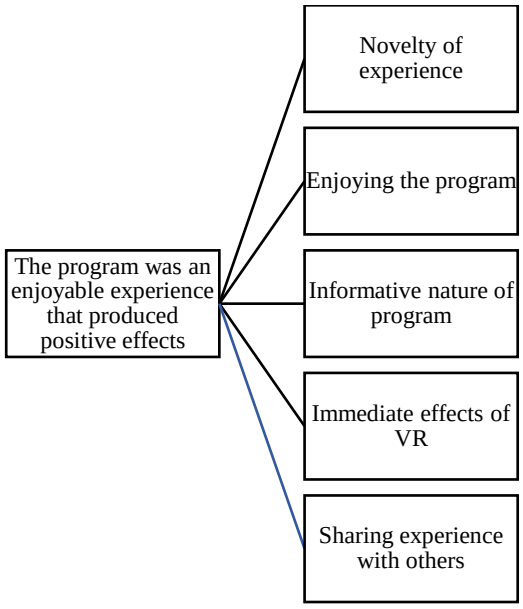


Theme 3: The program was an enjoyable experience that produced positive effects.

Categories within this theme related to novelty, enjoyment, interest, learning, sharing, and the immediate positive effects produced by the VR program. Many participants discussed their

enjoyment of the virtual tourism program. Participants were happy to have participated, enjoyed the experience, and enjoyed the travel aspects of the program. One participant "felt privileged" to take part in the study, and another discussed how the study "lived up to my expectations and I quite enjoyed it." One participant said, "I found most of the tapes energized me and that energy level carried through to the rest of the day." Not only did many participants enjoy the program, but most also found it to be interesting and a learning experience. For example, one participant discussed that they "learned a lot" and another mentioned that "it was an interesting experience." However, it is important to note that one participant mentioned disappointment with a lack of information that was provided in the videos. Participants also reflected on the fact that many of them discussed their experiences from the study with others, suggesting that the virtual tourism program may have impacted social engagement (see Figure 6).

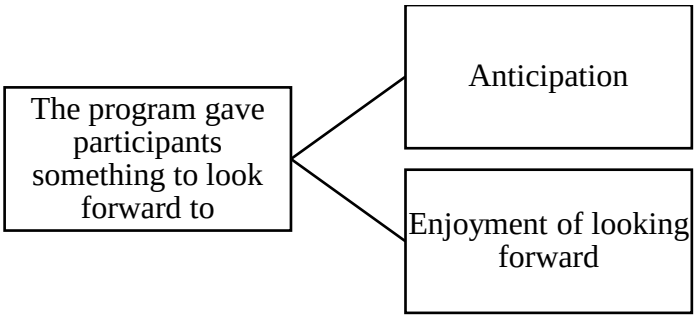
Figure 6. Theme 3 and corresponding categories.



Theme 4: The program gave participants something to look forward to, and the anticipation was a positive experience. Categories within this theme related to the anticipation of the virtual tourism experience. The majority of participants mentioned looking forward to and

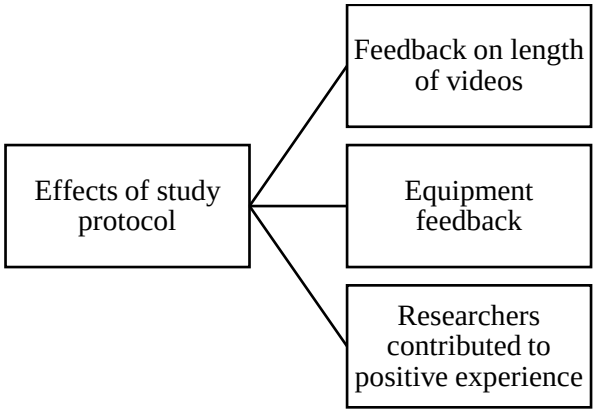
anticipating the virtual tourism program. For example: “I looked forward to it” and “it was something to look forward to.” One participant discussed enjoying the anticipation: “the anticipation that I was going to be able to look at something… and I wouldn’t know what it was until I got here” (see Figure 7).

Figure 7. Theme 4 and corresponding categories.



Theme 5: Effects of study protocol. Categories within this theme related to content feedback and positive effects of the researchers. A couple of participants commented on the nature of the length of the videos; some participants felt that 10 minutes was long enough and others felt that it was not enough time. No participants provided negative feedback on the VR apparatus or experience, and one participant said that the “equipment was fine.” One participant discussed the effect of the researchers on the study experience, expressing that the interactions were positive: “Well I think the staff, you guys were great… Yeah, and I think that makes a difference” (see Figure 8).

Figure 8. Theme 5 and corresponding categories.



Taken together, the emergent themes suggest that the virtual tourism program did not have any qualitative effects on subjective quality of life or loneliness, however, it did affect social engagement while also providing anticipation and enjoyment, stimulation for participants that lasted throughout the day, as well as a new and positive experience.

Discussion

VR technology is becoming increasingly more popular and accessible. These increases provide the opportunity to use VR for not only entertainment, but also as a tool to enhance quality of life. This is especially important for adults over the age of 65; the group that is projected to compose up to 25% of the Canadian population by 2036 and whom will likely begin to enter collective dwellings (Statistics Canada, 2011b; Statistics Canada, 2011c; World Health Organization, 2015). As it relates to the present study, VR is meant to provide older adults living in collective dwellings the ability to engage in meaningful leisure by virtually travelling to different locations around the world. Meaningful leisure, such as travel, is associated with increases in quality of life and happiness (Chen & Petrick, 2013; Val Malderen et al., 2013). It is important to maintain quality of life for older adults living in collective dwellings; for example,

life in long-term care is commonly associated with lower levels of quality of life and increased loneliness (Hedayati et al., 2014; Pinquart & Sörensen, 2001).

