WHERE AM I AND HOW DID I GET HERE? THE EFFECTS OF AGING ON INTERNET-BASED TRANSPORTATION NAVIGATION SKILLS

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ABSTRACT

Difficulties using the internet can represent a barrier to optimal daily functioning, particularly for older adults, who may experience age-related neurocognitive changes. While much of the research on aging and internet task performance has focused on information searching, internet transit planning and navigation may also be relevant for older adults. The current study examined the effects of older age on internet navigation skills using a novel transit planning paradigm, explored neurocognitive correlates of internet transit navigation performance, and assessed the potential benefit of brief experimental support designed to enhance internet transportation planning ability and performance. Participants included 40 older and 50 younger adults who completed three thematically interrelated transit internet navigation tasks via a live San Francisco Transit website. Regression analyses showed that older adults were less accurate and also slower to complete internet transit tasks compared to younger participants at the level of large effect sizes. Among all participants, internet transit speed and accuracy demonstrated small-to-medium positive associations with standard clinical measures of episodic learning and memory. For a fourth transit task, participants in each group were randomized into either a control condition or into a condition in which they received a brief experimental support session to facilitate the planning and execution of the task. A significant age by condition term was observed, whereby the planning supports were more beneficial in the younger group than in the older group. Findings suggest that older adults experience difficulties quickly and accurately using a transit website to plan transportation routes, which may be related to their ability to learn and recall information. Given the lack of efficacy of a brief, planning-based support strategy among older adults, future work might examine the potential benefits of effective learning and memory strategies (e.g., spaced retrieval practice, elaboration).

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Introduction

The adoption rate of the internet has far exceeded that of earlier mass communication technologies (Hannemyr, 2003). In 2000, over three-quarters (77%) of computer-owning households reported having an internet connection; by 2003, this figure jumped to 94%, supporting surveys suggesting that the internet has become ubiquitous (Madden, 2003). Over the past 15 years, innovations in internet technology have drastically changed how people navigate their day-to-day world. Internet users look to the World Wide Web to complete various activities including, email, games and hobbies, news, online shopping, banking, for travel and vacation planning, and to seek healthcare information (e.g., Chin & Fu, 2010). The internet has become a significant home management tool and is increasingly becoming indispensable to daily activities. Still, there are considerable risks involved when using the internet, including obtaining erroneous information about healthcare (e.g., Kunst, Groot, Latthe, Latthe, & Khan, 2002) and financial management (e.g., banking scams). Accordingly, internet navigation difficulties can represent a serious barrier to optimal daily functioning, particularly to older adults, who may have difficulty using this ever-advancing technology.

An Aging World

Today, approximately 10 percent of the world's population is over the age of 65; this figure is predicted to more than double by 2050 (Ortman, Velkoff, & Hogan, 2014). While many older adults remain healthy and productive, the general population of older adults has higher rates of physical and cognitive impairment compared to younger people (Pollack, 2005). We face a profound demographic shift from a world in which the majority of the population is relatively young, to one in which a large proportion of people are over the age 65 (NIH: An aging World, 2015). Thus, there may be fewer young people to assist older adults in coping with obstacles associated with aging. This change presents a challenge and an opportunity for the development of technologically based tools for daily tasks.

Age differences in computer use, skills, and internet use are well established (Agree, 2015). Older cohorts are far less likely than younger ones to use computers regularly, to rely on the internet for information, and report less ease in locating information on the “net” (Strong, Rogers, & fisk, 2006). Despite these differences, as adults who are more familiar with computers enter old age, closing of this age-based divide is anticipated. The proportion of individuals using the internet has steadily risen among adults of all ages. The number of adult Americans using the internet increased 50% from 2000 to 2003, with most of this increase accounted for by individuals 30 years and older (Hoffman, Novak, & Venkatesh, 2004). Internet use among adults aged 65 and above has risen from 13% to almost 60% in just ten years (Zickuhr & Madden, 2012). According to the 2017 Pew Research Center data, the rate of internet use is similar among men and women and also comparable between White, Black, and Hispanic individuals (Pew Research Internet Fact Sheet, 2018). Still, gaps remain based on factors of age, income, education, and community type, such that internet users tend to be younger, report higher salaries, more years of education, and tend to live in suburban or urban communities (Pew Research Internet Fact Sheet, 2018). While recent work suggests that internet use in older age is related to smaller cognitive decline in men (Ihle, Bavelier, Maurer, Oris, & Kliegel, 2020) and older adults represent one of the fastest-growing populations of internet users (e.g., Aula, Jhaveri, Käki, 2005), due to the complex characteristics of the web to be processed and heterogeneous organizations of websites, older adults still users face difficulties using the internet.

A number of age-related changes have been observed to impact internet use and performance on web-based tasks. For example, several studies report age effects on speed of performance (e.g., Pak & Price, 2008; Pak, Price, & Thatcher, 2009; Stronge, Rogers, & Fisk, 2006; Sharit et al., 2015) and efficiency during online information retrieval tasks (Dommes et al., 2011). One's approach navigating within and between websites also appears to be impacted by age. Compared to younger adults, older individuals tend to spend more time on search engines (longer time to make a choice of webpage to retrieve data) and tend to switch between the search engine and websites less often (Chevalier et al., 2015; Sharit et al., 2015). Strategies used to navigate the internet are often assessed as problem-solving behaviors. As such, researchers have attempted to isolate the planning (i.e., formalize a query, divide the problem, and develop a strategy), evaluating (i.e., comparing searched information with the problem in question), and controlling (i.e., modifying strategies to achieve the goal) processes involved in internet use (Sharit et al., 2008). Operating within this structure, Chevalier et al. (2015) reported that older adults demonstrate more engagement in evaluating processes and employ planning and controlling processes less often compared to younger cohorts. Czaja and colleagues (2001) examined performance on a computer navigation task, which required participants to simulate a series of job tasks of a customer service representative. Results indicated that older age was associated with reduced performance on various measures of work output including the number of correctly navigated tasks and efficiency of work (i.e., more job tasks per hour; Czaja, Sharit, Ownby, Roth, & Nair, 2001), suggesting that these age-related changes in internet navigation skills may have downstream implications for everyday functions. Moreover, as the internet seems to foster independence and reduce isolation, increase communication, and keep the mind active (Mellor, Firth, & Moore, 2008), understanding the role that age plays in internet navigation skills may increase the likelihood of older adults benefiting from its use.

