Investigating the Feasibility of Smartphone Applications as a Support for Older Adults with Mild Impairments in Cognition

by

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Abstract

Smartphone applications have the capacity to support many of the needs specific to older adults with mild impairments in cognition. This capstone examines characteristics and diagnostic terminology used to encompass various forms of mild impairments in cognition, the unmet needs of those with these conditions, smartphone applications that have the potential to address these needs, and technology adoption considerations. User personas based on the literature review provide examples of how smartphone applications can be incorporated to meet the needs of this population. Findings from the literature review indicate that certain smartphone applications match with the needs of this population and could be utilized if technology adoption barriers are addressed. Given these findings, a research proposal is made for a feasibility study investigating a peer-led smartphone application training program to facilitate goal achievement for older adults with mild impairments in cognition.

Keywords: Smartphone applications; information and communication technology; older adults; cognitive impairment; technology adoption

I dedicate this project to my grandparents and great aunt.

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List of Acronyms

Term	Initial components of the term
AAMI	Age-Associated Memory Impairment
AD	Alzheimer's disease
ADLs	Activities of daily living
APA	American Psychological Association
ARCD	Age-Related Cognitive Decline
CIHR	Canadian Institutes of Health Research
DSM	Diagnostic and Statistical Manual for Mental Disorders
IADLs	Instrumental activities of daily living
ICTs	Information and communication technologies
GAS	Goal Attainment Scaling
GPS	Global Positioning System
MCI	Mild Cognitive Impairment
NCD	Neurocognitive Disorder
NHSP	New Horizons for Seniors Program
PDA	Personal digital assistant
PLATINUM	Peer-Led Smartphone Training for Older Adults with Mild Impairments in Cognition
SMART	specific, measurable, attainable, realistic, and timely

Chapter 1.

Introduction

1.1. Mild Impairments in Cognition

The term *mild impairments in cognition* can be used to capture the range of cognitive functioning that is found among older adults whose cognitive status lies somewhere in between perfect cognitive health and dementia (van den Berg, Kessels, de Haan, Kappelle, & Biessels, 2005). While medical research on the treatment of mild impairments in cognition is needed (Petersen et al., 2005; Rozzini et al., 2007), the effectiveness of treatment options has, to date, been somewhat limited (Logsdon, Gibbons, McCurry, & Teri, 2002). Thus, in conjunction with medical research and treatment options, it would also be pertinent to understand how best to support the daily lives of older adults who are currently living with these impairments.

There is a great deal of confusion within the medical field regarding characterizations of those with various forms of mild impairments in cognition (Tuokko, Frerichs, & Kristjansson, 2001). Some diagnostic terms, such as Age-Associated Memory Impairment (AAMI) and Age-Related Cognitive Decline (ARCD), attempt to capture the impairments that are *normative* for older age groups, whereas others, including Mild Cognitive Impairment (MCI) and Mild Neurocognitive Disorder (Mild NCD), are considered to be *non-normative* impairments within a population of older adults (APA, 2000; APA, 2013; Crook et al., 1986; Petersen, 2004). Each of these conditions has a different set of diagnostic criteria and symptoms. In order to develop compensatory strategies, it is important to summarize and clearly differentiate between various normative and non-normative forms of mild impairments in cognition. Having a clear understanding of the differences between these conditions allows for the

development of more effective interventions for those with various forms of these cognitive impairments.

Estimates of the prevalence of mild impairments in cognition differ according to which diagnostic criteria are utilized. AAMI has been estimated to affect a large portion of the older population, ranging from approximately 41% of those aged 50 to 59 and 85% of those aged 80 and older (Larrabee & Crook, 1994). The prevalence of ARCD has been estimated at approximately 27% of the older population (Hänninen et al., 1996). As for non-normative types of mild impairments in cognition, MCI has a considerably lower prevalence rate, affecting approximately 7% to 10% of older adults (DeCarli, 2003; Petersen, 2011), and estimates of Mild NCD have not yet been published, as this is still a relatively new diagnostic term. These prevalence rates indicate that mild impairments in cognition affect a considerable amount of the older population.

Community-dwelling older adults with mild impairments in cognition are an important target group for health-related interventions. In comparison to those with dementia, individuals with mild impairments in cognition often lack adequate supports and services needed to successfully cope with their conditions (Austrom & Lu, 2010). Independence and ageing-in-place are highly valued in older adulthood (Chapman, 2009; Cisneros, Dyer-Chamberlain, & Hickie, 2012). However, those with mild impairments in cognition have a higher likelihood of eventual institutionalization (Hope, Keene, Gedling, Fairburn, & Jacoby, 1998; Gnjidic et al., 2012). There is a need for new and innovative strategies to support and promote the daily activities that enable these individuals to maintain independence while living within their communities (Hughes, Chang, Vanderbilt, Snitz, & Ganguli, 2012). Such strategies can allow for the postponement or prevention of institutionalization, which would foster ageing-in-place and a reduction of demands on the health care system (Aguero-Torres, von Strauss, Viitanen, Winblad, & Fratiglioni, 2001). Thus, the creation of interventions seeking to promote independence among those with mild impairments in cognition is a worthwhile endeavor.

1.2. Role of Technology

Although gerontechnology is still a developing field, a multitude of devices are being developed that have promising potential to enable older adults to independently perform daily activities (Sheets & Gallagher, 2012). Technological innovations in the areas of architectural adaptation, telehealth, robotics, and ergonomic design, for example, have been developed to support health, to compensate for functional and social limitations, and to decrease the burden placed on carers (Bouma, Fozard, & van Bronswijk, 2009). The development and introduction of technologies that promote independence are particularly valuable in enhancing the wellbeing of Canada's aging population (Schultz et al., 2013), as well as technologies that offer specialized features which support persons with cognitive impairments (Wild, 2013). These technologies have been proposed as an effective means to deal with changes in individual competence that threaten older adults' abilities to adapt to environmental pressures (Hernández-Encuentra, Pousada, & Gómez-Zúñiga, 2009). Therefore, it is important to identify technologies that could be helpful in facilitating older adults to adapt to the difficulties associated with mild impairments in cognition.

A growing trend in research focuses on the development of technologies that have the potential to improve the lives of older adults (Ries, 2010). However, the creation and dissemination of new health-related technologies can be costly (Bodenheimer, 2005). Thus, in consideration of cost-effectiveness, it is useful to focus efforts on how to innovatively utilize existing technologies. Smartphones, for example, offer a variety of relevant features for older adults with mild impairments in cognition. These portable and relatively low-cost devices can connect users to advanced systems for calendars and contacts, navigation, Internet access, and downloadable applications (Wild, 2013). Smartphones are rapidly being adopted by the Canadian population (Statistics Canada, 2012). The pervasiveness of these devices adds to their appeal as supportive technologies since individuals can make use of this widely accepted smartphone platform with less fear of stigmatization while out in the community (Wild, 2013). This is important because such a fear has been noted by older adults as a deterrent for assistive technology utilization when individuals are in public settings (Parette & Scherer, 2004).

Smartphone application adoption has the potential to be beneficial within a population of older adults with mild impairments in cognition. Some pilot studies have delved into the potential for smartphone applications to enhance the lives of older adults with various forms of cognitive impairments. In a literature review of smartphone technologies for individuals with Alzheimer's disease, Armstrong, Nugent, Moore, and Finlay (2010) explored the potential for smartphones to enhance quality of life among those with these conditions. They found that access to written prompts as well as repetition through errorless learning can potentially be successful in teaching smartphone use among those with Alzheimer's disease and determined that more research needs to be conducted in this area. Very little research has looked at the use of smartphones as a support specifically for older adults with mild impairments in cognition. Research which has been conducted in this area typically consists of small pilot studies to assess the usability of new smartphone applications, as is seen in the work by Das et al. (2012), who developed a smartphone interface for this population and found their smartphone application to show promising potential as a support for older adults with mild impairments in cognition, indicating that these devices were generally perceived as natural and useful, especially if prompts are delivered at the appropriate time during activity completion. These preliminary studies suggest that smartphone applications could be useful technologies for older adults with cognitive impairments.

Chapter 2.

Literature Review

2.1. Overview

2.1.1. Objectives

1. To clarify distinctions of various diagnostic terms for mild impairments in cognition in order to identify key unmet needs that older adults with these conditions experience in their daily lives
2. To review information on smartphone applications that offer supportive features relevant to the needs of this population and illustrate the potential of these devices through the creation of five hypothetical personas
3. To explore potential barriers and facilitators to technology adoption

2.1.2. Theoretical Background

The field of gerontechnology generally lacks its own specific theories. Thus, researchers in gerontechnology typically pull from theories in the fields of gerontology or technology in order to provide a theoretical basis for their empirical research (van Bronswijk et al., 2009). Various theories have been discussed in the literature, which have particular relevance to gerontechnology. For example, the ecological model of aging, the diffusion of innovations theory, and the life course theory have all been applied in empirical research in order to understand the relationship between technology and aging (Heinz et al., 2013; Hernández-Encuentra et al., 2009; Olson, O'Brien, Rogers, & Charness, 2010). The above theories are just a few examples of how gerontechnology can be conceptualized and contextualized for empirical research.

Maslow's Hierarchy of Needs

A major focus in gerontechnology is on how technological devices can address unmet needs of older adults (Wahl & Mollenkopf, 2003). In line with this objective, Maslow's hierarchy of needs theory emphasizes how people's behaviors are connected to their desire to fulfill various unmet needs (Maslow, Frager, & Fadiman, 1970). The categories of lower- and higher-level needs within this theory include: physiological needs, safety and security, love and belonging, esteem, and self-actualization.

Maslow's framework has been applied to gerontological research in previous studies. Acton and Malathum (2000) found that targeting needs conceptualized within Maslow's hierarchy was associated with health-promoting behaviors, particularly with regards to the satisfaction of physical needs, love and belonging, and self-actualization. Maslow's hierarchy has also served as the theoretical basis for research on health-related quality of life for individuals with dementia (Shozel-Dorenbos, Meeuwsen, & Rikkert, 2010). Given this information, targeting unmet needs can be an influential component in establishing positive health-related changes in older adults' lives.

Researchers have also used Maslow's framework when discussing technology adoption behaviors of older adults. Thielke et al. (2011) applied Maslow's framework in their understanding of how the features of technologies can motivate or deter technology adoption among older adults. The researchers noted that some technologies motivate adoption more than others, stating that the incorporation of systems that help with immediate needs are more commonly reinforced than those that promote long-term need fulfillment because these devices often have less evident immediate benefits. From this work, one can see the potential for technologies to address the unmet needs of older adults and the importance of imparting the usefulness of these devices when attempting to enhance utilization of these systems within an older population.

Given the tendency for technology research to center upon needs fulfillment, Maslow's hierarchy of needs was chosen as an influential theory for this capstone. This theory has been recommended as particularly relevant to research in gerontechnology (van Branswijk, Fozard, Kearns, Davison, & Tuan, 2008). As recommended by Bouma, Fozard, Bouwhuis, and Taipale (2007), the fulfillment of older adults' needs should guide

the research and development process in gerontechnology since the main purpose for technology is the fulfilment of needs. Furthermore, needs gratification has been argued to be an enforcer of technology acceptance and adoption within an older population (van Bronswijk, 2006). Thus, Maslow's hierarchy is a relevant and appropriate theory to help guide research in gerontechnology. Within the capstone, the literature review focused on how smartphone applications can be incorporated into the daily lives of older adults with mild impairments in cognition in order to fulfill their unmet needs. The application of this theory influenced how unmet needs of older adults with mild impairments in cognition were categorized throughout the literature review and how relevant smartphone applications were identified and organized for the capstone, as based on their potential to meet the needs of older adults with mild impairments in cognition.

2.1.3. Research Questions

1. How have various mild impairments in cognition been diagnostically distinguished within the literature?
2. What are potential unmet needs of individuals with these conditions?
3. What commercially available smartphone applications might be useful in addressing the needs of these individuals?
4. What are the technology adoption barriers specific to this population?

2.1.4. Approach

The literature review was a scoping study aimed at mapping out the key ideas of a relatively new field, supportive smartphone applications for older adults with mild impairments in cognition. In order to achieve this, both academic and 'grey literature' sources were compiled. Information from peer-reviewed journals and books were gathered through databases including Academic Search Premier, Ageline, CINAHL, IEEE, and PsychINFO. The following terms were searched: 1) Age-Associated Memory Impairment, Age-Related Cognitive Decline, Mild Cognitive Impairment, Mild Neurocognitive Disorder; 2) needs; 3) smart (/mobile/cellular) phones, mobile applications (/apps); 4) technology adoption (/barriers/usability).

A review of commercially available mobile applications was also included. The first step in this process was to examine app stores from major smartphone companies

in order to find relevant smartphone applications that were currently on the market. Further information was obtained from company websites found through the following Google Search terms: 1) apps, applications; 2) seniors; 3) memory, memory loss, cognition, cognitive decline, cognitive impairment. Inclusion criteria filtered out applications that were not relevant to the needs of older adults with mild impairments in cognition as identified from the academic literature within the review.