An important and novel finding from the present study is the notion that older adults were able to tolerate immersive VR without experiencing cybersickness. Results from the modified SSQ indicated that there were no significant differences in the experience of cybersickness before and after VR exposure. Average levels of cybersickness pre- and post-VR exposure were low relative to the range of possible scores on the scale. Interestingly, data trends suggest that average levels of cybersickness throughout the program decreased following VR exposure compared to before. For example, levels of fatigue were significantly lower after virtual tourism than before. A reduction in fatigue found on the SSQ corroborates the findings of the VAS qualitative analysis, in which the "fatigue" category that was present prior to VR exposure disappeared following VR exposure. Coupled with the fact that presence did not vary as a function of content, these findings suggest that participants were involved and immersed in the videos they were watching to the point of distraction and forgetting of physical symptoms present prior to exposure. In their report on Virtual Reality Induced Symptoms and Effects (VRISE), Nichols et al. (2000) found that over 65% of participants using a HMD reported an increase in symptoms following VR exposure. In the present study, only 50% of participants reported an increase in symptoms following VR exposure, and this increase only occurred 6.7% of the time (data not reported). Clearly, more research is needed to elucidate discrepancies in findings between studies.

The findings related to cybersickness obtained in the present study are critical, as very little research exists that employs immersive VR configurations (i.e., HMDs) with older adults, and, of the research that does exist, little expressly investigates older adults' tolerance of

immersive VR in terms of cybersickness (e.g., Lin, 2017; Optale et al., 2010). The need for research investigating older adults' ability to tolerate immersive VR is paramount; the rapid rate at which technology is advancing alongside the aging population will mean ample opportunity to incorporate technology into caring for older adults in the future. Although some older adults may stereotypically avoid or resist technology out of fear or inadequacy, many display positive attitudes towards using technology (Broady, Chan, & Caputi, 2010; Mitzner et al., 2010). In fact, baby boomers, the generation hastening the aging of Canada's population, may be more experienced with, and less anxious about technology (Niemelä-Nyrhinen, 2007; Statistics Canada, 2015). It is important to consider the reasons why older adults may or may not be wary of technology, however, doing so does not undermine the necessity of empirically testing the suitability of such technologies in samples of older adults.

In the present study, older adults enjoyed virtual tourism. Levels of happiness and excitement were significantly higher, and levels of anxiety were significantly lower, immediately following exposure to VR compared to before, and these levels did not significantly change throughout the duration of the program. Quantitative data is further supported by qualitative data from both the VAS and semi-structured interviews. Qualitative analysis of present-moment emotional words on the VAS revealed overlapping pre- and post-VR categories that included positive and negative emotions, positive arousal, neutrality, and relaxation. Interestingly, the category related to fatigue pre-VR was no longer present post-VR. Negative emotion and negative arousal were two prominent and distinct categories pre-VR, however, post-VR there was not enough content to make the distinction between the two categories and they were grouped together as a result. Words in the pre-VR "positive arousal category" centered on anticipation and excitement, whereas words in the post-VR "positive arousal category" centered

on awe. Qualitative interview data suggest that the virtual tourism program was a positive and enjoyable experience that led to anticipation, social engagement, enjoyment, and escape. Taken together, these findings suggest that older adults not only enjoyed virtual tourism, but that virtual tourism provided a sense of escape and pause from daily life, as well as an activity to anticipate.

These findings are important as they speak to the power of VR as a tool for recreation and leisure. At the beginning of the study, all participants reported enjoying travelling despite no longer doing so, and research has shown that older adults report satisfaction with tourism-related experiences (Milman, 1998; Wei & Milman, 2002). In fact, one unique motivation for travel for older adults is escapism (Cleaver & Muller, 2002). Results from the present study demonstrate that older adults enjoyed virtual tourism, and that virtual tourism transported participants out of their daily routines and into new worlds. These findings are novel because they suggest that VR may provide the opportunity for older adults to continue to travel, albeit virtually, while still experiencing the enjoyment and satisfaction that a physical trip may afford. Furthermore, participants discussed looking forward to and anticipating the virtual tourism program, which suggests that participants may have considered virtual tourism as an enjoyable leisure activity. Meaningful leisure and participation in leisure activities are beneficial for healthy aging, and have been shown to have positive effects on such indices as quality of life, life satisfaction, and psychological well-being (for a review, see Leitner & Leitner, 2012; Silverstein & Parker, 2002). Silverstein and Parker (2002) further posit that increases in leisure activity engagement may affect older adults' perception of their past quality of life, implying that changes in leisure participation in the present can affect perceptions of quality of life in the past. The findings from the present study support the notion that meaningful leisure is an area deserving of increased empirical attention as it pertains to interventions for older adults living in collective dwellings.

Levels of social engagement following the cessation of the virtual tourism program were significantly higher compared to baseline. Furthermore, participants reported qualitative changes in social interaction throughout the course of the six-week program; many participants discussed their experiences in the program with fellow residents and family members. Maintaining levels of social engagement for older adults is important, as social engagement has been shown to predict subjective and objective health status, mortality, and life satisfaction in older adults with disease and disability (for a review, see Bath & Deeg, 2005; Cherry et al., 2013; Jang, Mortimer, Haley, & Borenstein Graves, 2004). The positive effect of participation in social activities on life satisfaction has also been shown for older adults living in assisted living facilities (Park, 2009). Unfortunately, levels of social engagement can be lower for some, but not all, older adults; this may be especially true for older adults living in care facilities with functional and cognitive impairments (Silverstein & Parker, 2002; Zimmerman et al., 2003). Levels of social engagement are also heavily tied to facility characteristics and staff involvement (Schroll, Jónsson, Mor, Berg, & Sherwood, 1997; Zimmerman et al., 2003). The findings of the present study suggest that VR, a technology increasing in popularity, accessibility, and ease of use, is a tool that may be able to facilitate social engagement for older adults living in retirement homes.