The Aging Brain

Cognitive aging may play a role in internet navigation skills of older adults.

Mechanisms of Aging. Once thought to be a passive, uncontrollable process of deterioration over time with little to no genetic regulation, aging is now understood as a consequence of systematic mechanisms that actively control how cells, tissues, and organisms respond to their environment (Arking, 2006). Studies in animal models suggest that aging of neurons shares almost all aspects of aging with other tissues, including remarkable plasticity and malleability with regard to environmental influences (Anderson, Rizzo, Blackwell, 2018). The nervous system plays a prominent role in controlling the rate of aging in other tissues. In turn, it is also affected by the aging of the cell soma in complex ways that influence changes associated with aging of the brain. Indeed, regulatory structures that respond to internal or external changes and cause change via redistribution of resources away from somatic maintenance affect cellular aging (Anderson, Rizzo, Blackwell, 2018). While the magnitude of these influences varies depending on the habitat of the organism, size, metabolic need, and other bio-energetic factors, the causes of aging cells and tissues share several common features (Lopez-Otin, Partridge, Serrano, & Kroemer, 2013).

Despite the many mechanisms dedicated to the repair of DNA damage, the accumulation of genetic damage is a common feature of aging (Moskalev et al., 2013), and there is evidence that DNA repair enzymes do not function efficiently with age. For example, cohesive end-joining activity (joining of two nucleic acid fragments; Vyjayanti & Roa, 2006) as well as the ability for DNA to signal a damage response decreases with age (Wang et al., 2013). The lack of reliable DNA repair mechanisms is particularly evident in age-related neurodegenerative diseases, and several studies have reported greater rates of neuron accumulated DNA damage in human neurologic disorders compared to age-matched controls. It is unclear, however, how and if the random accumulation of somatic mutations that might increase in neurons with age as a consequence of inefficient repair mechanisms contribute to the more stereotypic changes in neuronal function and phenotype that occur with age (Anderson, Rizzo, Blackwell, 2018).

In contrast to the random nature of genetic mutations, the more consistent shortening of telomeres has provided a powerful concept for the time-dependent senescence of somatic cells (Blackburn, Greider, & Szostak, 2006). It is established that cells and unicellular organisms undergo replicative senescence, wherein they no longer divide after a certain number of cell cycles. While there are strong links between telomere attrition and organismal aging, given their postmitotic status, the aging of neuronal cells appears not to be directly affected by telomere length. Studies in rats indicate that, while the percentage of short telomeres increased with age in the kidney, liver, pancreas, and lung of both males and females, telomere length did not change significantly in the brain tissue itself (Cherif, Tarry, Ozanne, & Hales, 2003). Consistent with findings, patients with Werner syndrome have been shown to exhibit premature aging as a result of telomere dysfunction display an accelerated senescence phenotype in mesenchyme-derived tissues, but not in neural lineages (Blackburn, 2000). Recent studies report that reprogramming fibroblasts to pluripotency elongated telomere length and prevented telomere dysfunction, whereas re-differentiation to mesenchymal stem cells reasserted telomere dysfunction. Whereas Thus, telomere attrition is typically thought to affect neuronal tissue by affecting the proliferative capacity of adult neuronal stem cells (Ferron et al., 2009).

There are numerous additional factors that have been shown to contribute to age-related changes in the brain. For example, the neurotransmitters dopamine and serotonin are most often discussed with regard to aging (Peters, 2006). Dopamine levels decline by around 10% per decade from early adulthood and have been associated with declines in cognitive and motor performance (e.g., Nyberg & Backman, 2004). It may be that the dopaminergic pathways between the frontal cortex and the striatum decline with increasing age, or that levels of dopamine itself decline, synapses/receptors are reduced or binding to receptors is reduced (e.g., Nyberg & Backman, 2004). Serotonin and brain-derived neurotrophic factor levels also fall with increasing age and may be implicated in the regulation of synaptic plasticity and neurogenesis in the adult brain (Mattson, Maudsley, & Martin, 2004). Other factors that have been implicated in the aging brain include calcium dysregulation (Toescu, Verkhratsky, & Landfield, 2004), mitochondrial dysfunction, and the production of reactive oxygen species (Melov, 2004). Encompassing all of these potential mechanisms, protein homeostasis appears to play a special role in the normal aging of neurons well as in age-related neurodegenerative diseases, both of which are associated with the accumulation of diverse species of misfolded proteins in neurons (Anderson, Rizzo, Blackwell, 2018). Further, gross neuronal and glial number appear largely unchanged by age, rather the major mechanisms affecting neurons appears to be related to their long postmitotic lifespan, their excitability, interconnectedness and energetic requirements dependent on oxidative phosphorylation (e.g., van Zundert et al., 2008).