The above information informed five personas, which highlighted the needs and user experiences of a hypothetical group of older adults with mild impairments in cognition. Each persona centered upon one step of Maslow's hierarchy – physiological needs, safety and security, love and belonging, esteem, and self-actualization. These personas were utilized to portray potential needs and experiences of older adults with mild impairments in cognition who have incorporated smartphone applications into their daily activities, as well as to illustrate how smartphone applications could enhance the independence of older adults with mild impairments in cognition during the completion of their daily activities.

2.2. Mild Impairments in Cognition

The conceptualizations and diagnoses of mild impairments in cognition have evolved over time in an attempt to better differentiate between the various levels of non-dementia cognitive impairments that many individuals experience as they progress through older adulthood (APA 1994; APA 2013). While cognition is a multifaceted construct, diagnoses help to establish meaningful cut-off points between various levels of cognitive competence within older adulthood (Petersen, 2004). Age-Associated Memory Impairment (AAMI), Age-Related Cognitive Decline (ARCD), Mild Cognitive Impairment (MCI), and Mild Neurocognitive Disorder (Mild NCD), particularly the subtype of Mild NCD due to Alzheimer's disease, will be reviewed here since these conditions all attempt to label or operationalize the mild impairments in cognition faced by many adults in their later years. Once the terms are more clearly understood, the review can then discuss the needs central to the population of older adults with mild impairments in cognition, as well as smartphone technologies that might be able to help address these unmet needs.

2.2.1. Characterizations of Mild Impairments in Cognition

Normative impairments

A diagnosis of Age-Associated Memory Impairment (AAMI), as defined by the National Institute of Mental Health, requires the following criteria: over age 50, no dementia, adequate cognitive functioning, reports of gradual memory loss, and evidence of lower memory performance as compared to a normative group of young adults (Kidd, 2008). The term attempts to capture the cognitive impairment associated with "normal aging processes" that is distinct from the typical memory performance of younger groups (Rediess & Caine, 1996). Another term, Age-Related Cognitive Decline (ARCD), appears in earlier versions of the Diagnostic and Statistical Manual for Mental Disorders (DSM) and represents similar conditions of memory impairments that are typically characteristic of older age groups. In contrast to AAMI, the term ARCD also captures other impairments in higher-level executive functioning along with impairments in memory (APA, 1994). Both AAMI and ARCD are considered normative for older age groups and, thus, are understood as expected aspects of cognition for older adults (Ferris & Kluger, 2007). Notably, the term ARCD is not included in the DSM-5 (APA, 2013), illustrating the evolving opinions within the medical community on pertinent cut-off points along the cognitive continuum (Cargin, Maruff, Collie, & Masters, 2006). In summary, since AAMI and ARCD capture the expected cognitive performance of the older population, these terms are understood as components of mild impairments in cognition which are normative for older age groups.

Non-normative impairments

Mild Cognitive Impairment (MCI), understood as the in-between stage of normal cognition for older adults and various types of dementia (Marksteiner & Adelt, 2010), reflects cognitive impairment "beyond what is considered normal for one's age, but not of sufficient magnitude as to warrant the diagnosis of dementia or Alzheimer's disease" (Petersen & Negash, 2008, p. 46). Criteria for MCI require individuals to report subjective memory complaints without any significant impairment in functional abilities. Using these criteria as a diagnostic framework has been difficult to put into practice because individuals typically refrain from reporting such concerns to their physicians since these symptoms do not significantly impact most aspects of their functional

independence (Mitchell, 2013). The DSM-5 does not include MCI as a diagnostic entity, preferring to maintain a more broad perspective through the term Mild NCD, as this condition reflects a wide array of mild impairments in cognition which do not necessarily relate to old age (APA, 2013). Both MCI and certain forms of Mild NCD encompass the cognitive state between normal cognition for older adults and dementia.

MCI has been broken down into two categories, amnestic and nonamnestic (Petersen, 2011). In order to meet the criteria for amnestic MCI, an individual must display clinically significant impairment in memory without meeting the criteria for dementia. An individual with this subtype of MCI maintains relatively intact functioning with regards to cognitive domains unrelated to memory. This subtype of MCI is linked to a higher likelihood of developing future Alzheimer's disease (Petersen, 2011). The less common subtype of MCI, nonamnestic, is diagnosed for those displaying subtle declines in cognitive abilities not pertaining to memory. These individuals display increased impairment with regard to attention, language, and visuospatial skills (difficulty with vision during complex tasks such as reading or driving) (Chatterjee & Costlett, 2010; Petersen, 2011). Nonamnestic MCI can be indicative of future non-Alzheimer's dementia (Petersen, 2011). Thus, the symptoms and types of dementia associated with MCI differ for amnestic versus nonamnestic subtypes of the condition.

The term Mild Neurocognitive Disorder (Mild NCD), as found in the DSM-5 (APA, 2013), also attempts to define the gray area between normal cognition and dementia. Notably, Mild NCD encompasses various mild neurocognitive symptoms, with some subtypes of Mild NCD pertaining to older adults and others relating to a broader segment of the population (Geda & Nedelska, 2012). In fact, Mild NCD can be due to twelve specified and one unspecified cause, including traumatic brain injury and HIV infection (APA, 2013). In order to meet the criteria for Mild NCD an individual must show evidence of cognitive impairment in complex attention, executive functioning, learning and memory, language, perceptual-motor skills, or social cognition. Within these diagnostic criteria, the person must still have the ability to perform everyday activities, though complex instrumental activities of daily living (IADLs) often require accommodation, and the deficits cannot be due to delirium or another mental disorder. In addition to the above

inclusion criteria, different subtypes of Mild NCD have their own specific requirements for diagnosis (APA, 2013).

One particular subtype of this condition, Mild NCD due to Alzheimer's disease, has particular relevance for older adults showing mild impairments in cognition that are beyond what is typically associated with normal aging but are less severe than is seen in those with dementia (APA, 2013). Requirements for a diagnosis of Mild NCD due to Alzheimer's disease include the following: meeting criteria for Mild NCD, cognitive impairments are gradual, meeting criteria for probable Alzheimer's disease (evidence of a causative Alzheimer's disease genetic mutation) or possible Alzheimer's disease (impairments in memory and learning, gradual impairment in cognition, no signs of mixed etiology), and symptoms cannot be better explained by another condition (APA, 2013). Interestingly, Geda and Nedelska (2012) stated that MCI can be understood as a subset of Mild NCD. In accordance with this statement, the DSM-5 claims, "Mild Neurocognitive Disorder due to Alzheimer's disease is likely to represent a substantial fraction of Mild Cognitive Impairment" cases (APA, 2013, p. 612). Thus, in this conceptualization of the two terms, MCI and Mild NCD due to Alzheimer's disease can be considered somewhat synonymous in their diagnoses for non-normative mild impairments in cognition seen in older adulthood.

The DSM-5 treats amnestic and nonamnestic symptoms differently than is seen in categorizations of MCI. According to the DSM-5, cognitive symptoms of Mild NCD are usually considered to be in the amnestic vein, affecting both memory and learning (APA, 2013). While the diagnostic manual does note that nonamnestic symptoms of Mild NCD can occur within the areas of visuospatial limitations and logopenic aphasic impairments (language ability in repetition and ability to name objects) (Henry & Gorno-Tempini, 2010), nonamnestic cases are treated as unusual occurrences in the DSM-5 (APA, 2013). Unlike the MCI diagnosis, which has both amnestic and nonamnestic subtypes, the DSM-5 states under the definition of Mild NCD that the small number of nonamnestic cases of this disorder makes a specific nonamnestic subcategory unnecessary (APA, 2013; Petersen, 2011). Given this information, individuals showing signs of amnestic MCI might likely be diagnosed with Mild NCD due to Alzheimer's disease under the DSM-5, whereas, a person displaying symptoms consistent with nonamnestic MCI might

be diagnosed with Mild NCD due to one of the other subtypes listed in the DSM-5 (APA, 2013; Petersen, 2011).

2.2.2. Symptoms of Mild Impairments in Cognition

Normative subtypes

It can be difficult to operationally categorize normal cognitive impairments for older adults. A small group, only about one percent of the population, entirely avoids some form of gradual cognitive decline during their life course (Petersen, 2011). An important distinction between dementia and mild impairments in cognition is that most aspects of cognitive functioning remain largely intact for individuals with the latter condition (Petersen, 2011). Typically, certain cognitive abilities, such as abstract thought, remain intact in older adulthood (Cullum et al., 2000). Furthermore, verbal ability, implicit memory (memory associated with past experiences) (Geraci & Barnhardt, 2010), and crystallized intelligence (knowledge based on experience and culture) (Sternberg, & Grigorenko, 2005), are typically consistent with younger age groups until an individual reaches advanced old age (Ball, Ross, & Viomonte, 2009; Ballesteros, Mayas, & Reales, 2013). Notably, experiencing normative mild impairments in cognition does not significantly impact older adults' abilities to function within most aspects of their daily lives (Cullum et al., 2000).

Certain domains, however, are affected for those with these conditions. Older adults often exhibit reductions in certain areas of cognitive performance, typically showing decreased memory function and ability to solve complex problems as compared to younger groups (APA, 2000; Ferris & Kluger, 2007). Mild impairments in cognition considered to be normal within an older population often pertain to particular cognitive abilities such as processing speed, executive functioning, inhibitory control and attention, and episodic and working memory (Morra, Zade, McGlinchy, & Milberg, 2012). Given their typical difficulties with memory and executive functioning (Kidd, 2008; APA, 2000), the provision of supports to accommodate for impairments in these particular cognitive domains would be helpful for this population.

Non-normative subtypes

MCI affects approximately 7% to 10% of adults aged 65 years and older (DeCarli, 2003; Petersen, 2011). While independence in the ability to complete activities of daily living (ADLs) typically remains stable for individuals with MCI (Davis & Rockwood, 2004), this condition is linked to restrictions in the ability to perform instrumental activities of daily living (IADLs) (Griffith, Raina, Wu, Zhu, & Stathokostas, 2010). Gure, Langa, Fisher, Piette, and Plassman (2013) looked at functional limitations among older adults who showed signs of MCI. Forty-five percent of this population reported one or more IADL limitation, as compared to only 13 percent of those without cognitive impairments. Among persons with MCI, impairments in IADL performance are commonly seen in the tasks requiring higher cognitive functioning, such as financial management, the navigation of transportation systems, and adherence to complex medication regimens (Aretouli & Brandt, 2010; Dean & Wilcock, 2012). Since IADL performance may be impaired among persons with MCI but not in those with normative mild impairments in cognition, MCI impacts daily living activities more than is seen in a population of older adults with normative mild impairments in cognition (Griffith et al., 2010). Despite their ability to maintain functional independence with ADLs and many IADLs (Davis & Rockwood, 2004), technologies that offer support in the completion of IADLs that require higher-level cognitive functioning can be particularly useful for this population.

Examples of common limitations for those with Mild NCD are included in the DSM-5 and are detailed below (APA, 2013). Persons with this condition may discover errors in their performance of routine tasks, get distracted more easily, and take longer periods of time to complete these activities. Multitasking may become difficult and organizing, planning, and making decisions may require more effort. With regards to learning and memory, an individual with Mild NCD may adapt to lower memory performance by utilizing lists and reminders to keep track of daily activities. However, semantic, autobiographical, and implicit memory remains relatively stable for those with this condition. Word-finding may be difficult, as well as recalling specific names and acquaintances. Perceptual-motor abilities may be affected in the form of problems finding new places and following directions without notes or maps. Among persons with this condition, more effort and attention may be required while navigating a new

environment. Spatial tasks such as sewing may also become more difficult. Social cognitive issues can arise in the form of decreased ability to recognize social cues, changes in extraversion or introversion, and less inhibition during social interactions. For those with Mild NCD due to Alzheimer's disease, declines in memory and learning are required for diagnosis (unless evidence of an Alzheimer's disease genetic mutation is found), but these individuals may also show declines in any of the other neurocognitive domains listed above (APA, 2013).

2.2.3. Potential Unmet Needs

For those with normative subtypes

Within this capstone, the identification and classification of unmet needs for those with normative mild impairments in cognition was based on Maslow's theory. This was accomplished by identifying needs typical of the normal aging population, placing particular emphasis on those which are affected by mild impairments in memory and executive functioning, since these aspects of cognition have been identified as the primary symptoms for older adults with these conditions (APA 2000; Kidd, 2008).