Although both qualitative and quantitative changes in social engagement and enjoyment over the six-week study period were observed, these findings must be interpreted with caution. The present study did not include a control group, therefore, no causal inferences can be made suggesting that the virtual tourism program was the antecedent to any of the observed changes. Although qualitative data supports quantitative changes in social engagement and enjoyment over time, there may be other explanations for the quantitative findings. For example, the program itself was socially engaging by virtue of the fact that participation included interacting

with research assistants three times a week for six consecutive weeks. In fact, one participant discussed the impact of the positive interactions they had with the researchers in their interview. Participants also reported discussing their experiences in the study with their friends and family. Perhaps the changes in social engagement reported in this study were due to the natural social engagement that took place as part of the study, and may not be due to the virtual tourism program itself. Changes in social engagement may also reflect natural fluctuations over time.

Similar considerations must be made when interpreting the changes seen in happiness, excitement, and anxiety immediately following VR exposure. Although participants reported enjoying and anticipating the program, without a control group, it is impossible to determine whether the immediate changes in happiness, excitement, and anxiety were due to the virtual tourism program. For example, changes observed on the VAS may have been due to the social nature of the program; participants may have felt happier, more excited, and less anxious after spending 20-30 minutes engaging with friendly research assistants. It could also be that any temporary change in routine was enough to change state levels of happiness, excitement, and anxiety.

Future iterations of this research will necessarily require the addition of a control group to conclude that virtual tourism caused any of the observed changes. Despite an inability to draw firm causal conclusions, the present findings, both qualitative and quantitative, support the notion that positive changes take place over a six-week virtual tourism program. Future research is needed to elucidate whether these changes are due to social engagement associated with study participation, change in routine, or the virtual tourism program itself.

The present feasibility study has a number of limitations. Due to the small sample size, statistical power was limited. As a result, it is possible that some tests may not have reached the

threshold for statistical significance or that significant findings may be spurious. Replication with a larger sample is necessary for a better understanding of the effects of the virtual tourism program on quality of life, social engagement, and loneliness. Furthermore, low power prevented the inclusion of covariates in any statistical model. It is possible that the results of this study would be altered if covariates such as age, sex, and years of education were entered into any of the models. Future research should aim to recruit more participants to allow for more complex and versatile statistical analyses. Finally, multiple exploratory comparisons without statistical correction may have inflated the familywise Type 1 error rate.

Furthermore, the small sample size limits the generalizability of the findings to all older adults living in retirement homes or other collective dwellings. The present sample of older adults was relatively independent and living in dwellings that provided low levels of care and support, characterizations that may not be reflective of older adults in other living arrangements (e.g., long-term care). In order to be able to generalize the findings of this study, participants must be sampled from more diverse collective living arrangements.

Another limitation concerns the quality of the virtual content. Content for this study was not curated in a standardized way; for example, some videos contained tour guides while others did not, and some included augmented reality within the virtual environment. Unfortunately, it was impossible to ensure that every video was at a high level of quality due to the need for 18 distinct VR films. The effects of the variation in content quality is reflected in participant feedback. Throughout the course of the study, ample opportunity was provided for participants to provide feedback on their likes and dislikes about the program. Although this information was not formally collected or presented in this report, there were a number of times where participants expressed dissatisfaction with some of the VR content. Some of this dissatisfaction

was expressed in the qualitative interview; some participants discussed the length of the videos as being too short, and others were discontented with a lack of information in the videos. Learning has been shown to be an important element of meaningful leisure activities for many older adults (Roberson, 2005), therefore, ensuring virtual content is adequately informative may help to foster the positive effects of virtual tourism. At this time, however, it is possible that the virtual tourism program did not have the hypothesized effect on all indices of well-being due to the fact that participants were not satisfied with the content they were viewing.

Unsatisfactory content may have also led to less involvement with the virtual environment, a component of presence (Witmer & Singer, 1998). Participants may have found unsatisfactory content less stimulating or meaningful, both of which are factors that could have led to less presence (Witmer & Singer, 1998). A lack of presence may have contributed to a diminished effect of the program over time. Although there are individual differences in content satisfaction, it will be important to utilize participant feedback to create more enjoyable and immersive content for future studies.

Altogether, the results of the present study indicated positive changes in social engagement that took place over the course of the study, positive changes in affect that occurred immediately after VR exposure, as well as a sense of enjoyment and anticipation related to weekly participation. This is one of the first studies to use an immersive VR configuration that included a HMD and headphones in a sample of older adults living in retirement homes, and is the first study that attempts to use VR to improve quality of life exclusively through virtual tourism. However, without a control group, it is unknown whether any of the positive changes that were seen were due to the virtual tourism program. These findings necessitate a randomized control trial to isolate the effects of the virtual tourism program. Based on the results of future

randomized control trials, it is possible that, one day, collective dwellings may choose to offer virtual tourism as a variety of meaningful leisure for residents in an attempt to increase social engagement and quality of life, among other possible indices of well-being. Replication of the findings in future studies will validate the notion that older adults are able to tolerate immersive VR, creating many opportunities for psychological interventions and meaningful leisure in a variety of contexts.

Appendix A

Date of Examination ___/___/___ Examiner _____

Name _____ Age ____ Years of School Completed ____

Instructions: Words in boldface type should be read aloud clearly and slowly to the examinee. Item substitutions appear in parentheses. Administration should be conducted privately and in the examinee's primary language. Circle 0 if the response is incorrect, or 1 if the response is correct. Begin by asking the following two questions:

Do you have any trouble with your memory? **May I ask you some questions about your memory?**

ORIENTATION TO TIME		RESPONSE	SCORE (circle one)	
What is the...	year?		0	1
	season?		0	1
	month of the year?		0	1
	day of the week?		0	1
	date?		0	1

ORIENTATION TO PLACE*			
Where are we now? What is the...			
	state (province)?	0	1
	county (or city/town)?	0	1
	city/town (or part of city/neighborhood)?	0	1
	building (name or type)?	0	1
	floor of the building (room number or address)?	0	1

*Alternative place words that are appropriate for the setting and increasingly precise may be substituted and noted.

REGISTRATION*

Listen carefully. I am going to say three words. You say them back after I stop. Ready? Here they are... APPLE [*pause*], **PENNY** [*pause*], **TABLE** [*pause*]. **Now repeat those words back to me.**

[*Repeat up to 5 times, but score only the first trial.*]

APPLE		0	1
PENNY		0	1
TABLE		0	1

Now keep those words in mind. I am going to ask you to say them again in a few minutes.