Indeed, neuronal connectivity is one of the most plastic aspects of the adult brain, and changes in structural substrates of interneuronal communication may play an important role in brain aging (Raz, 2001). Two decades of in vivo examination of structural brain changes in the aging have yielded several well-replicated findings, although the degree of their agreement with the results of postmortem studies varies. Generally, neuroimaging findings confirm the postmortem findings of an association between age and expansion of the cerebral ventricles, generalized enlargement of cerebral sulci, and reduction in gross cerebral volume (Raz, 2001). Postmortem investigations of the human brain revealed a tendency towards greater age-related shrinkage of the white rather than grey matter (Raz, 2001). In contrast, the preponderance of in vivo studies in humans and nonhuman primates have found little age-related shrinkage of the cerebral white matter and have indicated that grey matter shrinkage accounts for the age-related decline in cerebral volume (Raz 2001). This difference in results is likely due to the resolution limitations of current MR imaging. Asymptomatic elderly people typically show a pattern of deep white matter and periventricular areas hyperintensities, with notable punctate lesions, periventricular caps, and rims (Raz, 2001). The etiologies of these age-related white matter abnormalities are diverse. Pathological changes observed in vivo reflect vascular and neuropathological phenomena such as a reduction in cerebral perfusion, especially in the border zones, subclinical ischemia, expansion of perivascular spaces stemming from axonal degeneration, gliosis, myelin pallor, and breakdown of the ependymal ventricular lining (Raz, 2001). Age-related deterioration of brain structure is also accompanied by a decline in the physiological indices of brain function. Normal aging is associated with a moderate reduction in regional cerebral blood flow, regional cerebral metabolic rate of oxygen utilization, and grey matter blood volume (Raz, 2001).

In the setting of generalized age-related brain changes, several lines of evidence support the notion of selective sensitivity of specific brain regions (Trollor & Valenzuela, 2001). When synaptic density and dendritic arborization of the cortical neurons are reduced with age, the reduction is particularly significant in the prefrontal cortex (Scahill, Frost, Jenkins, et al., 2003).

Following the prefrontal cortex, the reduction in the striatum has been consistently implicated in the aging literature (Trollor & Valenzuela, 2001). The temporal lobe, cerebellar vermis, cerebellar hemispheres, and hippocampus also exhibit differentiation in reduction with age (Trollor & Valenzuela, 2001). The occipital and parietal regions, in comparison, appear to be least affected (Raz, 2004). This pattern of differential vulnerability reflects the array of cognitive consequences conferred by the aging process.

Advancing age is associated with a general slowing of cognitive processes, decreased memory capacity, decreased attentional control, and difficulty in goal maintenance (Charness & Boot, 2009), while vocabulary appears relatively stable into later adulthood (e.g., Alwin & McCammon, 2001). Decline in memory function is the most common cognitive complaint among older adults. Indeed, as a group, older adults do not perform as well as younger adults on a variety of learning and memory tests (e.g., Henry, MacLeod, Phillips, & Crawford, 2004). Generally, memory function can be divided into four sections, episodic, semantic, procedural, and working (Parkin,1997). Episodic memory is defined as “a form of memory in which information is stored with ‘mental tags’ about where, when, and how the information was learned” (Reber, 1995), for example, details of the important meeting attended last week. Semantic memory involves a fund of information, language usage, and practical knowledge; for example, knowing the meaning of words. Episodic memory is performance is thought to decline from middle age onward (Nyberg & Backman, 2004), whereas declines in semantic memory are less common but can emerge in late life (Price, Said, & Haaland, 2004). Procedural memory involves memory for motor and cognitive skills. Examples of procedural memory include remembering how to tie a shoelace and how to ride a bicycle. In contrast to episodic and semantic memory changes, procedural memory remains relatively stable across the life span

(Lezak, Howieson, Bigler, et al., 2012). Memory can also be broken down into different stages. Acquisition is the ability to encode new information into memory. The rate of acquisition declines across the lifespan (e.g., Haalan, Price, Larue, 2003). However, retention of information that is successfully learned is preserved in cognitively healthy older adults (Whiting & Smith, 1997). Declines also occur in the ability to access newly learned information or retrieval in typically aging individuals. Neuroimaging data examining memory function among older adults reveal increased symmetrical hemispheric activation compared to younger individuals (Cabeza, 2001). It is not clear, however, if this change is an attenuation of the response observed in younger subjects, an inability to recruit specific areas, or an attempt to compensate for the aging process (e.g., Rosen, Prull, O'Hara, et al., 2002). Nevertheless, the change in activation occurring in the frontal lobes is consistent with memory performance and white matter age-related changes discussed above.

The literature on neuroanatomical correlates of working memory is less clear. Salat et al. (2002) reported that better working memory was seen in older adults with smaller orbitofrontal volumes, and Gunning- Dixon & Raz (2003) did not find a significant association between working memory and either prefrontal or fusiform cortex volume. In a longitudinal study, Raz et al. (2007) found that shrinkage of the fusiform gyrus over five years predicted working memory decline. While working memory is an interesting cognitive construct in its own right, most volume-cognition studies have used working memory performance as a mediating factor in predicting age-related differences in other domains of cognition such as visuospatial mental imagery (Raz et al., 1999). Working memory has been found to be a significant mediator of episodic memory and perseverative errors, respectively, and in both cases, working memory was mediated by PFC volume (Head et al., 2009). Working memory was also a salient mediator of implicit measures of priming and skill learning performance in many of studies (e.g., Raz, Ghisletta, Rodrigue, Kennedy, & Lindenberger, 2010; Kennedy & Raz, 2005; Kennedy et al., 2009; Raz et al., 2000). Thus, working memory likely depends upon intact volume in a wide variety of structures across the brain.