Older adults with normative mild impairments in cognition have certain unmet needs, which can be categorized under Maslow's hierarchy. Considering unmet physiological needs, this population can benefit from and have need for the incorporation of more physical activity in their daily lives. There is a strong correlation between impaired physical health and cognitive impairment (Bergman, Blomberg, & Almkvist, 2007), and physical activity has been confirmed to inhibit cognitive declines associated with normative mild impairments in cognition (Hogan, 2005). Furthermore, exercise in older adulthood has been found to enhance executive functioning (Colcombe & Kramer, 2003), which is an important area of attention for this population. Adequate nutrition should also be a priority, as a healthy diet has been associated with enhanced memory, visuospatial ability, abstraction, and recall within an older population (La Rue, 1997). As for safety and security needs, when memory is impaired, older adults living in the community can have difficulty maintaining safety during household chores and maintenance. For example, older adults with mild impairments in cognition are at risk of forgetting to lock their doors at night or turning off the stove after cooking (Thielke et al.,

2011). Thus, older adults with memory difficulties can benefit from reminders to maintain appropriate safety protocols within their homes. Furthermore, the need for belonging and love may be affected by cognitive changes, since social integration and cognitive impairment are negatively associated (Béland, Zunzunegui, Alvarado, Otero, & del Ser, 2005). Thus, additional supports to maintain social inclusion could also help to meet the needs of this population.

Unmet higher-level needs should also be a priority for older adults with normative mild impairments in cognition. Esteem and self-actualization are emphasized under Maslow's theory as essential aspects of wellbeing (Maslow et al., 1970). With regards to esteem, the ability to maintain independence is an important aspect of aging in many western cultures (Plath, 2009). Thus, the facilitation of independence in managing daily activities that may be affected for those with normative mild impairments in cognition can help to meet needs for esteem. Furthermore, the act of creating and meeting personal goals can also contribute to esteem (Thielke et al., 2011). In order to reach self-actualization, older adults may seek out organized religion (Krause, 2012), spiritual practices (Turesky & Schultz, 2010), meaningful leisure activities (Wright-St. Clair et al., 2012), or volunteering opportunities (Pavlova & Silbereisen, 2012). Providing reminders to help follow through with these activities could foster esteem and self-actualization within this population.

For those with non-normative subtypes

Older adults with non-normative mild impairments in cognition tend to have more unmet needs than their cognitively normal peers, especially in regards to the completion of IADLs (Griffith et al., 2010). This population would benefit from enhanced physiological supports in order to remember medication times and dosages, as well as additional prompting while preparing complex meals (Tabert et al., 2002). Issues might also arise from a decreased ability to independently manage financial security, as banking has been found to be more difficult for this population (Tabert et al., 2002; Thielke et al., 2011). Furthermore, persons with non-normative mild impairments in cognition often face more difficulty navigating public transit (Nygård, 2003), which may decrease safety while out in the community. Love and belonging can also be threatened because this population has trouble remembering names and details about new

acquaintances, as well as recognizing faces (APA, 2013). Thus, older adults with non-normative mild impairments in cognition require supports that help them to remember acquaintances in order to foster the creation and maintenance of new friendships. Unmet needs of esteem and self-actualization may be similar for those with normative mild impairments in cognition (e.g. independence, goal completion, performance of meaningful activities), though certain considerations regarding the achievement of these higher-level goals are discussed further in the next section on technological devices to meet the needs of this population.

Figure 2.1 provides a visualization that connects Maslow's hierarchical framework to examples of potentially unmet needs identified in the literature for older persons with normative and non-normative mild impairments in cognition.

Figure 2.1. Examples of Potential Unmet Needs for Older Adults with Mild Impairments in Cognition as Framed in Maslow's Hierarchy

2.3. Mobile Phone Technologies

2.3.1. Technologies to Address Unmet Needs

In the face of modest advancements in cognitive impairment treatment, a new focus has been placed on interventions that enhance meaningful changes in daily

functioning, rather than the treatment of symptoms alone (Logsdon et al., 2002). Schultz et al. (2013) conceptualized quality of life technologies as those devices, which can promote functioning. Demand for such technologies may increase as more individuals require supportive systems that can enhance their lives in meaningful ways. Assistive technologies for cognition have also been developed in order to provide support for those with cognitive impairments (Wild, 2013). Technologies that have the capacity to enhance cognitive processes and promote independence are significantly beneficial to those with mild impairments in cognition since these individuals require extra assistance in the completion of daily tasks involving memory yet are still cognitively capable of learning to use technological systems (Schultz et al., 2013). This consideration suggests that older adults with mild impairments in cognition have both need and capacity to utilize these devices. Furthermore, technological prompts have been assessed to be effective in providing assistance with everyday tasks for those with cognitive impairments (Seelye, Schmitter-Edgecombe, Cook, & Crandall, 2013). The focus of this section will be on how a specific technology, smartphone applications, has the potential to address the needs of older adults with mild impairments in cognition and how these systems can facilitate independence in the completion of daily activities.

For those with normative subtypes

Given the identification of unmet needs for this population (see Section 2.2.3), certain features of technological devices may be particularly beneficial for older adults with normative mild impairments in cognition. Unmet physiological needs can be addressed through systems that support a healthy lifestyle (e.g. exercising, preparing healthy meals, etc.). Health reminders can be especially useful given the memory difficulties of this population (e.g. calendars with alarms to exercise at a certain time each week). Mobile devices, in particular, have been proposed as promising emerging technologies for providing motivational health messages at the appropriate time and place to potentially maximize health benefits for older adults (Intille, 2004). Considering the safety and security concerns for older adults with mild memory difficulties, a system that offers checklists and reminders for home and community safety could be beneficial. In fact, technologies that offer guidance and reminders have been proposed as highly useful support systems for older adults with cognitive impairments as they perform their daily home activities and responsibilities (Pollack, 2005). Supportive devices can also

foster love and belonging through systems that facilitate communication and social connection, especially those devices which can help accommodate for problems with memory and executive functioning (e.g. a digital phone book with pictures, names, and details about acquaintances). Such devices have been proposed as useful catalysts for social communication for older adults with cognitive impairments who are living in the community (Morris, Lundell, & Dishman, 2004).

Technological devices may also help to meet needs of esteem and self-actualization. By providing systems that encourage autonomy and agency, esteem can be bolstered (Plath, 2009). Furthermore, the act of creating and meeting personal goals can contribute to esteem (Thielke et al., 2011). Thus, goal achievement would be an important component for a technology adoption intervention seeking to promote esteem. Technological memory aids which are unobtrusive have been proposed as esteem-boosting devices for older adults, as these devices can help to foster independence and the completion of daily activities (Mynatt & Rogers, 2002). Reaching self-actualization may require more complicated goals, which may take longer to achieve than those concerning lower-level needs. While it might be difficult for assistive devices to fully promote the ability to reach self-actualization (Thielke et al., 2011), external supports have the potential to facilitate self-actualizing behaviors in older adults who are experiencing mild impairments in cognition (e.g. providing access to religious and spiritual texts and blogs, offering reminders about meeting times for group leisure activities, detailing local community opportunities for engagement, etc.). Furthermore, modern technologies with Internet access, such as computers and smartphones, provide a significant potential for learning, personal growth, and enhancement in life by providing access to a vast array of social networks and information (Conci, Pianesi, & Zancanaro, 2009). The above information suggests that supportive devices can help address the lower- and higher-level needs of those with normative mild impairments in cognition.

For those with non-normative subtypes

Given the abilities and difficulties of those with non-normative mild impairments in cognition (APA 2013; Petersen, 2011), supportive systems for these individuals need to offer more features than for those with normative cognitive impairments. Technologies have been discussed as potentially useful devices to help compensate for difficulties in

completing IADLs (Pollack, 2009). For example, physiological needs can be supported through devices that assist with such tasks as cooking, grocery shopping, and recipe management (Wahl & Mollenkopf, 2003). Specialized banking technologies could greatly enhance financial security for these individuals (Gatto & Tak, 2008). Furthermore, devices equipped with a GPS and localization system could offer this population enhanced supports for safety by decreasing the likelihood of getting lost in an unfamiliar place and helping individuals when they are lost (Pollack, 2009). As for meeting needs of love and belonging, these individuals can benefit from technologies that offer a database with pictures of acquaintances, their names, and details about the person, since they often have some problems with facial recognition and social functioning (APA, 2013).

Within a population of older adults with non-normative mild impairments in cognition, certain considerations should be made in order to help meet their needs for esteem and self-actualization. Despite increased reliance on technology when incorporating supportive devices into one's life, esteem can still be fostered if the device is not overbearing and offers the appropriate amount of support for the individual's needs (Thielke et al., 2011). Furthermore, older adults are more accepting of technological assistance when the systems are unobtrusive and can address the user's specific needs (Demiris et al., 2004). Given their ability to maintain independence in most aspects of daily life (Petersen, 2011), supportive devices for these individuals should be matched appropriately to their needs in order to foster esteem. Once IADL completion is supported (Nygård, 2003), self-actualization support needs are similar to those with normative mild impairments in cognition. These systems can, however, be tailored to this group by providing detailed prompting symptoms, since their memory is typically more impaired than persons with normative mild impairments in cognition (APA, 2000; Petersen, 2011).

2.3.2. Mobile Phone Technologies

Many mobile phones now come equipped with a range of functionalities. Smartphones provide access to the Internet, cameras, and a multitude of downloadable applications. These devices also often come equipped with calendars, contact databases, reminders, and notepads (Wild, 2013). According to Hardill and Olphert

(2012), approximately half of older adults own or have access to mobile phones. The main reasons why older adults utilize these devices are for the purposes of personal communication, safety, and usefulness (Kubik, 2009; Lee, 2007; Nasir, Hassan, & Jomhari, 2008). Considering the advanced supportive features found through downloadable smartphone applications (Boulos, Wheeler, Tavares, & Jones, 2011), it could be beneficial for older adults to make use of more advanced features offered through these devices in the future.

An important step in facilitating smartphone utilization among those with mild impairments in cognition would be to identify appropriate systems for this specific population. Wild (2013) recommends Apple products for older adults with mild impairments in cognition because the consistency of hardware and user interfaces typically seen in Apple products make these devices considerably easier for cognitively impaired individuals to switch or upgrade systems, making for more seamless transitions between devices. However, it should also be noted that Android devices offer other particular advantages such as a higher number of available applications and enhanced compatibility with other companies' platforms (Goadrich & Rogers, 2011). Since technology users typically find switching between Apple and Android systems to be difficult (Tracy, 2012), it would be best to consistently offer one system or the other so that individuals learning how to utilize smartphones do not have to face the added difficulty of trying to navigate multiple platform interfaces.

The user-interface should be appropriate for the specific population of older adults with mild impairments in cognition. Patomella, Kottorp, Malinowsky, and Nygård (2011) asserted that information and communication technologies (ICTs) designed for older adults with cognitive impairments should be user-friendly and uncomplicated. Wild (2013) suggested that mobile applications for those with mild impairments in cognition should have a clear purpose that effectively addresses the needs specific to this population and should also have features that are tailored to their abilities and lifestyles. Given the above information, the technological preferences of users should be incorporated into their chosen smartphone devices and applications (Wild, 2013). Thus, systems should be highly usable (Patomella et al., 2011), and the applications should be relevant to the lives of its users (Wild, 2013).

Choosing the best applications for those with mild impairments in cognition is easier once the target population's needs are fully understood. Using Figure 2.1 and the previous section's information on unmet needs of those with mild impairments in cognition, applications with specific functionalities can be more appropriately identified, helping to ensure that the devices offered to older adults with mild impairments in cognition are relevant to their needs. Keeping in mind the review of potential unmet needs for this population, Appendix A lists and details relevant smartphone applications for these individuals. This list is organized into five categories, including multifaceted applications (those that address multiple needs within one application and user interface), as well as supports for memory, health, social connection, personal development, and IADL performance. The organization of this list is based upon trends found in smartphone applications relevant to the needs of older adults with mild impairments in cognition. Only applications offered through Android and Apple systems were included because these are the two largest companies within the smartphone application market, offering the largest varieties of the latest smartphone applications (Victor, 2013).

Multi-faceted applications may be particularly beneficial, as older adults would only have to familiarize themselves with a single interface and would be able to incorporate various technological supports through one system (Wild, 2013). However, giving older adults the option to pick and choose different apps would help to foster agency and to ensure that the apps are relevant to their interests and needs (Plath, 2009). Applications which serve as memory aids can help older adults to manage their daily activities, as well as the safety concerns within their households (Thielke et al., 2011). Health-related applications could assist older adults to exercise, learn about nutrition, and incorporate healthy lifestyle habits into their daily activities (Bergman et al., 2007). Social connections (Béland et al., 2005) would be strengthened through applications that connect to videoconferencing, social networking, personal family exchanges, and specialized dating systems. Meaningful personal development can also be encouraged through applications that facilitate the achievement of important life goals, such as volunteering, religious practices, and spirituality (Krause, 2012; Pavlova & Silbereisen, 2012; Turesky & Schultz, 2010; Wright-St. Clair et al., 2012). Of particular merit for the population with non-normative mild impairments in cognition are apps that

provide assistance with IADL completion (Griffith et al., 2010). Each of the applications listed in Appendix A could serve as supports for older adults with mild impairments in cognition.

Figure 2.2 offers a list of smartphone applications, which have been organized according to their relevancy to potential unmet needs identified in Figure 2.1. The applications have been organized into Maslow's framework in order to visually conceptualize how technologies can meet the higher- and lower-level needs of older adults with mild impairments in cognition. A detailed description of each smartphone application can be found in Appendix A.