*Alternative word sets (e.g., PONY, QUARTER, ORANGE) may be substituted and noted when retesting an examinee.

ATTENTION AND CALCULATION [*Serial 7s*]*

Now I'd like you to subtract 7 from 100. Then keep subtracting 7 from each answer until I tell you to stop.

What is 100 take away 7?	[93]		0	1
If needed, say: **Keep going.**	[86]		0	1
If needed, say: **Keep going.**	[79]		0	1
If needed, say: **Keep going.**	[72]		0	1
If needed, say: **Keep going.**	[65]		0	1

*Alternative item (WORLD backward) should only be administered if the examinee refuses to perform the Serial 7s task. →

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Substitute and score this item only if the examinee refuses to perform the Serial 7s task.

Spell WORLD forward, then backward.

Correct forward spelling if misspelled,

but score only the backward spelling.

____ (D = 1) ____ (L = 1) ____ (R = 1) ____ (O = 1) ____ (W = 1) ____ (0 to 5)

RECALL	RESPONSE	SCORE (circle one)
What were those three words I asked you to remember? [*Do not offer any hints.*]		
APPLE	_____	0 1
PENNY	_____	0 1
TABLE	_____	0 1

NAMING*

What is this? [*Point to a pencil or pen.*]	_____	0 1
What is this? [*Point to a watch.*]	_____	0 1

*Alternative common objects (e.g., eyeglasses, chair, keys) may be substituted and noted.

REPETITION

Now I am going to ask you to repeat what I say. Ready? "NO IFS, ANDS, OR BUTS." Now you say that.
[*Repeat up to 5 times, but score only the first trial.*]

NO IFS, ANDS, OR BUTS.	_____	0 1

Detach the next page along the lengthwise perforation, and then tear it in half along the horizontal perforation. Use the upper half of the page (blank) for the Comprehension, Writing, and Drawing items that follow. Use the lower half of the page as a stimulus form for the Reading ("CLOSE YOUR EYES") and Drawing (intersecting pentagons) items.

COMPREHENSION

Listen carefully because I am going to ask you to do something.
Take this paper in your right hand [*pause*], **fold it in half** [*pause*], **and put it on the floor** (*or* **table).**

TAKE IN RIGHT HAND	_____	0 1
FOLD IN HALF	_____	0 1
PUT ON FLOOR (*or* TABLE)	_____	0 1

READING

Please read this and do what it says. [*Show examinee the words on the stimulus form.*]

CLOSE YOUR EYES	_____	0 1

WRITING

Please write a sentence. [*If examinee does not respond, say:* **Write about the weather.**] 0 1

Place the blank piece of paper (unfolded) in front of the examinee and provide a pen or pencil. Score 1 point if the sentence is comprehensible and contains a subject and a verb. Ignore errors in grammar or spelling.

DRAWING

Please copy this design. [*Display the intersecting pentagons on the stimulus form.*] 0 1

Score 1 point if the drawing consists of two 5-sided figures that intersect to form a 4-sided figure.

Total Score = _____ (*Sum all item scores.*) (30 points max.)

Assessment of level of consciousness.

Alert/ Responsive — Drowsy — Stuporous — Comatose/ Unresponsive

Tellegen Absorption Scale

This questionnaire consists of questions about experiences that you may have had in your life. We are interested in how often you have these experiences. It is important, however, that your answers show how often these experiences happen to you when you are not under the influence of alcohol or drugs.

1----------2----------3----------4
Never Always

1. **Sometimes I feel and experience things as I did when I was a child.**

1----------2----------3----------4
Never Always

2. **I can be greatly moved by eloquent or poetic language.**

1----------2----------3----------4
Never Always

3. **While watching a movie, a TV show, or a play, I may become so involved that I may forget about myself and my surroundings and experience the story as if it were real and as if I were taking part in it.**

1----------2----------3----------4
Never Always

4. **If I stare at a picture and then look away from it, I can sometimes "see" an image of the picture almost as if I were still looking at it.**

1----------2----------3----------4
Never Always

5. **Sometimes I feel as if my mind could envelop the whole world.**

1----------2----------3----------4
Never Always

6. **I like to watch cloud shapes change in the sky.**

1----------2----------3----------4
Never Always

7. **If I wish I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does.**

1----------2----------3----------4
Never Always

8. **I think I really know what some people mean when they talk about mystical experiences.**

1----------2----------3----------4
Never Always

9. **I sometimes "step outside" my usual self and experience an entirely different state of being.**

1----------2----------3----------4
Never **Always**

10. Textures -- such as wool, sand, wood -- sometimes remind me of colors or music.

1----------2----------3----------4
Never Always

11. Sometimes I experience things as if they were doubly real.

1----------2----------3----------4
Never Always

12. When I listen to music I can get so caught up in it that I don't notice anything else.

1----------2----------3----------4
Never Always

13. If I wish I can imagine that my body is so heavy that I could not move it if I wanted to.

1----------2----------3----------4
Never Always

14. I can often somehow sense the presence of another person before I actually see or hear her/him.

1----------2----------3----------4
Never Always

15. The crackle and flames of a wood fire stimulate my imagination

1----------2----------3----------4
Never Always

16. It is sometimes possible for me to be completely immersed in nature or in art and to feel as if my whole state of consciousness has somehow been temporarily altered.

1----------2----------3----------4
Never Always

17. Different colors have distinctive and special meanings for me.

1----------2----------3----------4
Never Always

18. I am able to wander off into my thoughts while doing a routine task and actually forget that I am doing the task, and then find a few minutes later that I have completed it.

1----------2----------3----------4
Never Always

19. I can sometimes recollect certain past experiences in my life with such clarity and vividness that it is like living them again or almost so.

1----------2----------3----------4
Never Always

20. Things that might seem meaningless to others often make sense to me.

1----------2----------3----------4
Never Always

21. While acting in a play I think I could really feel the emotions of the character and "become" her/him for the time being, forgetting both myself and the audience.