Broadly speaking, complex skills of planning, self-monitoring, inhibiting prepotent response, and adjusting behavior in response to changing environments, comprise the term “executive functions.” In total, neuroanatomical evidence suggests that the ability to successfully, plan, organize, and execute cognitive output with age is associated with shrinkage of the prefrontal cortex (e.g., Raz, Gunning-Dixon, Head, Dupuis & Acker, 1998) and loss of axonal integrity in prefrontal white matter (Valenzuela et al., 2000). Better performance on some executive tasks (e.g., Wisconsin Card Sorting Test, WCST) is associated with larger prefrontal cortex volumes (e.g., Gunning-Dixon & Raz, 2003; Head et al., 2009; Raz et al., 1998). Multivariate analyses of brain volume and cognition reveal that age-related differences in volume exert effects on executive function via complex associations of mediating factors. For example, Head et al. (2009) found that age-related increase in perseveration on WCST is differentially dependent on the integrity of PFC but also on declines in selected cognitive processes such as processing speed, temporal order processing, working memory, and inhibition, which also depend upon this region. In a small sample of older adults, Elderkin-Thompson et al. (2008) found differential effects among the PFC subregions and differing aspects of executive function. In that study greater volume of the anterior cingulate was associated with Stroop interference and larger gyrus rectus volume was associated with inductive reasoning, whereas smaller orbitofrontal volume was associated with greater verbal fluency; suggesting concerted efforts of anterior and posterior neural circuits connected by extensive white matter tracts have also contributed to systems that support executive abilities (see Cabeza & Nyberg, 2000 for review).

Lower neurocognitive capacity in the domains of such as episodic memory and executive functions is also a unique risk factor for concurrent functional declines (e.g., Tucker-Drob, 2011) in older adults. This may not be surprising if we consider that successful completion of many everyday activities involves a systematic sequence of behaviors that engage cognitive abilities affected by aging. Even setting the table, for example, entails various executive, episodic memory, motor, and visuospatial components (Weintraub, Baratz, & Mesulam, 1982). Among these various neuropsychological processes, the strongest and most reliable cognitive predictors in older adults are deficits in executive functions (e.g., complex attention, verbal fluency, and planning) and episodic memory (e.g., Koehler et al., 2011). Tasks completed via the internet also vary in complexity and processing demands. For some activities, success may depend on simple storage and maintenance of information, while in others, manipulation of information is necessary. Older adults may be particularly vulnerable to declines in internet-based tasks due to age-related changes of both the prefrontal cortex (e.g., Fortin, Godbout, & Braun, 2003), which support manipulation of information and the hippocampus (Haug & Eggers, 1991) that facilitates information storage.

Neurocognitive Correlates of Internet Use and Aging

There are several reasons to believe that executive functions and episodic memory play a critical role in internet-based everyday activities. Obtaining information successfully online requires one to discriminate, understand, and use information – in addition to basic computer skills. Simply operating a computer alone involves a combination of complex behaviors: motor function to operate the keyboard and move the mouse; language processing to comprehend, select, retrieve, and generate appropriate words; and executive function to plan, inhibit, focus, and shift attention in meaningful and efficient ways (Austin, Hollingshead, & Kaye, 2017). Using the internet, and more specifically navigating online information sources, places heavy demands on the processes that allow us to learn and adapt in novel situations, or “fluid abilities” (Garfein, Schaie, & Willis, 1988). For example, when browsing or navigating a website, one must keep track of and continually update where they are in the system (working memory) and create abstract maps or models of that system (spatial abilities) (Pak, Rogers, & Fisk, 2006). For older adults, declines in sensory ability, and cognition that support these fluid abilities, impact the usability of available online resources.

In a systematic review, Woods et al., (2019) identified 17 studies that have examined the relationship between neuropsychological functions and internet behaviors such as online shopping, banking, pharmacy, and search, among clinical and healthy populations (e.g., Agree et al., 2015, Dommes et al., 2011, Woods et al., 2016). The review provided considerable support for the internet performance-based tasks as modern measures of everyday functioning and revealed that studies evaluating the association between global cognition and internet task performance generally report large associations (e,g., Austin et al., 2017; Goverover et al., 2016; Woods et al., 2016; 2017). However, when considering specific domain-level relationships, there is clear variability in these associations. For example, among the studies investigating individual neurocognitive constructs, the largest and most reliable effects were observed on measures of episodic learning and memory and executive functioning (e.g., Czaja et al., 2010; Goverover et al., 2015, 2017). Consistent with these findings, previous work has suggested that internet search behavior is associated with activation in prefrontal and temporal regions (e.g., Dong & Potenza, 2015). In contrast, tests of language (e.g., verbal fluency and vocabulary), attention/working memory, psychomotor speed, and visuospatial abilities were not reliably or strongly related to internet task performance (e.g., Goverover 2015; Woods et al., 2017). This variability in significance and magnitude of effects across cognitive domains likely reflects differences in measurement and population studied.