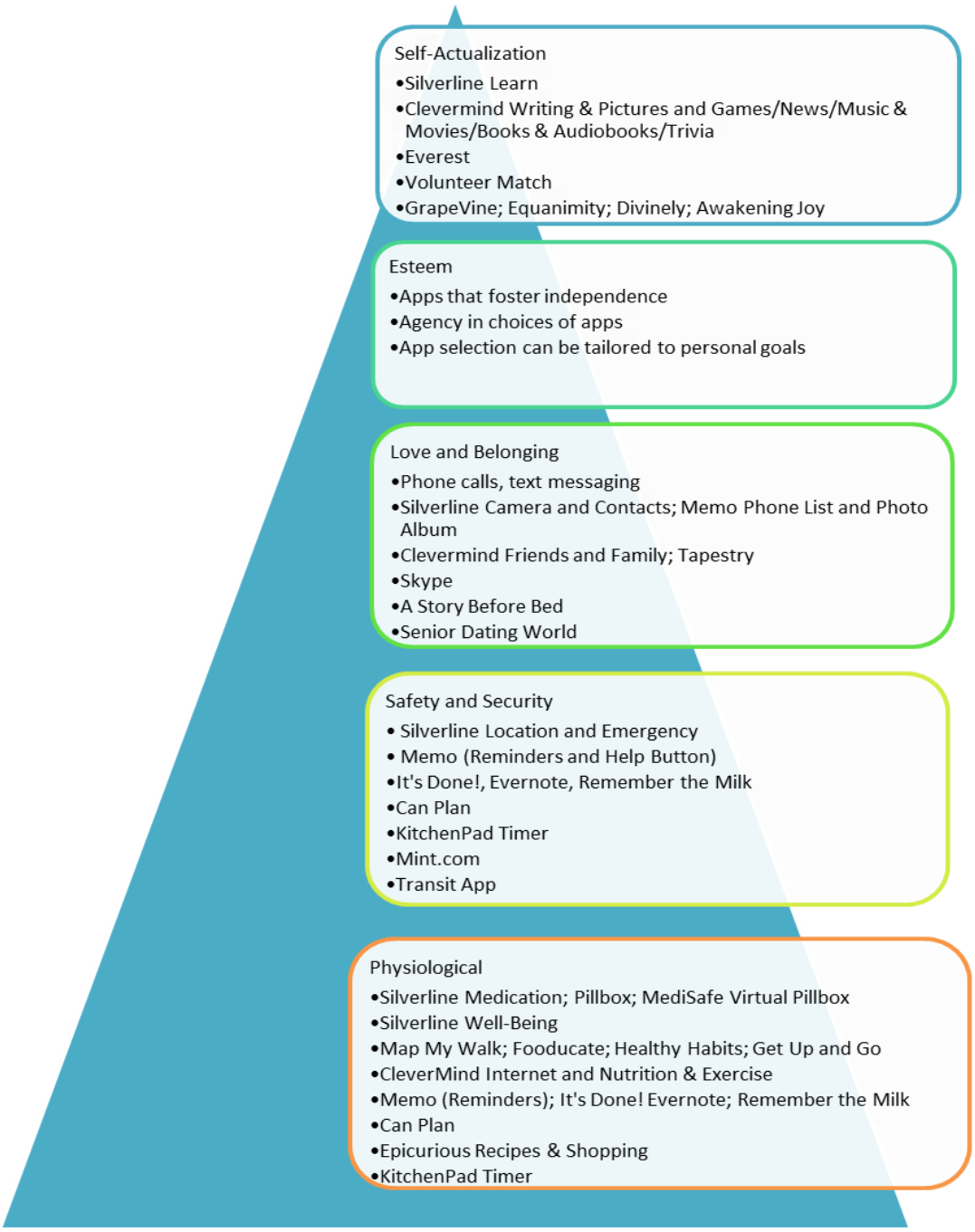

Figure 2.2. Smartphone Applications with Potential Relevancy for Older Adults with Mild Impairments in Cognition as Framed in Maslow's Hierarchy

Chapter 3.

User Personas

Personas can be a useful part of a user-centric approach to understanding how technologies relate to the lives of targeted technology users (Hosono, Hasegawa, Hara, Shimomura, & Arai, 2009). These fictional user experiences help to identify needs, illustrate typical features of the targeted user of a given technology, and discuss how a technology can be relevant to the lives of its end users (Hosono et al., 2009; Meneses & McNees, 2007). This type of approach helps to illustrate multiple dimensions of the potential users' lives in order to more accurately depict the targeted population, the needs of this group, and how a given technology can be useful for these individuals (Meneses & McNees, 2007). Five personas were created for this capstone, which illustrate how smartphone applications can be incorporated as a support for independent completion of daily living activities among older adults with mild impairments in cognition.

3.1. Method

Developing personas requires a period of data collection in which the number of personas is established, and the needs and characteristics of each persona are identified and differentiated (Nielson, 2013). The personas created for this capstone were based upon the identified symptoms and potential needs of those with mild impairments in cognition, as discussed in Section 2.2.3 of this capstone, as well as relevant smartphone applications, which were reviewed in Section 2.3.2. The decision to include five personas was based upon Maslow's hierarchy of needs, in which each of the five personas (see Tables 3.1 - 3.5) represent one of the unmet needs discussed in Maslow's theory (physiological needs, safety and security, love and belonging, esteem, and self-actualization). Affinity for technology adoption must also be considered when creating personas (Nielson, 2013). The personas created for this capstone intentionally

centered upon the positive potentialities of smartphone application adoption for individuals who were fully capable of adopting these technologies and were motivated to do so. The decision to emphasize the positive potentialities of both the smartphone applications and the adoption patterns of targeted users was made in order to explore how these technologies could be useful since little research has been completed in this area. Once technology adoption is more clearly understood, negative aspects of the technologies and the adoption of these devices can also be explored.

3.2. Results

The following five personas can be used to anecdotally illustrate hypothetical scenarios of this population's needs and highlight the adaptations that these individuals can make through the incorporation of smartphone technologies. The first persona followed Robert and his son Michael as they dealt with his unmet physiological needs through the use of two smartphone applications, Memo and Healthy Habits (See Table 3.1). In the second persona, James was able to address his unmet safety and security needs without the unwanted help from his wife Patricia by using the Kitchen Pad Timer and Transit apps (See Table 3.2). Mary established love and belonging by maintaining long-distance family connections and establishing new romantic relationships through the use of the following smartphone applications: Remember the Milk, Skype, A Story before Bed, Tapestry, and Senior Dating World (see Table 3.2). John learned how to deal with his concerns over a lack of independence and inability to perform his traditional family responsibilities through the use of the Mint.com app, which helped him to establish a higher sense of esteem (see Table 3.4). Supported by the Volunteer Match App, Evernote, and Everest, Betty worked towards self-actualization, trying to incorporate meaningful activities into her retirement and achieve important life goals (see Table 3.5). These user personas emphasize how the successful adoption of smartphone applications can help to support the lives of those with mild impairments in cognition. Characterizing the needs for each user persona through Maslow's hierarchy of needs helps to elucidate how various smartphone applications can be utilized in different ways to address a range of unmet needs relevant to older adults with mild impairments in cognition.

Table 3.1 Physiological Needs Persona

User:	Robert, 70 years old
Mild impairment type:	Non-normative
Unmet need:	Physiological
Difficulties:	Medication administration; Maintenance of healthy activities
Smartphone apps:	Memo; Healthy Habits

Robert had noticed that his memory had been declining. Usually, this did not interfere with his day, but his son, Michael, was concerned about his dad forgetting to take his medicine. Robert was recently diagnosed with glaucoma, and Michael was worried that if his father forgot to take his eye drops and go to the optometrist regularly, the glaucoma would permanently damage his eyesight. Robert tried using various digital reminders and alarms to remember his medications. While the alerts initially helped, he had trouble remembering to reprogram the devices when there was a change in his medication regimen or when he needed a reminder for a new doctor's appointment. His son, Michael, would have been happy to reprogram these changes, but he lives an hour away and is not able to visit regularly. Last month, Robert subscribed to an app service called "Memo," which has helped to solve their predicament. Using the Memo app, Michael can log into an online account and type out medication reminders that are sent to his father's device. He can also change these reminders when new medications are prescribed without having to drive to his father's house. Using this reminder system, Robert has been able to remember his eye drops every day and has not forgotten any recent doctor's appointments.

Robert also wanted to incorporate other healthy activities into his day so he decided to download another application for his smartphone. He chose the "Healthy Habits" app and decided to target three new health behaviors - flossing once a day, exercising three times a week, and drinking eight glasses of water per day. The application provides him with reminders, motivational messages to keep up the activities, reports of past activities, and quotes to inspire him on his journey towards a healthier lifestyle. The behavior tracking system has been especially useful in helping him to remember what he has already accomplished in a given day and what he still needs to complete in order to achieve his daily goals. Robert is feeling better now that he has learned to incorporate these healthy habits into his daily routine.

Table 3.2. Safety and Security Persona

User:	James, 72 years old
Mild impairment type:	Non-normative
Unmet need:	Safety and security
Difficulties:	Household safety; Localization
Smartphone apps:	KitchenPad Timer; Transit App

James loves to cook complex meals, and his friends have always enjoyed coming over for good food and conversation during his weekly get-togethers. Recently, however, James has been forgetting to turn off the stove after cooking, and managing the cooking times of multiple dishes has been strenuous for him. The fire alarm went off during his last Sunday dinner when he left the asparagus on the stovetop for an hour. As a result, his wife, Patricia, has been volunteering to cook the Sunday dinners. This annoyed James because Patricia had never shown any interest in helping with the cooking before the 'asparagus incident'. When discussing this issue with a friend, Patricia learned about an app called "KitchenPad Timer." This app tracks the cooking times and temperatures for multiple dishes, providing reminders when a dish should be taken off the stove. After incorporating this application into his cooking routine, James felt much more relaxed when cooking multiple dishes and no longer worries about forgetting to turn off the stove.

Another issue James has experienced lately has been difficulty navigating the transit system when he is traveling to a new place. The last time he tried to go to a friend's house, he got lost and wandered around for twenty minutes before he was eventually able to find a street he recognized. After this experience, he felt apprehensive about going to new places. Eventually, he downloaded the "Transit App" to help him navigate new areas. This app provides transit information, schedules, and itineraries, using GPS technology to help track his location. James feels more confident in his ability to find new places now that he has this app and has saved some of his common destinations into the phone's database so that he can access these sites easily when he needs a little extra assistance figuring out where he is and which bus he should take to get to his desired destination.

Table 3.3. Love and Belonging Persona

User:	Mary; 65 years old
Mild impairment type:	Normative
Unmet need:	Love and belonging
Difficulties:	Maintaining connection with distant family members; Need for companionship/romance
Smartphone apps:	Remember the Milk; Skype; A Story before Bed; Tapestry; Senior Dating World; Phone calendar

Although Mary's memory has been fading in recent years, she always remembers her weekly videoconferencing dates with her daughter and grandson thanks to the "Remember the Milk" app, which organizes all of her daily and weekly reminders into her smartphone. Mary's daughter, Jennifer, moved to Brazil ten years ago but is still able to see her mother every week thanks to the "Skype" app that Jennifer encouraged her mother to download for her smartphone. Despite the distance, Mary is still able to see her grandson as he grows. In order to help foster Mary's presence in her grandson's life, Mary also found another useful app called "A Story before Bed." She used this application to record an audio and video file of herself reading children's stories. Her grandson loves to open up this app to see his grandmother tell him his favorite stories. As he listens to his grandmother tell the story, he can read along since the app lets the child see both the pages of the story and the image of his grandmother in the corner of the screen.

When Mary wants to share photos of her grandson with her family and friends, she logs into the "Tapestry" app. This particular application provides a senior-friendly interface for social networking that allows her to safely and securely navigate all of her accounts. The simple photo-sharing system allows her to share pictures of her blossoming garden and to see new pictures of all of the hijinks that her mischievous grandson gets up to at his home in Brazil.

Mary has also been using her smartphone for other, more romantic endeavors. When she is feeling flirtatious, she logs into her "Senior Dating World" app to connect with the men that catch her eye. She particularly enjoys getting to send private emails to the bachelors who also use the application. Furthermore, Mary is better able to manage the times and locations of all of the dates that she goes on by making use of her phone's calendar function.

Table 3.4. Esteem Persona

User:	John, 75 years old
Mild impairment type:	Non-normative
Unmet need:	Esteem
Difficulties:	Banking; Maintaining independence; Managing familial responsibility
Smartphone apps:	Mint.com

John has managed the finances for himself and his wife, Barbara, for the near fifty years that they have been together. However, John has been forgetting to pay the bills on time lately so his wife has been checking in repeatedly each week to make sure he gets this work done. This irritates John because he feels that his wife doesn't trust him to take care of his household duties, despite the fact that he has successfully managed their bills for decades. Barbara suggested that he should hire someone to take over the financial management, but John is hesitant to give up that control. He isn't sure that he could trust someone else to have influence over his family's money and doesn't want to ask his wife to take on another responsibility since she is already so busy with her volunteer work.