1----------2----------3----------4
Never Always

22. My thoughts often don't occur as words but as visual images.

1----------2----------3----------4
Never Always

23. I often take delight in small things (like the five-pointed star shape that appears when you cut an apple across the core or the colors in soap bubbles).

1----------2----------3----------4
Never Always

24. When listening to organ music or other powerful music I sometimes feel as if I am being lifted into the air.

1----------2----------3----------4
Never Always

25. Sometimes I can change noise into music by the way I listen to it.

1----------2----------3----------4
Never Always

26. Some of my most vivid memories are called up by scents and smells.

1----------2----------3----------4
Never Always

27. Some music reminds me of pictures or changing color patterns.

1----------2----------3----------4
Never Always

28. I often know what someone is going to say before he or she says it.

1----------2----------3----------4
Never Always

29. I often have "physical memories"; for example, after I have been swimming I may still feel as if I am in the water.

1----------2----------3----------4
Never Always

30. The sound of a voice can be so fascinating to me that I can just go on listening to it.

1----------2----------3----------4
Never Always

31. At times I somehow feel the presence of someone who is not physically there.

1----------2----------3----------4
Never Always

32. Sometimes thoughts and images come to me without the slightest effort on my part.

1----------2----------3----------4
Never Always

33. I find that different odors have different colors.

1----------2----------3----------4
Never Always

34. I can be deeply moved by a sunset.

1----------2----------3----------4
Never Always

UCLA-R SCALE

Instructions: Please indicate how often each of the statements below is descriptive of you.

1. I feel in tune with the people around me

Never Rarely Sometimes Often

2. I lack companionship

Never Rarely Sometimes Often

3. There is no one I can turn to

Never Rarely Sometimes Often

4. I do not feel alone

Never Rarely Sometimes Often

5. I feel part of a group of friends

Never Rarely Sometimes Often

6. I have a lot in common with the people around me

Never Rarely Sometimes Often

7. I am no longer close to anyone

Never Rarely Sometimes Often

8. My interests and ideas are not shared by those around me

Never Rarely Sometimes Often

9. I am an outgoing person

Never Rarely Sometimes Often

10. There are people I feel close to

Never Rarely Sometimes Often

11. I feel left out

Never Rarely Sometimes Often

12. My social relationships are superficial

Never Rarely Sometimes Often

13. No one really knows me well

Never Rarely Sometimes Often

14. I feel isolated from others

Never Rarely Sometimes Often

15. I can find companionship when I want it

Never Rarely Sometimes Often

16. There are people who really understand me

Never Rarely Sometimes Often

17. I am unhappy being so withdrawn

Never Rarely Sometimes Often

18. People are around me but not with me

Never Rarely Sometimes Often

19. There are people I can talk to

Never Rarely Sometimes Often

20. There are people I can turn to

Never Rarely Sometimes Often

OPQOL-35

We would like to ask you about your quality of life:
Please circle one statement in each row. There are no right or wrong answers. Please select the response that best describes you/your views.

1. **Thinking about both the good and bad things that make up your quality of life, how would you rate the quality of your life as a whole?**

***Your* quality of life as a whole is:**

Very good Good Alright Bad Very bad

2. **Please indicate the extent to which you agree or disagree with each of the following statements by circling one of the statements:**

Life overall:

1. **I enjoy my life overall**

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

2. **I am happy much of the time**

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

3. I look forward to things

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

4. Life gets me down

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Health:

5. I have a lot of physical energy

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

6. Pain affects my well-being

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

7. My health restricts me looking after myself or my home

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

8. I am healthy enough to get out and about

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Social relationships:

9. My family, friends or neighbours would help me if needed

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

10. I would like more companionship or contact with other people

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

11. I have someone who gives me love and affection

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

12. I'd like more people to enjoy life with

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

13. I have my children around which is important

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Independence, control over life, freedom:

14. I am healthy enough to have my independence

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

15. I can please myself what I do

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

16. The cost of things compared to my pension/income restricts my life

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

17. I have a lot of control over the important things in my life

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Home and neighbourhood:

18. I feel safe where I live

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

19. The local shops, services, and facilities are good overall

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

20. I get pleasure from my home

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

21. I find my neighbourhood friendly

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Psychological and emotional well-being:

22. I take life as it comes and make the best of things

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

23. I feel lucky compared to most people

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

24. I tend to look on the bright side

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

25. If my healthy limits social/leisure activities, then I will compensate and find something else I can do

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Financial circumstances:

26. I have enough money to pay for household bills

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

27. I have enough money to pay for household repairs or help needed in the house

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

28. I can afford to buy what I want to

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

29. I cannot afford to do things I would enjoy

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Leisure and activities:

30. I have social or leisure activities/hobbies that I enjoy doing

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

31. I try to stay involved with things

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

32. I do paid or unpaid work or activities that give me a role in life

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

33. I have responsibilities to others that restrict my social or leisure activities

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

34. Religion, belief or philosophy is important to my quality of life

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

35. Cultural/religious events/festivals are important to my quality of life

Strongly Agree Agree Neither agree/disagree Disagree Strongly disagree

Social Engagement Scale

In the last **2 weeks,** how often have you engaged in the following?