Much of the research among aging populations specifically and online task performance, has focused on the effective search of information. Finding information on the web requires use of search engines, such as Google or Yahoo!, among others. Within the search engine, individuals must generate words to produce a query and then determine if the result fits their initial search objective. In this context, crystallized aspects of intelligence that tend to remain stable or even increase with aging, such as vocabulary (e.g., Horn & Cattell, 1967), may support successful internet investigation. However, if the result obtained in the initial search is not consistent with the goal, modifications such as adding or removing words or perhaps even adjusting the search objective may be necessary. This multi-step process may draw upon fluid, executive, abilities and present a challenge for older individuals experiencing difficulties in cognitive flexibility (e.g., Pak & Price, 2008) and learning new tools (e.g., Stronge et al., 2006). Indeed, several studies have shown that older adults experience more difficulties in searching for and finding information compared to younger adults. They often take longer time, find fewer correct answers, and implement less efficient search strategies compared to younger adults (e.g., Aula, 2005, Chevalier, Dommes, & Martins, 2013, Czaja, Sharit, Ownby, Roth, & Nair, 2001). Moreover, Chevalier and colleagues (2015) noted that these difficulties are exacerbated with increased search complexity and that older adults did not change search strategies when searching for answers to intricate versus simple questions online. Taken together, research indicates decreased performance among aging adults when searching for information on the web, which may be related to general cognitive decline (e.g., Dommes et al., 2011). Extant literature also suggests that the observed declines in fluid intelligence expected with age, are not always compensated by crystallized abilities as strengths in experienced skills. For example, strengths in vocabulary, do not appear to overcome the negative impacts of declines in planning and flexibility on internet search.

In summary, older adults are increasingly using the internet for ADLs and may be vulnerable to experiencing problems doing so due to cognitive aging and its effects on domains upon which internet navigation skills depend. Early studies of internet search paradigms among older adults indicate that poorer cognitive function may play an important role in web-based ADLs and studies in clinical samples further support that neurocognition does indeed play a role in online-based tasks; however, we do not yet know whether older adults do worse on internet-based ADLs than younger adults nor the potential role of cognition in that regard.

Planning and Navigation

Planning and navigation may play an important role in older adults' ability to use the internet for ADLs. Below I detail a conceptual framework for planning and navigation, review findings in the context of cognitive aging, and discuss the construct's relevance internet-based transportation tasks. The ability to plan refers to the organization of one's behavior in relation to a specific goal based on a series of intermediate steps (Owen, 1997). For example, planning a simple trip to pick up a prescription from a pharmacy involves several subtasks to be successful (e.g., ordering the prescription, allotting time for the prescription to be filled, arranging time in a schedule, driving to the pharmacy, bringing payment). From a theoretical perspective, planning can be further broken down into two stages: formulation and execution (Grafman, 1989; Shallice, 1982). During the formulation stage, an individual must design a plan, typically incorporating multiple steps, which should logically lead to resolution a given problem. The execution aspect of planning involves monitoring, adjusting, and guided action to a successful conclusion (Allain et al., 2005). A number of traditional standardized neuropsychological tests have been used to assess planning abilities (e.g., Rey Complex Figure; Meyers & Meyers, 1995; Six Elements Test; Shallice & Burgess, 1991, 20 Questions Test; Delis Kaplan, & Kramer, 2001, etc.). The Tower of London (TOL) task, for example, requires participants to plan a series of actions to move discs on a pegboard one by one from initial set-up to match a goal (shown on a picture) using as few moves as possible. The time between seeing the initial set-up and taking action toward the first move has been identified as the planning stage, while the execution phase is measured as the time average move time. To comprehensively evaluate planning abilities, both the formulation and execution stages must be operationalized and examined. Further, assessing the multiple components of planning in the context of common tasks encountered in day-to-day life allows for greater generalization to everyday planning ability (e.g., Sorel & Pennequin, 2007).

While studies on normal aging and cognitive functioning commonly describe early and more pronounced age-related changes in executive functions compared to other cognitive abilities (e.g., Andre`s & Van Der Linden, 2000; Libon et al., 1994), only a small number of studies have focused on planning performance in older adults, with partially conflicting results. For example, Brennan, Welsh, and Fisher (1997), using the Tower of Hanoi planning task found differences between young adults and elderly adults on the four-disk version. In contrast, Allain et al. (2002) reported similar planning capacities between young adults and elderly adults using the Tower of London planning task. Studies using ecological tasks in healthy elderly participants, though rare, appear to yield more consistent results. Using a real-life simulation of activities of daily living (a kitchenette meal-preparation task), Godbout, Doucet, and Fiola (2000) found that the elderly participants were impaired in the anticipation-planning dimension and on shifting of attention between ongoing tasks. In 2005, Allain et al., examined age effects on the Zoo Map Test, wherein, participants are given a map of a zoo and a set of instructions relating to places they have to visit (e.g., elephant house, lions cage) and rules they must stick to (e.g., starting at the entrance and finishing at a designated picnic area, using designated paths in the zoo just once). Results demonstrated that normal older adults manifest planning impairments. In particular, older adults appeared to demonstrate more problems in predetermining a complex course of action aimed at achieving some specific goal than in guiding the execution of complex sequences of actions to a successful conclusion (Allain et al., 2005). The Six Elements Test (SET; Shallice & Burgess, 1991), requires the individual to devise a simple plan, schedule the subtests efficiently, and to keep track of the time. An investigation of individuals with frontal lobe impairment who exhibited difficulties in their everyday living but showed no impairments on traditional measures of executive functions, performed poorly on the SET. Likewise, Allain and colleagues (2002) observed that older people performed poorly on a modified version of the SET, suggesting that advancing age may confer increased difficulty in planning, self-monitoring, organization, and decision-making that individuals may exhibit when attempting to carry out real-life tasks.