John wanted to maintain independence in managing the household's finances but recognized that he might not be able to accomplish this without learning to approach his finances in a new way. He researched various financial management tools online and found one system that looked particularly appealing because it was mobile so he could easily attend to the bills, even when he was traveling on one of his fishing trips. The "Mint.com" app he uploaded onto his smartphone allows John to easily track his expenditures and budget accordingly. He finds the bill reminder function very useful. Furthermore, the alert system, which notifies him when his account is getting low, has saved him from overdraft fees on more than one occasion.

While John is happy to have better financial security after using this app, he is even more appreciative that the app has allowed him to maintain independence in an activity that he has always prided himself at being able to do well. He is so appreciative of all that Barbara does to take care of their house and is happy that he can still do this for his family. He is especially relieved that he does not have to hire someone else to manage the finances because he feels that this is something he can do on his own, without any help from others. John is now using the application to save money for a surprise trip for Barbara and himself on a cruise to the Bahamas. His wife has always wanted to go, and he would like to treat her to something special since she has done so much for him over the years. John loves the idea of being able to do this for his wife and is happy that the application has helped him save up the money to do so.

Table 3.5. Self Actualization Persona

User:	Betty; 67 years old
Mild impairment type:	Normative
Unmet need:	Self-actualization
Difficulties:	Finding meaningful activities; Remembering activity times; Achieving an important life goal
Smartphone apps:	Volunteer Match; Evernote; Everest

Betty found the adjustment to retired life to be a difficult process. She had worked hard all of her life and had built a successful career for herself over the years. When she was working those long hours, Betty told herself that retirement would be a time for her to do all of the things she had always wanted to accomplish in her life, particularly traveling to Europe and becoming more involved in volunteer work. She thought she would first try out volunteering, but her memory impairments kept her from consistently remembering to attend the training sessions for her volunteer group. Because of this, Betty felt stressed when she actually made it to the meetings, and she worried that she was missing out on too much information to volunteer to the best of her ability. Betty also didn't feel like the volunteer opportunities she was finding were utilizing the useful skills she had learned at work.

She decided to download a couple of different applications to solve this problem. First she found the "Volunteer Match" app, which provided her with information on a huge selection of volunteer opportunities within her community. The app also helped to match Betty's expertise to the right volunteer opportunities for her skillset. She then downloaded the "Evernote" app, which provided her with reminders of when she needed to go to the volunteer meetings. These apps helped her to feel more confident and prepared when attending volunteer opportunities.

Betty's second major goal, to travel to Europe, took a bit more planning. She decided to use the "Everest" app in order to help her work towards this goal. The application divided up the tasks she would need to achieve before she could make it to Europe and provided reminders whenever she needed to works towards a particular goal that day. At first, the app helped her to remember simple things, like finding a travel agent, buying luggage, and getting a passport. Then, the application helped her to save up the money she needed for the travel expenses. She eventually made it to Europe with the help of the "Everest" app and now feels like she was always meant to be a world traveler. She is proud of herself for reaching this major life goal.

The above personas help to illustrate how those with mild impairments in cognition could incorporate smartphone applications as a support for their daily lives. However, if they are unable to adopt these technologies, this population will not have the opportunity to reap the benefits of these systems. Therefore, the following section focuses on potential barriers to technology adoption, both among the general population of older adults and among those with mild impairments in cognition.

Chapter 4. Technology Adoption Considerations

4.1.1. For a General Population of Older Adults

As described earlier, smartphone applications offer features that have considerable potential to enhance cognition and wellbeing by featuring applications which support the needs of older adults to remain independent and active in their communities for longer periods of time (Wild, 2013). Although aging baby boomers are expected to be more comfortable adopting technologies into their everyday lives than previous groups of older adults (Lazer & Mayer-Schonberger, 2004), a digital divide still persists among current populations of older adults with regards to smartphone utilization (Zickuhr & Smith, 2012). Hardill and Olphert (2012) found that one-third of older mobile phone users reported some timidity in utilizing these devices to talk. The researchers discussed that, often, when older adults had complaints about their phones, it was because the phones were too complicated or the individuals had problems remembering the proper procedures required to utilize the devices. In a study comparing older and younger generations' mobile phone behaviors, older adults' navigation performance matched the behaviors of younger users only when the complexity of the mobile phone was low (Ziefle & Bay, 2005). Thus, device complexity is one barrier to adoption among older adults.

The technology acceptance model can be applied in understanding how perceived ease-of-use and perceived usefulness affect technology adoption (Davis, 1986). Perceived ease-of-use is an important factor for technology adoption among older adults. Offering smartphone devices with simple and clear interfaces could have a significant impact on the adoption of these devices for the older population (Ziefle & Bay, 2005). Devices should also allow for the accommodation of older users' physical limitations (e.g. proper illumination to address visual impairments, buttons that are easy to press to compensate for dexterity issues, etc.) (Pattison & Stedmon, 2006). Furthermore, both the smartphone device and the applications downloaded onto the

device should be personalizable since older adults are more likely to utilize a mobile phone if it is simple and personalized to their needs (Olway, Lachanas, & Zacharouli, 2011).

Perceived usefulness is also an important component of technology adoption (Davis, 1986). Although a large portion of older adults now own mobile phones, some do not use these devices once they have them or discontinue their use after a period of time (Hardill & Ophert, 2013). Zhou, Rau, and Salvendy (2012) found that older adults often obtain their mobile phones under pressure from their family and friends. In their study, a number of older adults received their phones from other people. Thus, older adults often do not have agency in choosing what phone to purchase and are unable to voice their opinions on personal preferences for the device. This likely contributes to older adults' perceptions that their mobile phones are not useful and that it is not worthwhile to learn how to adopt this technology into their daily lives.

Motivation should be a major concern for a program seeking to facilitate technology adoption among older adults. Conci et al. (2009) found that older adults' motivation to adopt mobile phones is tied to a combination of intrinsic hedonic motives and extrinsic utilitarian motives. The extrinsic value placed on these devices can be influenced by the presence of a reference social group who encourages the older adult to adopt the devices (Conci et al., 2009). Another way to enhance technology adoption motivation is to highlight the relevancy of these devices for the everyday lives of older adults, a concept which is in line with the technology acceptance model (Davis, 1986). In order to accomplish this, the benefits of such technologies should be made apparent to the end-user (Thielke et al., 2011). In order to change perceptions of the relevancy of smartphones, older adults should be involved in the decisions for application selection, and their concerns should be fully voiced and understood (Zhou et al., 2012). By keeping the user's needs in mind and understanding the timidity older adults often have towards using such devices, motivation can be more fully encouraged. In these ways, technology adoption barriers common among older adults can be more fully addressed.

4.1.2. For those with Mild Impairments in Cognition

Certain barriers to smartphone application adoption are more prevalent among those with mild impairments in cognition than are seen in a general older population. Typically, older adults who adopt mobile phones into their daily lives have higher cognitive functioning than non-users (Ng, Lim, Niti, & Collinson, 2012). Those with cognitive impairments typically adopt advanced technologies at a lower rate than cognitively healthy adults. Malinowsky, Almkvist, Kotorp, and Nygård, (2010) compared everyday technology use among older adults with and without cognitive impairment. They found that those with mild-stage Alzheimer's disease and those with mild cognitive impairment (MCI) had significantly more problems utilizing these technologies as compared to older adults who did not show signs of cognitive impairment. Furthermore, the sample with MCI showed higher capability to manage these technologies than those with mild-stage Alzheimer's disease, suggesting that higher cognitive impairment is linked to more difficulties with such systems. Alvseike and Bronnick (2012) also determined that cognitive deficits have a detrimental effect on the ability to use an iPad as a platform for smart house technology. These difficulties could have a significant impact on an intervention designed to encourage supportive smartphone application adoption if the target population is unable to properly utilize the technology. Thus, it is important to more fully understand the factors that can be manipulated to encourage technology adoption.

One issue that adds to the digital divide for this population is a decreased amount of exposure to and engagement with the latest technologies. Individuals with mild impairments in cognition often note that they do not see themselves as a part of technological development and feel more isolated from these technologies after retirement (Rosenberg & Nygård, 2013). Furthermore, persons with mild impairments in cognition see everyday technologies such as mobile phones to be less relevant to their lives than do those without cognitive impairments (Rosenberg, Kottorp, Winblad, & Nygård, 2009), an issue concerning perceived usefulness (Davis, 1986).

Motivation for smartphone adoption can be enhanced if individuals are allowed to interact with the technology, understand how the technology can be personalized to their specific needs, and see this system as both useful and usable in their daily lives (Davis,

1986; Rosenberg et al., 2009; Rosenberg & Nygård, 2013). Addressing motivation is an important step in the direction towards alleviating barriers to adoption (Rosenberg & Nygård, 2013). Some individuals with cognitive impairments have reported feeling discouraged about learning new technologies, seeing themselves as “old and sick” while others report finding pleasure in the technology adoption process and perceiving these technologies as useful to their daily lives (Rosenberg & Nygård, 2013). Enhancing meta-cognition is another way to encourage the use of mobile phone devices (Wild, 2013). This can be achieved by teaching the individuals about the purposes and reasons for smartphone usage. Furthermore, Boman, Rosenberg, Lundberg, and Nygård (2012) propose that providing information to both those with cognitive impairments and other members of their social support network about technologies such as mobile phones encourages motivation to utilize such technologies. This suggests that a mobile phone technology intervention program designed for those with mild impairments in cognition should provide clear information about the benefits of the technology to both participants and their family in order to encourage technology uptake.

Frequent use of technologies also encourages technology adoption in this population (Patomella et al., 2011). Rosenberg and Nygård (2013) found that frequent and continuous use of everyday technologies was identified as the most important strategy when learning how to adopt new technologies among those with MCI. These researchers noted that individuals with cognitive impairments are most likely to attempt new technology adoption through a connected process of learning and continuous use, with steady practice being a more essential adoption strategy than learning. However, Rosenberg and Nygård (2013) also noted that repetitive learning often only momentarily enhances learning processes, and new knowledge can be easily lost after even short periods of technology disuse. Thus, repetitive learning has been found to be a somewhat problematic technique for enhancing technology adoption among those with mild forms of cognitive impairment.

Another factor that further complicates mobile phone adoption for those with mild impairments in cognition is the need for innovative technology training techniques. In one study, an intervention program utilizing an instructor-led computer and Internet training program supplemented with written materials was administered to older adults of

various cognitive capacities (Wild et al., 2013). The study found that individuals without cognitive impairments responded better to intervention than those with mild impairments in cognition. This disadvantage persisted after a one year follow-up, as those with mild impairments in cognition reported less confidence and higher levels of anxiety related to the utilization of computer technologies (Wild et al., 2013).

Social support can play an integral role in the technology adoption process for this population. Social networks often motivate, provide access to, urge, teach, and assist with technical support for those with mild impairments in cognition (Rosenberg & Nygård, 2013). There is evidence that social support systems help to enhance older adults' abilities to utilize new technologies (Mori & Harada, 2010). Older adults with cognitive impairments living in multigenerational households with married children and their grandchildren have been found to utilize mobile phone features, such as receiving text messages, taking cameraphone photos, and changing phone settings more often than those living with spouses alone. Pulling from the social learning theory (Bandura, 1977), Alvseike and Bronnick (2012) propose that role models and support groups can encourage technology adoption among those with mild impairments in cognition. Given this information, it would be valuable to explore how a social component in a technology training program, such as peer-led training and group training sessions, could encourage adoption in a smartphone application training program.

4.1.3. Other Considerations

Physical impairments

Older adults may experience difficulties in utilizing smartphone systems due to comorbid conditions in addition to cognitive impairment. For example, older adults with physical disabilities are less likely to adopt modern technologies (O'Neill et al., 2009). Common physical limitations in older adulthood related to technology adoption include poor eyesight resulting in screen glare and issues with manual dexterity during phone navigation. Another physical limitation that could affect mobile phone adoption is the ability to use keypads. Choosing phones with larger key sizes may help to alleviate this issue (O'Neill et al., 2009). Further recommendations to address these physical barriers to adoption include using interactive systems with supplemental cues which combine

visual, auditory, and tactile cues and also changing the device settings to a larger font and higher screen contrast. Lastly, creating advanced technologies, such as smartphones, with principles of universal design may help to address some of these issues (Baker & Bellordre, 2004). The selection of smartphone devices for older adults should factor in such physical barriers to technology adoption.