1. Engaged in activities outside of the residence with family or friends?

   0 times 1 to 2 times 3 times 4-5 times

2. Engaged in church or religious activities such as services, committees or choirs?

   0 times 1 to 2 times 3 times 4-5 times

3. Engaged in sports or other physical activities with other people?

   0 times 1 to 2 times 3 times 4-5 times

4. Engaged in other recreational activities involving other people, including hobbies, bingo, and other games?

   0 times 1 to 2 times 3 times 4-5 times

Have you engaged in the usual amount of activities in the past two weeks? If not, have you been more or less active than usual?:

Modified SSQ

PRE VR EXPOSURE

General discomfort	None	Slight	Moderate	Severe
Nausea	None	Slight	Moderate	Severe
Fatigue	None	Slight	Moderate	Severe
Headache	None	Slight	Moderate	Severe
Eye strain	None	Slight	Moderate	Severe
Dizziness	None	Slight	Moderate	Severe

POST VR EXPOSURE

General discomfort	None	Slight	Moderate	Severe
Nausea	None	Slight	Moderate	Severe
Fatigue	None	Slight	Moderate	Severe
Headache	None	Slight	Moderate	Severe
Eye strain	None	Slight	Moderate	Severe
Dizziness	None	Slight	Moderate	Severe

Notes:

Things to follow-up with if participant indicates having any of the above symptoms

- Difficulty focusing/concentrating
- Salivation increasing
- Sweating
- "Fullness of the head"
- Blurred vision
- Vertigo
- "Stomach awareness"
- Burping

Modified PQ

1. **How much did the visual aspects of the environment involve you**

|_____|_____|_____|_____|_____|_____|_____|
Not at all Somewhat Completely

2. **How much did the auditory aspects of the environment involve you**

|_____|_____|_____|_____|_____|_____|_____|
Not at all Somewhat Completely

3. **How aware were you of events occurring in the real world around you**

|_____|_____|_____|_____|_____|_____|_____|
Not at all Somewhat Completely

4. **How involved were you in the virtual environment experience**

|_____|_____|_____|_____|_____|_____|_____|
Not involved Mildly Completely

Participant ID: Time & Date: Session #:

5. How quickly did you adjust to the virtual environment experience?

|_____|_____|_____|_____|_____|_____|_____|

Not at all Slowly Less than one minute

6. How much did the visual display quality interfere or distract you from performing assigned tasks or required activities

|_____|_____|_____|_____|_____|_____|_____|

Not at all Interfered somewhat Interfered greatly

7. Were you involved in the experimental task to the extent that you lost track of time

|_____|_____|_____|_____|_____|_____|_____|

Not at all Somewhat Completely

To what extent did you feel like you were at the destination?

VAS : PRE-VR

1. Please make a vertical mark on each line which best corresponds to how you are feeling ***right now***:

1. How ***happy*** do you feel right now?

Very Unhappy **Very Happy**

2. How ***excited*** do you feel right now?

Very Bored **Very Excited**

3. How ***anxious*** do you feel right now?

Very Relaxed **Very Anxious**

Please write **ONE EMOTIONAL WORD** below that best represents how you feel **right now**:

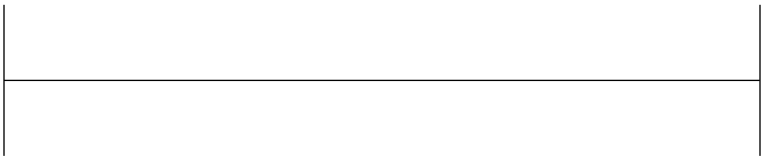
VAS: POST-VR

1. Please make a vertical mark on each line which best corresponds to how you are feeling ***right now***:

1. How ***happy*** do you feel right now?

Very Unhappy **Very Happy**

2. How ***excited*** do you feel right now?



Very Bored **Very Excited**

3. How ***anxious*** do you feel right now?

Very Relaxed **Very Anxious**

Please write **ONE EMOTIONAL WORD** below that best represents how you feel **right now**:

Appendix B

Consent Agreement

Virtual Reality Travel for Wellbeing in Seniors: Phase 2

You are being asked to participate in a research study. Before you give your consent to be a volunteer, it is important that you read the following information and ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators:
Principal Investigator: Dr. Alexandra J. Fiocco, PhD., Department of Psychology, Ryerson University
Co-Investigator: Dr. Richard Lachman, ProfD., RTA School of Media, Transmedia Research Centre, Ryerson University
Student Investigators: Katlyn Peck, MA, and Laura Krieger, Department of Psychology, Ryerson University

Collaboration:
The investigators are working in collaboration with Gianne Willett, Founder of Owlflix, a Toronto-based Virtual Reality company.

Funding:
This study is funded by the Ryerson Research Health Fund and RECODE.

Purpose of the Study:
This study aims to evaluate the benefit of virtual reality (VR) technology as a tool for "virtual travel" for seniors living in a retirement residence. The ability to travel is an important leisure activity that is associated with satisfaction of one's quality of life. As the ability to travel may decline in late life due to financial, mobility, or health barriers, it is thought that virtual travel using high-quality computer technology might satisfy this void. As such we are testing a virtual travel program (VTP) tailored for seniors living in a retirement residence.

We are inviting 20 seniors to participate in this study. The information (i.e., data) that we get from this study will provide pilot data for future funding opportunities. Results from this study will also be presented in scientific journals, at conference presentations, and community events.

What you will be asked to do:
As a participant, you will be asked to use the VTP for 10 minutes a day, 3 days a week, over 6 consecutive weeks. Each day, a researcher will visit you and will set you up with the device. The researcher will remain with you during the session to ensure that you are comfortable. We will also collect data from you before, during, and after the 6-week testing session.

Before and after the 6-week testing session, you will complete questionnaires that ask you about your wellbeing and quality of life. We will also ask you questions that are specific to your experience with the

program using an interview format which the researcher will audio record, using a password protected recording device. If you are uncomfortable being recorded, please ask the researcher to stop the recording device. These two assessment sessions will take approximately one-hour of your time in a private location located in the residence building.

On each day that you use the VTP, we will ask you to sit while wearing the VR headset. Immediately after the VTP, we will ask you to remain seating and relax with your eyes closed for another 5 minutes. We will also ask you to report your mood directly before and after using the virtual travel device, which will take no more than 5 minutes total.

Risks or Discomforts:
Risks associated with participating in this study are minimal. There may be some discomfort with the VR equipment and/or environment. However, any discomfort experienced is only temporary. If this does occur, you will be asked to take a break. You can also choose to temporarily or permanently stop your participation. If any discomfort is felt while wearing the VR headset, please inform the researcher – you are not expected to "tough it out".