Selecting novel routes and map planning tasks also draw upon open-ended and abstract thinking skills via ecological paradigms. Consistent with online search paradigms and standardized assessments of executive function, selecting routes requires one to make decisions about how to achieve a specific goal (i.e., a destination) while satisfying various constraints (e.g., avoiding barriers, visiting intermediate locations). Early investigations of this ability focused on spatial decisions in large-scale environments. The Traveling Salesman's Problem (TSP; Christophides, 1976) tasked participants with arranging an order between various locations, displayed as letter configurations while minimizing travel distance. In the decades since, measures developed with the goal of understanding problems with everyday planning, such as the Multiple Errands Test (MET; Shallice and Burgess, 1991) and the Apartment Map Task (AMAP; Sanders & Schmitter Edgecombe, 2012) have emerged. The MET is a shopping task carried out in a pedestrian precinct. In the initial study, three patients who had suffered a Traumatic Brain Injury were instructed to achieve a number of simple tasks within arbitrary guidelines. Compared to healthy controls, the patients completed fewer tasks and broke more rules when matched for age and intellectual ability. This early study identified the MET as a potentially useful and unique assessment of high-level executive impairments among people whose general level of cognitive ability was "superior" and who passed existing tests of cognitive functioning. The AMAP, modeled after the MET, requires participants to construct and carry out a plan to complete several tasks throughout a campus apartment (e.g., locating and moving several objects, answering questions about items located at various key locations). To be achieved efficiently, goals must be interweaved. The AMAP task includes a designated formulation stage, during which participants are instructed to plan a route of task completion. Subsequently, participants carried out their formulated strategies during the execution phase. In comparison to younger adults, older adults are reported to be significantly less accurate and less efficient in plan formulation as well as plan execution, even after taking formulation performance into consideration (Sanders & Schmitter Edgecombe, 2012).

Route selection certainly involves aspects of planning as well as other cognitive abilities (e.g., visuospatial functioning). Furthermore, tasks with these requirements have been hypothesized to be particularly sensitive to frontal systems damage (e.g., Shallice & Burgess, 1991; Burgess, Alderman, Wilson, Evans, & Emslie, 1996). The preponderance of evidence examining learning and memory of routes does not support a general age-related decline but suggests that aspects of route memory are differentially susceptible to aging (e.g., Caplan & Lipman, 1995; Lipman & Caplan, 1992: Kirasic, 1991; Kirasic & Bernicki, 1990). Generally, it has been demonstrated that during route learning older adults, compared with younger adults, (a) are more likely to focus on discrete features of the surrounding environment, especially those that are emotionally or otherwise salient (Bruce & Herman, 1986; Lipman, 1991); (b) have difficulty selecting the most relevant course-maintaining environmental features (Kirasic et al., 1992); and (c) show deficits in organizing these features in a manner temporospatially consistent with the to-be-learned route (e.g., Lipman, 1991). Age differences favoring young adults have also been reported in learning to navigate through real (e.g., Barrash, 1994), or virtual (e.g., Moffat & Resnick, 2002; Moffat, Zonderman, & Resnick, 2001), environments. Wilkniss, Jones, Korol, Gold, & Manning (1997) reported that although older adults are able to encode visual information and recognize landmarks, they are less likely than younger adults to select or effectively use critical cues. This is consistent with evidence for an age-related deficit in the selection of information most useful in route maintenance (Kirasic et al., 1992; Lipman, 1991). In total, age-associated difficulties on tasks of route selection and strategy formulation suggest that navigation may present a particular challenge for older individuals while highlighting the formulation and execution stages critical to successful planning.

Route selection and navigation are a key feature in the independent maintenance of "transportation." Defined broadly on several questionnaires which assess activities of daily living (e.g., Lawton & Brody, 1969), "transportation" encompasses the ability to "get into, in and out of public or private transportation and may comprise the following range of actions (Sonn, Tornquist, & Svensson, 1999): 1) traveling independently 2) arranges own travel via taxi, but does not otherwise use public transportation; 3) travels on public transportation when assisted or accompanied; 4) travel limited to taxi or automobile with assistance; 5) does not travel at all. Web mapping services like Google have altered the methods by which we map routes and travel (Schmidt &Weiser, 2012). In the era of widespread internet availability, planning navigation tasks such as the MET and AMAP translate to the use of online transit sites and interactive map applications, such as “GoogleMaps.” The implementation and advance of these online map services have been impressive. In 2007, Google released Google Street View, which provides a panoramic street-level view of various locations; by 2011, indoor maps were added to Google Maps allowing users the ability to navigate within buildings; as of 2007, Google Local Guides now features videos and information regarding wheelchair accessibility (APKMirror, 2018). These tools combine the executive requirements of planning, such as formulation, execution, and monitoring with an online interface that inherently involves visuospatial and sensory skills affected by age. To date, little is known about the potential age-related differences of internet navigation planning using a live transit website or how cognition impacts the ability to successfully complete these tasks.

Aim One, Hypotheses One and Two

As older age confers increased vulnerability to cognitive functions related to successful navigation, the primary aim of the current study is to examine the effects of aging on internet navigation skills using a transportation planning paradigm. It was hypothesized that older adults would demonstrate poorer performance when navigating the live transit site, as evidenced by lower accuracy scores and longer completion times as compared to their younger counterparts. It is also hypothesized that internet navigation performance on the transportation paradigm would be associated with episodic memory, executive function, and prospective memory (PM).

Can Cognitive Supports Enhance Internet-Based Navigation Skills?