Risks associated with adoption

Risks of technology adoption should also be considered. For instance, older adults have expressed concerns about the privacy associated with smartphone applications (Dennison et al., 2013). However, older adults have been found to accommodate for concerns over the privacy of monitoring systems if they perceive direct benefits from adoption of the device (Tran, Buckley, Bertera, & Gonzales, 2009). Cost of the device may be another concern, as many assistive technologies and gerontechnologies are not covered by health insurance plans, and financial factors may be prohibitive to technology adoption within the older population (Baker & Bellordre, 2004). A review of the costs for health-related smartphone applications showed that the applications themselves are oftentimes highly affordable (Rosser & Eccleston, 2011). However, the purchase of smartphones and subscription fees for data plans can be a considerable expense for many older adults. Strategies to address this issue include mobile data offloading through WiFi connectivity and plans which limit heavy usage (Lee, Lee, Yi, Rhee, & Chong, 2010). However, these strategies may limit usage and opportunities for technology benefit. Another option is to provide governmental policies which financially incentivize health-related smartphone application adoption, such as tax credits or bursaries (Brawley, Rejeski, & King, 2003). Another potential risk associated with technology adoption is that of technology dependence. In order to avoid this, systems should be appropriately matched to users' needs (Schulz et al., 2013). This could be easily done in smartphone systems since applications can be matched to needs and additional applications can be easily downloaded as need increases. Proponents of smartphone technologies for older adults should remain mindful of the above considerations when deciding best practices for the facilitation of technology adoption.

Chapter 5. Conclusion

Innovative means of facilitating independence and addressing the unmet needs of older adults with mild impairments in cognition should be further explored. Older adults with mild impairments in cognition are a heterogeneous group within society (APA, 2013; Petersen, 2011). Both normative and non-normative mild impairments in cognition encompass a variety of cognitive symptoms that older adults often face, particularly concerning memory and executive functioning. Many individuals with these conditions have certain unmet needs that can be potentially addressed through the use of unobtrusive technologies such as smartphones. Conducting research on emerging support strategies for this population, such as the adoption of smartphone applications, can be a useful way to learn more about how older adults with mild impairments in cognition can accommodate for their impairments through the use of technological support systems.

A variety of smartphone apps, which have the capability to meet the needs of older adults with mild impairments in cognition, are currently on the market. Commercially available smartphone applications relevant to the needs of this population can provide multi-faceted applications, as well as apps to support memory, health, social connection, personal development, and IADL performance (see Figs. 2.1, 2.2, Tables 3.1 – 3.5, and Appendix A). Given the potential of these devices in facilitating the independence of older adults with mild impairments in cognition and addressing their unmet needs, more research should be conducted in order to ascertain the feasibility of smartphone application adoption within this population and how the adoption of such devices could be promoted if found to be effective support systems for this population.

This literature review provides us with a good deal of information as to what strategies should and should not be enacted in order to foster smartphone adoption among older adults with mild impairments in cognition. The devices chosen should be

simple, affordable, and offer appropriate and individualized functionalities for this population (Ziefle & Bay, 2005). Older adults should be involved in the decision as to what systems they prefer and what applications they would like to utilize in order to ensure that the devices offer features relevant to their personal needs, interests, and preferences (Hardill & Olphert, 2012). Furthermore, the benefits of the technology should be made clear and the concerns of those adopting the technology should be understood (Boman et al., 2012). Frequent exposure to the devices helps to enhance adoption (Rosenberg and Nygård, 2013), as well as the involvement of a social component within the intervention design (Mori & Harada, 2010). All of these considerations can be factored into a smartphone application adoption intervention targeting a population of older adults with mild impairments in cognition.

Chapter 6.

Research Proposal

6.1. Overview

6.1.1. Title of Research

Peer-Led Smartphone Training for Older Adults with Mild Impairments in Cognition (PLATINUM): A Feasibility Study

6.1.2. Description of Problem Area and Rationale

Mild impairments in cognition, which encompass the cognitive functioning in between perfect cognitive health and dementia, affect a considerable proportion of the older population (van den Berg et al., 2005; DeCarli, 2003). Despite the ability to independently complete most aspects of daily life (Cullum et al., 2000; Petersen, 2011), mild impairments in cognition typically affect memory, executive functioning, and/or the ability to independently complete instrumental activities of daily living (IADLs), particularly those IADLs which require higher-level cognitive functioning (Aretouli & Brandt, 2010; Ferris & Kluger, 2007; Morra et al., 2012). Older adults with these impairments are at risk of losing independence in certain aspects of their daily lives if they are unable to accommodate for their declines in cognition (Wadley et al., 2007).

Investigating compensatory strategies for older adults with mild impairments in cognition should be a priority in research. Because mild impairments in cognition are associated with a higher likelihood of dementia (Petersen, 2011), a great deal of research has gone into potential treatments to reverse these impairments, such as pharmaceutical and cognitive training interventions (Belleville, 2008; Petersen et al.,

2005). Although finding a cure is important, there is a need for more immediate interventions for those who are currently experiencing these impairments (Logsdon et al., 2002). Caregiver burden is elevated for those providing care to this population, as these individuals report elevated depression and anxiety symptoms (Garand, Dew, Eazor, DeKosky, & Reynolds, 2005). Furthermore, costs of medical care for those with mild impairments in cognition have been estimated to be approximately 44% higher than for cognitively normal older adults (Zhu et al., 2013). Considering this, it would be pertinent to investigate strategies for older adults with mild impairments in cognition to more successfully adapt to life with these impairments and to encourage independence for these individuals.

Technologies have been developed with the purpose of helping older adults to adapt to changing competencies (Bouma et al., 2009). However, the development of new technologies can be an expensive process (Bodenheimer, 2005). Therefore, it is important to explore whether existing technologies can be utilized to meet the needs of older adults with mild impairments in cognition. Few studies have explored how smartphone applications can be used as a support in the daily lives of older adults with mild impairments in cognition. It is important to understand how a smartphone adoption training program could foster the abilities of this population to independently address their cognitive deficits (Das et al., 2012). Smartphones already have a wide variety of applications which would likely be useful for those with mild impairments in cognition, such as multifaceted applications specifically designed for older adults and applications which have been developed to facilitate memory, health, social connection, and the completion of IADLs (see Appendix A).

The role of smartphones as a supportive device for cognitive impairments is a burgeoning field. Previous studies have started looking into smartphone devices for those with Alzheimer's disease (Armstrong et al., 2010), individuals with Autistic Spectrum Disorders (Mintz, Branch, March, & Lerman, 2012), and those with traumatic brain injuries (DePompei et al., 2008). A case study completed in 2008 found that a 55-year old woman with moderate-to-severe memory impairment was able to utilize smartphone technology in support of her memory (Svoboda & Richards, 2009), and findings from a pilot smartphone training program suggested that those with mild-to-

moderate memory impairments are capable of learning to navigate smartphone devices (Svoboda, Richards, Leach, & Mertens, 2012). However, the efficacy of these devices as memory supports has not been adequately studied (de Joode, van Heugten, Verhey, & Boxtel, 2010). There is a need to better understand how smartphone applications could fit into the daily lives of older adults with mild impairments in cognition, which could be more fully understood through a feasibility study on a peer-led smartphone application adoption training program.

6.1.3. Theoretical Background

Maslow et al. (1970) theorized that motivation is linked to individuals' unmet physiological needs, safety and security, love and belonging, esteem, and self-actualization. This hierarchy of needs theory influenced the proposed research approach. Examples of potential unmet needs of older adults with mild impairments in cognition have been identified, as outlined in Figure 2.1, and examples of smartphone applications which could facilitate individuals to meet these needs are represented in Figure 2.2. Thielke and colleagues (2011) have previously recommended the use of technologies for older adults, justifying their argument through the hierarchy of needs theory. The assumption taken from Maslow's theory for the proposed feasibility study is that older adults with mild impairments in cognition will have certain unmet needs, and the adoption of smartphone applications can help this population by facilitating the fulfillment of goals relevant to these needs.

Bandura's (1977) social learning theory also helped to inform the structure of the proposed project. According to this theory, observational learning from peers facilitates reinforcement of new tasks. Bandura's social learning theory has been applied within a gerontechnological context, influencing the design of effective technology training programs for older adults (Cody, Dunn, Hoppin, & Wendt, 1999). The structure of the training sessions designed to teach the target population how to use smartphone applications will be administered by trained peers in a group session format, allowing for the participants' peers to serve as role models to the other members of the group.

6.1.4. Purpose and Objectives

The purpose of this study is to explore the feasibility of a training program called 'Peer-Led smArtphone TraINing for older adUlts with Mild impairments in cognition (PLATINUM). Feasibility studies focus on investigating acceptability, demand, implementation, practicality, adaptation, integration, expansion, and limited-efficacy testing in order to determine whether larger and more comprehensive evaluations are warranted within underdeveloped research areas (Bowen et al., 2009). Since the research regarding smartphone applications as a support for those with mild impairments in cognition is limited, a feasibility study would add to our understanding of the utility of smartphone applications for this population. Such a study could also add to the knowledge base on the appropriate means of achieving goals for this population and an effective method of choosing appropriate smartphone applications for the individualized needs of older adults with mild impairments in cognition.

This project will examine the feasibility of conducting a study with the following objectives:

1. To evaluate the utility of smartphone applications identified in Appendix A as a means to achieve goals set by participants.
2. To study the feasibility of the PLATINUM training program, gathering evidence for an effective means of choosing appropriate smartphone applications and a specific, peer-led training method that will help to foster smartphone application adoption within this population
3. To assess if a larger and more comprehensive evaluation of the PLATINUM program is warranted

6.2. Method

6.2.1. Approach

This feasibility study will be organized through the introduction of the PLATINUM program, a peer-led, participatory, user-driven intervention program to train older adults with mild impairments in cognition how to utilize smartphone applications. The peer-led component of the training program was chosen because this type of training has been found to be an effective means of training older adults how to use information and

communication technologies (ICTs) (Woodward et al., 2013). Consulting participants and actively involving them in the intervention process enhances the usability and acceptance of programs attempting to introduce new technologies into the lives of older adults (Demiris et al., 2004). A user-centered approach will be incorporated into the peer-led PLATINUM program in order to more fully engage the participants into both the intervention and the desire to incorporate smartphone applications into their lives.

The PLATINUM program will involve participants in three major processes: identifying goals, selecting appropriate smartphone applications, and learning to utilize these technologies through a peer-led training program. After the intervention has been completed, the feasibility study will assess participants' experiences of the training program and of the smartphone applications, recruitment and retention within the intervention, and potential efficacy of application adoption in helping this population to achieve their goals. Once the feasibility study has been completed, the potential for the training program and for the adoption of smartphone applications as a support for older adults with mild impairments in cognition can be more confidently assessed.

A mixed methods approach will be utilized for data collection. Post-intervention interviews will be conducted in order to investigate participants' experiences and perceptions of the smartphone training program and the use of smartphone applications as a support for their daily activities. Quantitative outcome measures for the feasibility study will include recruitment and retention rates, as well as Goal Attainment Scaling scores to assess participants' abilities to achieve specified goals upon completion of the PLATINUM program.

6.2.2. Research Procedures

The major phases of this study will involve peer trainer recruitment and preparation, participant recruitment, identification of goals, smartphone application selection, peer-led group training sessions, feasibility assessment, data analysis, and knowledge translation.

Peer trainer recruitment and preparation

A first step in the research process will be to recruit peer trainers for the group training sessions of PLATINUM. The trainers will be older adults who have been fully trained on the technology and the procedures for the training program, in order to enhance participants' self-efficacy and opportunities for peer-learning. This method has been found to be an effective means of training older adults to utilize computer and ICT technologies (Woodward et al., 2013). Two volunteers will be recruited through flyers in community gathering places (e.g. grocery stores, community centers, churches, libraries, and university lifelong learning centers) to serve as peer trainers for the PLATINUM program. Selection criteria for trainers will require these individuals to be aged 65 or older and have a self-reported comfort with presenting in front of groups and with using smartphone technology. These participants will be trained on how to utilize the smartphone applications listed in Appendix A and will then be trained on the material to teach to the participants during group sessions.

Participant recruitment

Twelve participants will be recruited for the study, as this number has been ascertained to be adequate for initial feasibility assessment (Bazeley, 2013), and similar numbers of participants have been recruited for initial testing of smartphone training programs (Svoboda et al., 2012). Since the target population for this study is community-dwelling older adults with mild impairments in cognition, inclusion criteria will require participants to be 65 or older, not living in a residential facility, having a subjective memory complaint, not having received a diagnosis of dementia, and having access to a smartphone device with a data plan. A convenience sample of participants will be gathered by targeting specific groups and facilities within the greater Vancouver area. Potential sites for recruitment include memory clinics such as the Neuro Health Clinic (2011), which focuses on care for those with memory and cognitive concerns, clinics offering memory rehabilitation, such as Dr. Andrew Miki's Mental Fitness (n.d.) clinic, and local senior centers/neighborhood houses such as the Mount Pleasant Neighborhood House (n.d.).

Goal-setting

Goal Attainment Scaling (GAS) provides a process for identifying specific, measurable, attainable, realistic, and timely (SMART) goals and assessing pre-post changes on participants' goal achievement (Kiresuk, Smith, & Cardillo, 1994). The GAS score is calculated by quantifying a goal's weight, participants' baseline and post-intervention functioning on goals, and comparisons between expected and actual outcomes. The documentation worksheet for GAS goal-setting is included in Appendix B (Turner-Stokes, 2009).