You may feel some discomfort answering questions about your health and emotional wellbeing. If any discomfort occurs from a question, you are free to skip that question, to take a break, and/or to stop participating completely.

Benefits of the Study:
Exposure to virtual reality travel can provide you with an enjoyable experience. While we cannot guarantee that you will directly benefit by taking part in this study, you will be contributing to the development of a virtual reality program for seniors living in a retirement residence.

Confidentiality:
Your involvement in this study will remain confidential. We will not discuss your participation with anyone outside of the research team. We will not discuss your participation with the retirement home coordinator or manager, unless there is a health condition that warrants a conversation.

All data collected for this study will remain confidential. Research records will be kept in a cabinet file to which only the research team will possess the key. Data will be coded in order to prevent any assistant from making a link between a participant's name and test results, thus maintaining confidentiality of all test results. Once data is collected, identifying information (e.g., name, contact information) will be destroyed. All audio recordings will be transcribed and saved electronically, after which the recording will be deleted from the device. Electronic data will be securely stored on the university server in password-protected files. All coded data will be securely stored up to 5 years after study completion, after which all hard copy material will be properly destroyed. De-identified electronic data will be kept indefinitely for purpose of continued analysis or verification.

Costs and/or Compensation for Participation:
There is no cost to you by participating in this study. The research team will visit your facility to conduct this research at a time that is convenient for you. There is no compensation offered.

Voluntary Nature of Participation:
Participation is voluntary. Your choice of whether or not to participate will not influence your future

relations with Ryerson University or your retirement residence. At any particular point in the study, you may refuse to answer any particular question or stop participation altogether. If you decide to participate, you are free to withdraw your consent and stop your participation at any time without penalty or loss of benefits to which you are allowed. If you decide to stop participating, all information that you provided before stopping will be destroyed. Withdrawing from the study will not affect your relations with Ryerson University, the investigators, or your facility.

Questions about the Study:
If you have any questions about the research now, please ask. If you have questions later about the research, you may contact the principal investigator: Dr. Alexandra J. Fiocco via phone (416-979-5000 ext 3008) or email (afiocco@psych.ryerson.ca).

If you have questions about the VR system, please contact Gianne Willett via phone (647-515-3911) or email (owlflixfilms@gmail.com).

If you have questions regarding your rights as a human subject and participant in this study, you may contact the Chair of the Research Ethics Board at Ryerson University via phone (416-979-5042) or email (rebchair@ryerson.ca). You may also write them at:

Research Ethics Board
c/o Office of the Vice President, Research and Innovation
Ryerson University
350 Victoria Street
Toronto, ON M5B 2K3

Virtual Reality Travel for Wellbeing in Seniors: Phase 2

Agreement:

Your signature below indicates that you have read the information in this agreement and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to be in the study and have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement.

You have been told that by signing this consent agreement you are not giving up any of your legal rights.

_____
Name of Participant (please print)

_____ _____
Signature of Participant Date

Consent to be Audio recorded:

Your signature below indicates that you agree to have this interview audio recorded. You understand how these recording will be stored and destroyed.

_____ _____

Signature of Participant Date

_____ _____

Appendix C

Pre-VR Exposure Questions

1. Do you have any previous experience with virtual reality?

2. What are your expectations from taking part in the VR tourism program?

Appendix D

DEMOGRAPHICS, HEALTH and Travel QUESTIONNAIRE

Demographic:

1. Age _____
2. Sex: male female
3. Education
   a. Total years of education? _____
   b. Highest level attained?
      - Elementary or less
      - High school
      - some college or technical school
      - University
      - Graduate
4. Mother tongue _____
5. Language(s) most often used _____
6. What was your occupation before retiring? _____
7. Do you have any pilot experience? (i.e. as profession or pastime)_____
8. Are you concerned or uncomfortable with trying new technology?

LTCF Living:

9. How long have you lived in a LTCF? _____
10. How long in this LTCF?_____
11. Do you have family who visit? YES NO
    a. If YES, how often do they visit? _____
12. Do you have any friends in this facility (new or old)? YES NO
13. Does your facility have planned activities for its' members? YES NO

14. Do you participate in any of the planned activities? YES NO

    a. If YES, what do you participate in?

    b. If NO, why do you not participate?

Health:

15. How would you rate your general health?
    1. Very Poor
    2. Poor
    3. Fair
    4. Good
    5. Very good
    6. Excellent

16. Do you suffer from migraines? YES (EXCLUDE) NO

17. Do you have problems with your hearing? YES NO
    If YES, is your hearing corrected? _____

18. Do you have problems with your vision? YES NO
    If YES, is your vision corrected? _____

19. Do you have any mobility problems?
    i.e. Do you need assistance walking (e.g. with a cane, a walker, a wheelchair?) YES NO

    If YES, do you consider your mobility a barrier? (open ended)
    Probe if balance issue is due to inner ear problems

20. Have you ever received any of the following diagnoses?
    - Hypertension YES NO
    - IF YES, is it being treated and how? _____
    - Cardiovascular disorder YES NO
    - Stroke YES NO

- Neurological disorder (e.g. Parkinson's, dementia, normal tension hydrocephalus)
  YES NO
- Depression YES NO
- Anxiety YES NO
- Diabetes YES NO
- Cancer YES NO
  - IF YES, what form of cancer? _____
  - IF YES, when were you diagnosed (age)? _____
  - IF YES, how was it treated? _____
  - IF YES, is it remitted? _____
- Vertigo YES NO
- Other _____

Travel Experience

21. Do you like to travel? YES NO

22. Have you ever been a frequent traveller? YES NO

23. Do you still travel? YES NO

    If YES, how frequently?

    If NO, why not?

24. What, if any, are some barriers that prevent you from touring/travel?

Appendix E

VR Tourism Study: Phase 2
Qualitative Interview Questions
(Administered at T2 only)

Now that you have completed the study program, I would like to ask you a few questions.

1. Has the VR program met your expectations?

2. What was the best part about participating in the VR tourism program?

2. Over the past 6 weeks, can you tell me…

A. about any changes you may have experienced in your social life?

Prompt: changes in social interactions with friends or family?
Prompt: changes in your daily interaction?