While the innovations in internet technology have been rapid, there has been little movement in the way of interventions aimed at improving the cognitive underpinnings necessary to engage with these systems. Over the past decade, there have been a number of commercial brain-training programs developed. Popular products such as *Lumosity* and Nintendo’s *Brain Age* have made “pop-psychology” brain games a billion-dollar industry (Fernandez, 2013). Certainly, individuals purchase and participate in these programs with the goal of improving performance on specific tasks that are important to them, for example, to be more efficient at work or to recall colleagues’ names. Yet, the claims of these commercial advertisements remain vague, highlighting improvements such as reaction time, attention, and memory with little evidence presented that the intervention may transfer to everyday tasks (Boot & Kramer, 2014). To date, the ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly) clinical trial is the largest investigation of the effectiveness of brain training to improve perceptual and cognitive abilities in older adults (Tennstedt & Unverzagt, 2013). The study included 2,802 adults randomly assigned to one of four conditions: memory training, reasoning training, speed-of-processing training, or no-contact control group. Immediately after training, results revealed large improvements that were specific to each type of training (for example, memory trained participants only improved on memory tasks); however, no improvements on measures of everyday functioning were observed (Tennstedt & Unverzagt, 2013).

The struggle to create rehabilitation to improve complex tasks we face in daily life is not surprising. Historically, the development of effective execution function interventions has proved challenging, in part due to the wide range of cognitive and behavioral skills subsumed under this label (e.g., Levine, Turner, Stuss, 2008). The term “executive” is often used synonymously with “frontal,” referring to functions supported by the frontal lobes. Indeed, the frontal lobes are critical to adaptive functioning, including complex information processing, decision making, and social interaction. Indeed, the heterogeneous nature of the cognitive changes often described as “executive dysfunction” or “frontal lobe syndromes” vary widely, making it difficult to isolate specific components of these cognitive abilities to inform effective interventions. Stuss & Alexander (2000) classify frontal functioning across four categories: behavioral/emotional self-regulation associated with ventral (medial) frontal cortex, energization regulating functions associated with the medial prefrontal cortex, metacognitive functions associated with the frontopolar cortex and executive/cognitive functions associated with the lateral prefrontal cortex. Given the heterogeneity of frontal lobe functions and the extensive interconnections among these regions, the functional designations proposed by Stuss and Alexander are advantageous in that each infers clinical symptoms as a potential target of rehabilitation. High-level, executive functions facilitated by the frontal lobes and are commonly dissociated between tasks consistent with left ventrolateral prefrontal regions such as planning and task-setting (e.g., Alexander et al., 2003) and the right lateral prefrontal area important for output monitoring and checking (e.g., Picton et al., 2006).

Despite the prevalence of strategic deficits commonly associated with frontal lobe disorders and aging, few studies have specifically aimed to improve problem-solving and planning abilities. Moreover, evidence in support of these interventions has demonstrated little generalizability. In a systematic review of this body of literature, Turner and Levine (2004; see also Cicerone et al., 2000) identified 40 studies on executive functioning interventions in patients with brain disease, 70% of which were case studies. Only 7% of studies included randomized control groups, 48% of the identified reports assessed generalization, with 17% examining real-life outcomes. One potentially promising study involved a rehabilitation probe experiment conducted by Hewitt et al. (2006) found that brief training (30 minutes) in the retrieval of autobiographical information (past events) aids in overall planning efficiency following Traumatic Brain Injury (TBI). Results indicated that the group of participants who were asked to recall previous memories of completing a daily activity performed better at a verbal planning measure of everyday tasks (Everyday Descriptions Task) compared to the group who was not instructed to remember a prior successful planning memory (Hewitt et al., 2006). However, this experiment utilized a small clinical sample, and there was no report of generalization to other measures (Hewitt et al., 2006). Although symptom-oriented, pragmatic interventions are often effective, interventions derived from theory, such as Goal Management Training (GMT), may be most likely to produce consistent effects (e.g., Green et al., 2004).

Goal Management Training. GMT is a staged program derived from theories of prefrontal cortex function, most prominently, Duncan's (1995) theory of goal neglect. GMT emphasizes an educational, interactive structure, wherein patients are trained to "stop and think" about problems and goals before and during task execution. Training involves learning to identify absent-minded slips, recognizing when these are likely to occur, and their potential consequences. During training, participants complete exercises, perform outside assignments and incorporate anecdotal examples to illustrate concepts. Participants practice checking their "mental blackboards" to ensure that their behavioral output (i.e., execution) is consistent with their intentions (i.e., plan). Each of the five GMT stages corresponds to an important aspect of goal-directed behavior. In Stage 1, orienting, participants are trained to assess the current state of affairs and direct their attention toward a relevant objective. Stage 2 involves designating an overall goal, which is partitioned into sub-goals in Stage 3. In Stage 4, goals and sub-goals are encoded and retained. Lastly, in Stage 5, the outcome of the action is compared with the goal state (monitoring). In the event of a mismatch, the entire process is repeated.

Levine and colleagues (2000) reported an experimental probe of GMT in patients with TBI. Following one session of GMT, patients showed significant improvements in paper and pencil tasks designed to simulate real-life tasks (e.g., proofreading). However, the intervention was designed to serve as a proof-of-principle rather than bona fide rehabilitation. In a supplementary case study, a postencephalitic patient showed improvement in her cooking ability following successful employments of an eight-session GMT (Levine et al., 2000). More recently, Levine et al. (2007) applied GMT within a large-scale cognitive rehabilitation trial in 49 healthy older adults. The training, although expanded in time from the original rehabilitation probe to 4 three-hour sessions, was modified to emphasize the first three of five stages described above. The overall goals were to train participants, when confronted with a task, to stop and think about the task demands, define the main task, split the complex tasks into subtasks, and monitor their performance. Accordingly, the 2007 investigation utilized a "Stop-State-Split" model. Outcome measures included desktop simulated real-life tasks (SRLTs). For example, participants were asked to organize and plan a carpool, where task dimensions included specific shift (i.e., morning or afternoon), a map, available seating, and acting as a passenger or driver. Task completion was videotaped and scored according to trained concepts. Results indicated improvements in SRLT performance as well as self-rated executive deficits coinciding with training. Though these gains were maintained at long-term follow-up (6 months), it was not possible to attribute the improvements to GMT specifically, as the GMT protocol was rooted within a larger rehabilitation program (Levine et al., 2007). Nevertheless, these results present evidence in support of GMT as a promising intervention to improve the planning and execution of everyday activities among a sample of older adults.