Participants will start the program by identifying goals they would like to achieve by the end of the PLATINUM program. Goal-setting will occur during a pre-intervention interview and survey with each participant in order to begin the process of GAS goal-setting. Pre-intervention steps for GAS will include the following tasks: 1) identifying 'patient-stated goals' 2) ensuring that the goals are SMART, 3) assessing the perceived importance of goals and the perceived difficulty of goal achievement, and 4) assessing baseline ability of goal performance (Turner-Stokes, 2009). The interview guide for the GAS pre-intervention interview is attached in Appendix C. Part 1 of the interview will focus on setting 'patient-stated goals' pertaining to unmet needs identified in Maslow's hierarchy (Maslow et al., 1970). Part 2 of the interview will involve adjusting the 'patient-stated goals' with the participants as needed in order to ensure that the goals are SMART. After the interview has been completed, a short survey will be administered in order to obtain needed information to calculate the weight (perceived importance of the goal *multiplied by* the perceived difficulty of goal achievement) and a score of baseline performance for each goal (See Appendix D). The goal-setting process will be an important precursor to the smartphone application selection process, which centers on pinpointing the smartphone application(s) that the participants will learn to utilize throughout the training sessions to help achieve their predetermined goals.

Person-centered smartphone application selection

Relevant smartphone applications will be identified for each participant based on their predetermined goals in a process which involves both the researcher and the participant. Appendix A contains applications which have been previously identified as

potentially relevant to the needs of older adults with mild impairments in cognition. Smartphone application options will be selected from this list by the research team based on their relevancy to each SMART goal previously determined during interviews. A selection of smartphone applications taken from Appendix A will be compiled by the research team and presented to each participant so they can have options as to which applications they will choose to focus on during the training sessions of the PLATINUM program. The rationale behind including the participants in the decision for which applications they would like to learn is that older adults have been found to show less interest in learning mobile phone technologies when they are uninvolved in the process of choosing the device (Zhou et al., 2012). Furthermore, in a real-world setting, the multitude of smartphone applications made available through app stores provide users with a variety of options to make the devices tailored to their interests. Given this, involving participants in the application selection process will allow the selected applications to be more relevant to participants' needs while also more closely simulating real-world smartphone application selection processes. The person-centered focus of app selection through this method will enhance participant engagement in the training sessions.

Peer-led group training sessions

The group training sessions will comprise the intervention component of the PLATINUM program. The choice to conduct peer-led group training sessions is based upon the social learning theory (Bandura, 1977) and is supported by research findings that the inclusion of a social component and role modeling enhances learning of mobile devices within a population of older adults with mild impairments in cognition (Rosenberg & Nygård, 2013). Svoboda et al. (2012) enacted a training program for personal digital assistant (PDA) and smartphone use among individuals of all ages who had moderate-to-severe memory impairments. Results from this study suggested that the program was helpful in teaching PDA/smartphone navigation. Thus, certain aspects of the training structure from this study will be mirrored in the PLATINUM program. As per the Svoboda et al. study, a total of ten training sessions will be held twice weekly for one hour and will focus on basic skill acquisition of the smartphone device, as well as smartphone application utilization and real-world scenarios in which smartphone applications could

be used. The peer trainers will conduct all leadership, role modeling, and training for the group sessions.

Feasibility assessment

After the intervention has been administered, an assessment will be conducted in order to gather evidence for the potential benefits of exposure to the training program and to smartphone application adoption. Individual interviews will be conducted, focusing on the participants' experiences with the smartphone applications and with the training program (See Appendix E). At this time, a follow-up survey to obtain post-intervention GAS information will also be administered (See Appendix F). This data will help to explore potential efficacy of the devices and of the program in facilitating goal completion. Furthermore, attendance and recruitment records will be investigated in order to assess recruitment and retention rates for such a program. The assessments described above will provide the major support for whether or not such a program is feasible and if smartphone applications would be an appropriate support for the targeted population.

Data analysis

Data from the in-depth interviews will be investigated using qualitative thematic analysis. These interviews will be recorded, transcribed, and analyzed for themes. As per thematic analysis protocol, the researchers will familiarize themselves with the data by reading the transcripts and taking notes. The next steps of qualitative thematic analysis will involve generating initial codes, searching for themes, reviewing themes, defining and naming themes, and, finally, producing a report of findings (Braun & Clarke, 2006). Data from transcriptions of these interviews will be coded and refined using NVivo software. Attendance and participation records will be reviewed to calculate an exposure implementation index. In this analysis the exposure rate (exposed participants to each phase of the research *divided by* the eligible participants at recruitment) is divided by the performance standard (set at 100%) to calculate the implementation index. Data from the GAS form will be analyzed by calculating the scores through a GAS calculation spreadsheet (Turner-Stokes, 2009). Information on GAS score calculations is included in Appendix G. The quantitative data will be gathered, along with the qualitative data, to provide evidence for the feasibility of the PLATINUM program.

Knowledge translation

Upon completion of data analysis, the researchers will involve participants and peer trainers in knowledge translation. These individuals will be presented with the findings from the study and will then provide feedback about their opinions of the results and their recommendations for future directions. Research findings will also be presented to any community collaborators and/or partner agencies connected with the PLATINUM program. Appendix H provides a timeline for the proposed study, detailing research procedures and estimated completion times. The estimated completion time for the proposed study is approximately six months.

6.2.3. Other Considerations

Ethical aspects

The proposed study would be subject to review from the Simon Fraser University Research Ethics Board. The information obtained from interviews and assessments would be kept anonymous. The participants in this study may or may not be able to provide informed consent, depending on their extent of cognitive impairment. Maintaining person-centered informed consent whenever possible with older populations of cognitively impaired individuals requires a process of maximizing decision-making competence and providing adequate protection (Mayo & Wallhagen, 2009). As Mayo and Wallhagen (2009) state, “assuming there is a reasonable direct benefit to the participant in studies where risks are minimal or low, the complexity level of information can be reduced to facilitate understanding and the assessment of decisional competence (p. 109).” In cases in which participants are considered to have decisional incapacity, authorized third party members will be consulted for informed consent purposes. The participants will also be modestly compensated sporadically throughout the study to recognize participants’ costs of attending the program (e.g. parking fees, time commitments, and travel expenses). Considering the content of the study, no adverse outcomes are anticipated from participation.

Fit with funding priorities

Canadian Institutes of Health Research (CIHR). One potential funding source for this research project would be from the CIHR's (2013) Institute Community Support Grants and Awards, specifically targeting the Institute of Aging. Several of the strategic research priorities within CIHR's Institute of Aging align themselves with the priorities of this feasibility study. One research priority within this funding organization is "adding life to the late years." As stated by the organization, this is influenced by individual, social, and environmental conditions. The research within the proposed feasibility study acknowledges the diversity of individual needs, offering a highly tailored and personalized intervention. Regarding environmental conditions, the Institute of Aging discusses how "older people's quality of life is improved when they can live in their preferred home environment and have a built environment that is designed to meet their needs." If found to be useful and usable, smartphone applications would help older adults with mild impairments in cognition to independently complete activities within their homes, potentially increasing the likelihood that these individuals will be able to age-in-place. Furthermore, the built environment, in this case, one's exposure to smartphone applications, is tailored within this study to meet the individual needs of participants.

Another research priority within CIHR's Institute of Aging is the funding of interventions that are "appropriate to the complexity of older people's state of health." Under this priority, the Institute of Aging specifically emphasizes the need for new knowledge on interventions for those with cognitive impairments, making the feasibility study highly relevant to this priority. The tailored and multifaceted capabilities of smartphone applications also acknowledge the complexity and heterogeneity of older adults who have mild impairments in cognition.

A third relevant priority of this funding agency is their emphasis on "health care and services that combine and integrate continuity, innovation, and efficiency". Smartphone applications can provide older adults with mild impairments in cognition an innovative means of adapting to their health conditions. Because this technology is mobile, access to this form of support would be widespread throughout one's community. Furthermore, the user-centered approach to the study would encourage

participation of knowledge users, another important emphasis stated within the research priorities for the Institute of Aging.

Lastly, the funding agency emphasizes the need for “evidence to support the best training programs for health workers and health professionals.” One emphasis of the proposed feasibility study is better understanding the best training methods for the target population of older adults with mild impairments in cognition. The findings from this study could be translated into other training programs for the target population if found to be feasible.

New Horizons for Seniors Program (NHSP). The research processes of the proposed feasibility study also align itself with the priorities of Community-Based Projects for Seniors, which is part of the NHSP. One of the funding objectives of this organization is to engage seniors in the community through the mentorship of others (Employment and Social Development Canada, 2013). The intervention involves seniors as trainers for how to use the smartphone applications. The user-centered approach of the study also fosters the participation and volunteerism of seniors, which is important to the priorities of NHSP.

Under the general project eligibility guidelines, the research projects under NHSP must present an innovative and creative approach to address a concern within the community. The proposed research uses technology innovatively to assist the target population by facilitating them to complete daily activities independently. The program also fosters the efficient and effective use of resources since smartphone applications would be a relatively cost-effective supportive device. Another priority of the program, to involve collaboration and partnerships, could also be incorporated into the study (See the ‘Potential Collaborators’ section below).

Potential collaborators

Academic collaborators with strong research backgrounds contribute a great deal to the likelihood of a given study being funded. Dr. Andrew Sixsmith, Director of the Gerontology Research Centre at Simon Fraser University, conducts research in the field of gerontechnology. He is currently working in conjunction with the Ambient Assistive

Living Technologies for Wellness, Engagement, and Long Life (n.d.) project, which is looking into innovative ambient assistive living technologies to enhance the lives of older adults with mild cognitive impairment (MCI). Dr. Sixsmith has been closely involved in the development of the proposed study and can serve as an important collaborator for this project. Dr. Ben Mortensen, an assistant professor at the University of British Columbia, would also be a key collaborator for this project. Having a strong background in assistive technology research, he would be an ideal contributor and has also been closely involved in the development of this study.

Establishing community connections is another important aspect of successful research. Claudine Matlo works in affiliation with the Mount Pleasant Neighborhood House. She has expressed interest in connecting the proposed study to her organization. This neighborhood house could serve as an important connection to seniors who attend this facility, linking potential participants to the study through a familiar and trusted organization. Another association, Retirement Concepts (2013), has also expressed interest in the proposed research. Their independent living facilities would be an ideal place to target participants since individuals living in these residences often need extra supports to independently complete daily activities. Both of these potential collaborators could serve as key community connections for the proposed study.

Feasibility risk analysis

Certain problems could arise during the program which should be acknowledged from the beginning of the research process. First of all, the target population of older adults with mild impairments in cognition might not be interested in learning the smartphone application technology. The user-centered design of this study should alleviate some of this concern, since the participants are able to take part in the decision as to which applications they would like to learn about during the training sessions. Another potential problem is that the participants would not be able to adopt the smartphone applications. Thus the barriers to technology adoption and appropriate learning styles specific to this population should be considered (See ‘Technology Adoption Considerations’ in Chapter 4 of this report for more details on this topic). As for the peer trainers, these individuals may face motivational and/or knowledge difficulties

with regards to their training responsibilities. Thus, the selection of these volunteers should be based upon their abilities and enthusiasm for the program. Keeping these issues in mind, the proposed study should be able to decrease risk of program infeasibility.

Resources

Resources required for this research program include funds for the researcher's salary, compensation for the participants, the cost of smartphone applications and subscription fees where applicable, and an NVivo student license for data analysis. The cost for this research program is estimated at $12,700. A breakdown of the budget is detailed in Appendix I. Notably, the incorporation of peer trainers who are volunteers from within the community, instead of using paid researchers to serve as trainers, significantly reduces costs of this program.

Deliverables

The deliverables that can come out of the PLATINUM program include four academic papers and poster presentations at conferences. One paper will focus on the needs/goals of those with mild impairments in cognition. The second will focus on the experiences that those with mild impairments in cognition had with the smartphone application training program, providing recommendations for future studies utilizing a user-centered approach within the target population. The third publication will discuss the findings of the potential efficacy of smartphone applications as a support for those with mild impairments in cognition, and the fourth paper will focus on the feasibility of the PLATINUM program. Poster presentations of the information from each publication will be presented at relevant gerontology or technology conferences within Canada.

Potential implications and practical benefits for the aged population

Given feasibility, more research in this area would be warranted. The feasibility study could be enacted as part of a larger, three-part research program. After investigating feasibility, a second research initiative with a larger sample could seek to more strongly establish efficacy of the smartphone applications for older adults with mild impairments in cognition. Furthermore, the second study would help to test the protocol

and intervention strategy developed in the initial feasibility study in order to fine-tune the intervention procedures. Once efficacy has been confirmed and the intervention protocol has been adequately tested, the third research initiative could then focus on knowledge translation, enacting the PLATINUM program on a larger scale.

As for the practical benefits for the target population, enhancing the knowledge base on supportive technologies could eventually lead to better strategies for older adults with such impairments to independently address their needs. Smartphone application supports could be found to enhance their health, wellbeing, and ability to age-in-place, and the intervention could also prove useful in identifying needs not met by current smartphone applications, which would help to inform future application development. Adoption of efficacious smartphone applications could also decrease strain on carers who are currently providing assistance in the completion of these daily activities. Considering the potential benefits of smartphone applications, the adoption of these technologies among older adults with mild impairments in cognition could also be a significantly cost-effective support strategy within this population. Smartphone applications are a relatively cheap alternative to other supportive devices and could significantly reduce health care costs if health behaviors are improved and future institutionalization is reduced. If the PLATINUM program proves efficacious, a follow-up study could also look at the cost-effectiveness of such an intervention.