B. about any changes in your outlook in life?

C. about any changes in your emotional wellbeing?

D. about any changes in your physical wellbeing/health?

Do you think any of these changes are related to the VR program? Or something else?

E. about any travel-related experiences you may have had?

Appendix F

Consent Agreement

Virtual Reality Travel for Wellbeing in Seniors: Follow-up Interview

You are being asked to participate in a follow-up session for this research study. Before you give your consent to be a volunteer, it is important that you read the following information and ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators:
Principal Investigator: Dr. Alexandra J. Fiocco, PhD., Department of Psychology, Ryerson University
Co-Investigator: Dr. Richard Lachman, ProfD., RTA School of Media, Transmedia Research Centre, Ryerson University
Student Investigators: Katlyn Peck, MA, and Laura Krieger, Department of Psychology, Ryerson University

Collaboration:
The investigators are working in collaboration with Gianne Willett, Founder of Owlflix, a Toronto-based Virtual Reality company.

Funding:
This study is funded by the Ryerson Research Health Fund and RECODE.

Purpose of the Study:
As a participant in the virtual travel study, we are inviting you to participate in a final interview session that aims to evaluate the long-term benefit of virtual reality (VR) technology as a tool for "virtual travel" for seniors living in a retirement residence.

We are inviting the same 20 seniors from the 6-week VR intervention to participate in this final phase of the study. The information (i.e., data) that we get from this phase will provide pilot data for future funding opportunities. Results from this study will also be presented in scientific journals, at conference presentations, and community events.

What you will be asked to do:
One month following the completion of the 6-week VR program and subsequent interview, you will be asked to complete another interview and series of follow-up questionnaires assessing the long-term effects of the 6-week intervention. Questionnaires assessing wellbeing, quality of life, loneliness, happiness, and quality of social interactions will be administered. Some questions may require open-ended answers from the participant. The questionnaires will be administered in a similar interview format that, with your permission, the researcher will audio record with a password protected recording device. If you are uncomfortable with being recorded, please ask the researcher to stop the recording device. This final assessment session will take approximately one hour of your time in a private location located in the residence building.

Risks or Discomforts:
Risk or discomfort associated with participation is minimal. You may feel some discomfort answering questions about your health and emotional wellbeing. If any discomfort occurs from a question, you are free to skip that question, to take a break, and/or to stop participating completely.

Benefits of the Study:
While we cannot guarantee that you will directly benefit by taking part in this study, you will be contributing to the development of a virtual reality program for seniors living in a retirement residence.

Confidentiality:
Your involvement in this study will remain confidential. We will not discuss your participation with anyone outside of the research team. We will not discuss your participation with the retirement home coordinator or manager, unless there is a health condition that warrants a conversation.

All data collected for this study will remain confidential. Research records will be kept in a cabinet file to which only the research team will possess the key. Data will be coded in order to prevent any assistant from making a link between a participant's name and test results, thus maintaining confidentiality of all test results. Once data is collected, identifying information (e.g., name, contact information) will be destroyed. All audio recordings will be transcribed and saved electronically, after which the recording will be deleted from the device. Electronic data will be securely stored on the university server in password-protected files. All coded data will be securely stored up to 5 years after study completion, after which all hard copy material will be properly destroyed. De-identified electronic data will be kept indefinitely for purpose of continued analysis or verification.

Costs and/or Compensation for Participation:
There is no cost to you by participating in this study. The research team will visit your facility to conduct this research at a time that is convenient for you. There is no compensation offered.

Voluntary Nature of Participation:
Participation is voluntary. Your choice of whether or not to participate will not influence your future relations with Ryerson University or your retirement residence. At any particular point in the study, you may refuse to answer any particular question or stop participation altogether. If you decide to participate, you are free to withdraw your consent and stop your participation at any time without penalty or loss of benefits to which you are allowed. If you decide to stop participating, all information that you provided before stopping will be destroyed. Withdrawing from the study will not affect your relations with Ryerson University, the investigators, or your facility.

Questions about the Study:
If you have any questions about the research now, please ask. If you have questions later about the research, you may contact the principal investigator: Dr. Alexandra J. Fiocco via phone (416-979-5000 ext 3008) or email (afiocco@psych.ryerson.ca).

If you have questions about the VR system, please contact Gianne Willett via phone (647-515-3911) or email (owlflixfilms@gmail.com).

If you have questions regarding your rights as a human subject and participant in this study, you may contact the Chair of the Research Ethics Board at Ryerson University via phone (416-979-5042) or email (rebchair@ryerson.ca). You may also write them at:
Research Ethics Board
c/o Office of the Vice President, Research and Innovation
Ryerson University
350 Victoria Street
Toronto, ON M5B 2K3

Virtual Reality Travel for Wellbeing in Seniors: Follow-up Interview

Agreement:

Your signature below indicates that you have read the information in this agreement and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to be in the study and have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement.

You have been told that by signing this consent agreement you are not giving up any of your legal rights.

_____
Name of Participant (please print)

_____ _____
Signature of Participant Date

Consent to be Audio recorded:

Your signature below indicates that you agree to have this interview audio recorded. You understand how these recording will be stored and destroyed.

_____ _____
Signature of Participant Date

_____ _____
Signature of Investigator/Study Coordinator Date

Appendix G

VR Tourism Study: Phase 2
Qualitative Interview Questions
(Administered at T3 only)

Now that it has been a month since you have completed the VR study, I would like to ask you a few questions.

1. Have there been any times where the VR program has popped into your mind? If so, can you tell me about them?

2. What was the best part about participating in the VR tourism program?

3. Over the past month since finishing the VR program, can you tell me…

A. about any changes you may have experienced in your social life?

Prompt: changes in social interactions with friends or family?
Prompt: changes in your daily interaction?

Do you think any of these changes are related to the VR program? Or something else?

E. about any changes in your feelings towards travel?

F. about any travel-related experiences you may have had?

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