The study also would have implications for the peer trainers. These volunteers would likely become more socially engaged in their communities through participation in the training program. They would also have a strong working knowledge of smartphone applications that could provide them with support. Furthermore, the act of teaching would likely have positive consequences for their leadership skills and levels of community involvement. All of these aspects of the PLATINUM training program could have positive implications for future research initiatives, as well as positive effects on both participants and the peers that trained them.

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Appendix A.

Relevant Mobile Applications for Older Adults with Mild Impairments in Cognition

Theme	Application	Description
Multifaceted Systems	Silverline Care Pack (Silverline Mobile, 2013)	Medication: Provides medication reminders and offers a function that records personalized voice reminders Camera: Incorporates time stamps, voice notes, and geo-tagging (capturing GPS information at the time a photo is taken), which, in conjunction with the phone's camera, creates detailed photo albums or notes about the day. Contacts: Offers an age-friendly interface for the phone's address book. Learn: Offers news stories, human interest pieces, and uplifting quotes through text, picture, and video systems. Well-Being: Records water intake, exercise, and mood, offering reminders to facilitate the completion of these health-related activities. Location: Uses GPS technology to write out the person's current position in address form and can also show their location on a map. Emergency: Offers an emergency system with numbers for emergency contacts, as well as programmable documentation of pertinent health information.
	CleverMind (2013)	MYIRA: the "Intelligent Robotic Assistant" provides voice-activated information Internet: Links to medical information and other websites Nutrition and Exercise: Information pertaining to health, diet, and exercise Friends & Family: Specialized interfaces connecting to social networking sites Writing & Pictures: Journaling, goal management, photo albums and video storage Other Features: Games, News, Music & Movies, Books & Audiobooks, Trivia

	Memo (2013)	Memo: Family/caregiver remotely updates reminders, calendar events (with audio alerts), to-do lists, notes, and photos through an Internet-based database. These items then appear on the older adults' tablet device. Pillbox: Contains information on medications, instructions for medication administration, and scheduled reminders Phone list and Photo album: Specialized to be simple and easy to read/navigate Help button: Connects to family/caregiver Weather
Memory	Its Done! (2013)	Activity reminders and task completion recording Offers reminder alarms for time-sensitive activities, such as medication reminders Optional notification to family members when activity is done
	Evernote (2013)	Enables the completion of notes, to-do lists, and tasks (written, voice-recorded, and/or picture) Reminders can by organized into different notebooks/tags
	Remember the Milk (2013)	Organizes reminders, to-do lists, and tasks
Health	Map My Walk (2013)	Tracks walking, cycling, and running behaviors with real-time feedback and voice prompts to help encourage exercise Offers food and weight monitoring
	Fooducate (2013)	Scans the barcodes on packaged foods and analyzes the nutrition information, providing a nutrition grade for the product Offers alternatives to unhealthy products
	Healthy Habits (2013)	Encourages the incorporation of healthy habits into user's day and discourages unhealthy habits Provides reminders, motivation, reports, and inspirational quotes Can choose from a library of commonly targeted health habits or create custom targeted habits
	Get Up and Go (2013)	Discourages prolonged sitting by providing scheduled reminders to get out of one's seat and walk around/exercise
Social Connection	Skype (2013)	Connects through the Internet to provide free video calls with other Skype contacts
	Tapestry (2013)	Senior-friendly interface that connects multiple social networking accounts through a safe and secure format Offers easy-to-use photo sharing with family and friends Enables private messaging

	A Story Before Bed (2013)	Grandparents can record audio and video of themselves reading children's stories Grandchild can follow along with the story simultaneously with the recorded image/audio of their grandparent in the corner of the screen
	Senior Dating World (2013)	Dating application targeted for singles aged 50+ Allows for photos and videos to be uploaded to dating profile Sends private emails to those the user wishes to contact and targets members that match user's profile
Personal Development	Everest (2013)	Encourages user to meet both simple and complex life goals Breaks up goals into daily accomplishments Offers reminders to increase habitual achievement of daily goals Tracks progress through photos, quotes, and journaling Shares progress with friends/other Everest members
	Volunteer Match (2013)	Connects user to local volunteer opportunities within their area Matches user's interests and expertise to relevant volunteer opportunities
	GrapeVine (2013)	'Lifelong, personal concierge' that recommends activities, materials, and connections related to Judaism Sensitive to personal interests, friends, stage-in-life, and geographical location Opportunities can be saved, added to calendar, and shared with friends Links to Facebook Currently only available in select cities
	Equanimity (2013)	Facilitates time management for routinized meditation through the provision of a timer, ambient music, and journaling Provides reminders for meditation times
	Divinely (2013)	Christian social site allows user to create prayers and invite others to pray along Sends daily inspirational photos and scripture to user Offers functionality to share inspirational/meaningful photos and add text Photos can be shared with other app users Syncs with Facebook

	Awakening Joy (2013)	Provides exercises designed to enhance emotional wellbeing and reminders to facilitate completion of these activities throughout the day
		Experiences can be documented through a journal feature that allows for sharing of photos, text, and inspirational quotes
		Suggests activities based on the specific and personalized goals for growth identified by the user
IADL Performance	CanPlan (2013)	Provides task assistance through sequenced and customizable prompts (pictures, text, and voice)
		Includes scheduled activity reminders
		Offers task assistance in such areas as food preparation, household maintenance, shopping, transportation, exercise, workplace activities, and more
	Epicurious (2013) Recipes & Shopping	Recipes can be selected and ingredients transferred to a shopping list
		Can filter for what ingredients you have, healthy meals, and seasonal ingredients
		Provides step-by-step prompts for cooking
	KitchenPad Timer (Touch Village, 2013)	Helps to manage cooking times when creating multiple dishes simultaneously
		Provides a visual display of cooking times and temperatures
		Alerts user when each dish is ready
	Mint.com (2013)	Combines tracking, budgeting, and money management to help understand where money is being spent through simple and easy-to-read charts
		Manages bank, credit, loan, and retirement accounts
		Provides reminders for upcoming bills and alerts when accounts are getting low
		Syncs with all devices (computers, tablets, and smartphones)
	Transit App (2013)	Provides transit information (schedules, itineraries, quickest routes to destination) for 43 major cities
		Schedules and itineraries can be accessed offline
		Can set favorite locations for easier access to these trip planners
	MediSafe (2013) Virtual Pillbox	Reminds user to take medications at specific times
		Family member/carer is notified if user does not check in after medication alarm goes off
		Notifies user when it is time to refill prescriptions

Appendix B.

Goal Attainment Scaling Form

Patient stated goal	SMART goal	Weight	Baseline	Achieved	Expectation Comparison	Description of variance from expectation
#1			Some function OR None	Yes No	Much better A little better As expected Partially achieved Same as baseline Worse	
#2			Some function OR None	Yes No	Much better A little better As expected Partially achieved Same as baseline Worse	
#3			Some function OR None	Yes No	Much better A little better As expected Partially achieved Same as baseline Worse	

(Source: Turner-Stokes, 2009)

Appendix C.

Goal Attainment Scaling Pre-Intervention Interview Guide

Part 1 - Patient Stated Goal

- Do you have any goals you would like to work towards with regards to your…
  - Physical health (*physiological needs* - e.g. nutrition, exercise, healthy lifestyle)?
  - *Safety and security* (e.g. safety while in home, safety while in community, financial security)?
  - Relationships with others (*love and belonging* - e.g. communication and interaction with family, friends, romantic relationships)?
  - Progress in working independently towards the achievement of meaningful life goals (*esteem and self-actualization* – e.g. vacation, volunteerism, hobbies, religious pursuits)?

Part 2 - SMART Goal

- Specific – How can you work towards this goal?
- Measurable – What specific changes would you like to see?
- Attainable – What changes in working towards this goal do you think you could achieve during the intervention?
- Realistic – Is this goal realistic?
- Timely – Do you think you will be able to achieve this goal during the timeframe of the intervention?

Appendix D.

Goal Attainment Scaling Pre-Intervention Survey

Circle the answer that best pertains to you.

How important is the achievement of this goal to you?

0 Not important
1 A little important
2 Moderately important
3 Very important

How difficult do you think this goal will be to achieve?

0 Not difficult
1 A little difficult
2 Moderately difficult
3 Very difficult

With respect to this goal, I have…

-1 Some ability
-2 None (as bad as can be)

Appendix E.

Post-Intervention Interview Guide

1. What was your overall impression of the intervention you received?
2. What did you dislike about the intervention? What did you like?
3. How do you think the intervention could be improved?
4. What aspects of the intervention did you find most helpful? Least helpful?
5. What were your opinions of the time commitment for the training program? For using the applications?
6. What aspects of your experience with the training program were beneficial? With the applications?
7. What were the problems that you encountered with the training program? With the applications?
8. What costs were associated with participation in the training program? With using the applications?
9. What impact did involvement in the intervention have on you? Impact of using the applications?
10. What impact did participation in the program have on your social network/caregivers? The impact of using smartphone applications on your social network/caregivers?

Appendix F.

GAS Post-Intervention Survey

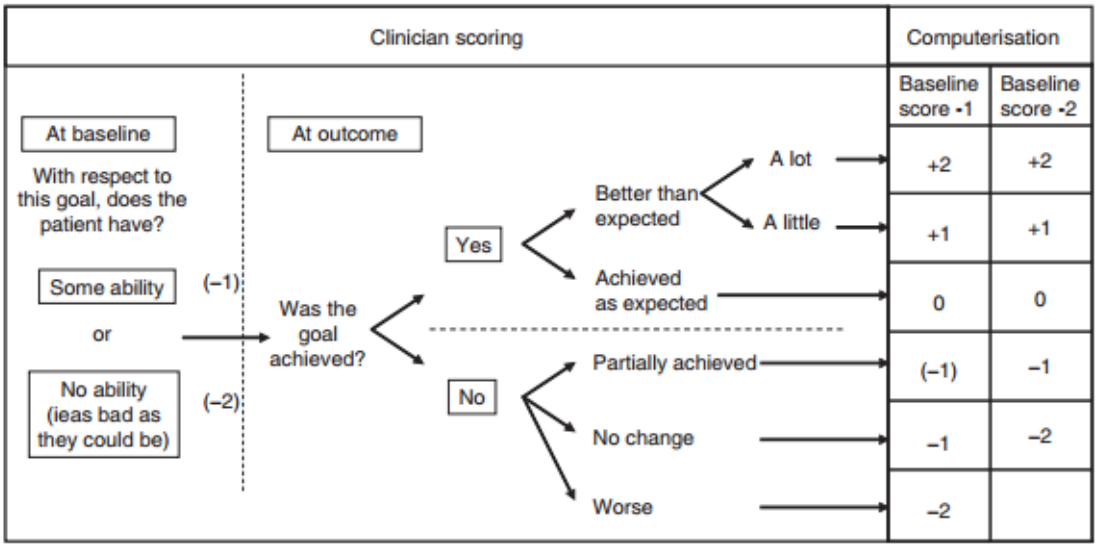
Circle the answer that best pertains to you.

Compared to my expectations set for goal achievement at the start of the program, my current level of goal achievement is…

-2	Worse than expected
-1	Same as baseline / Partially achieved
0	As expected
1	A little better than expected
2	A lot better than expected

Appendix G.

GAS Calculation



$$\text{Overall GAS} = 50 + \frac{10\sum(w_i x_i)}{\sqrt{((1-\rho)\sum w_i^2 + \rho(\sum w_i)^2)}}$$

(Source: Turner-Stokes, 2009)

Appendix H.

Research Procedures and Timeline

Procedure	Activities	Estimated Completion
Peer trainer recruitment / preparation	Recruitment	Week 2
	Training	Week 5
Participant recruitment	Recruitment	Week 7
Goal-setting	Pre-intervention interview	Week 8
	Pre-intervention survey	Week 8
Smartphone application selection	Individual list creation	Week 9
	Individual application selection	Week 10
Group training sessions	10 training sessions	Week 15
Feasibility assessment	Post-Intervention interview	Week 16
	GAS post-intervention survey	Week 16
Data analysis	Thematic qualitative analysis	Week 19
	GAS scores	Week 20
	Exposure implementation index	Week 20
Knowledge translation	KT with participants and peer trainers	Week 21
	KT with partner agencies/collaborators	Week 22

Appendix I.

Breakdown of Budget

Expense	Details	Rate	Estimated Cost
Researcher salary	Full time – 17 weeks	$17/hr	$11,560
Participant compensation	Recruitment Training sessions (given once per week, 5 out of 10 sessions) KT session	$5 per participant per compensation	$420
Intervention materials	Smartphone applications Application subscription fee	$10 per participant $40 per participant	$600
Data analysis materials	GAS assessment NVivo student license	free $120 per license	$120
			$12,700