Aim Two, Hypotheses One and Two

Given the limited evaluations of interventions addressing executive functions among healthy older adults, a second aim of the proposed study was to determine the potential benefit of a brief GMT-based intervention to enhance INS-transport planning ability and performance. It was hypothesized that supporting the underlying executive mechanisms that facilitate planning and execution (e.g., maintaining an objective, identifying steps), would promote better planning performance and accuracy on an online navigation task. Specifically, main effects of intervention were expected, such that individuals in the intervention condition would perform better on a planning task and earn higher scores on the transportation task than those in the control condition. Main effects of age were also expected, such that older adults, in general, would demonstrate poorer planning and earn lower scores on the transportation task compared to younger adults. Lastly, we also expected to observe an intervention-age interaction, such that the difference in performance between older adults who receive the intervention and those who do not would be greater than the difference in performance between younger adults in the experimental versus control conditions.

Methods

Participants

In total, 52 younger adults and 45 older adults were recruited to participate in the current study. One younger adult was excluded due to a low MoCA score, and a second younger adult was excluded for current and severe substance use. Three older adults were excluded due to low MoCA scores, and two were excluded due to discontinued testing. Thus, participants for the current study included a total of 50 younger adults and 40 older adults. Participant demographic characteristics are shown in Table 1.

The sample of younger participants was recruited directly from the University of Houston and the general Houston area community. Undergraduate students recruited directly from the university via the SONA system were compensated 4.0 research credits. Younger adults enrolled from the community via word of mouth received a $20 gift card for participation. Inclusion criteria to participate in the study as a younger adult include being between the ages of 18 and 35, Native or bilingual proficiency in English language (materials that require English proficiency were used), and capacity to provide consent. No participants were excluded on the bases of gender, race, or ethnicity. Participants were excluded if reported history of a major neurological (e.g., head injury with loss of consciousness greater than 30 minutes, seizure disorders, multiple sclerosis, etc.) or psychiatric (e.g., bipolar disorder, psychosis) condition that may interfere with cognitive measures. Furthermore, younger adults were excluded if they scored 1.5 standard deviations below what is expected given their age and education on the Montreal Cognitive Assessment (MoCA; Smith, Gildeh, & Holmes, 2007; Rossetti, Lacritz, Cullum, & Weiner, 2011).

Older adult participants were recruited through outreach postings at local libraries and the general Houston community via word of mouth and online platforms (i.e., Craigslist, Facebook, Next Door). Older adults were at least 50 years of age and met the above criteria. Based on a 2013 study by Choi and DiNitto, among older adults who use the internet, nearly 75% report using the internet daily or every few days at least. Thus, frequency of internet use of at least 1.5 hours per week was required to participate in the current study (e.g., Choi & DiNitto, 2013). In addition to the general exclusion criteria listed above, older adults who scored 1.5 standard deviations below the normative expectancies for their respective age group and education on the MoCA were excluded (Rossetti, Lacritz, Cullum, & Weiner, 2011). Upon completion of study procedures, the older participants received a small gift card from their choice of two local grocery chains and an optional written summary of their cognitive performance.

Materials and Procedures

The data were collected in compliance with the Institutional Review Board (IRB) of the University of Houston regulations. All participants provided written, informed consent prior to completing various self-report, cognitive, and experimental tasks. The participants were tested individually in a single testing session. The assessment consisted of the experimental online transit task, a battery of standardized neuropsychological tests, and several questionnaires, which included measures assessing for relevant clinicodemographic factors. All tasks were administered by graduate students or trained undergraduate research assistants. Participants were tested individually in a quiet room on a university campus equipped with a desktop or laptop computer. A small subset of older adults (n=5) was tested off-site using university or personal laptops. For this subset, all measures and assessments remained the same ,with the exception that the AMAP Heyne task was not completed due to the off-site testing location. For all participants, regardless of test setting, internet broadband speed tests were performed pre- and post-test session to evaluate potential effects of internet connection on test performance.

Transportation Measure

Transit Navigation Task. Three thematically interrelated transit internet navigation tasks were used to assess Aim 1. Participants were seated at a desk with a computer monitor, keyboard, and mouse. Prior to beginning the task, all participants were provided a brief orientation of the site functions and options important for successful completion of the study measures (e.g., "You can use the trip planner here to get directions to and from specific locations."). Study participants were also given a "letter" from their doctor's office (Dr. Navigation), which included information about their appointment (e.g., The appointment is set for Monday morning at 9 am; see Appendix A). The transportation paradigm required participants to navigate the San Francisco Municipal Transit site to plan various routes and answer questions about their decisions in the context of a mock healthcare appointment. Specifically, participants were asked to imagine that they had been referred to the University of California San Francisco Medical Center to receive treatment for a recently diagnosed medical condition. In this mock scenario, participants were staying in the city at the Inn at The Opera hotel. They had several tasks to complete that required planning and navigating routes to designated locations using specific parameters (e.g., "select a route which is wheelchair accessible," "choose the closest location"). Following the site orientation, participants were asked to begin the first task. They were asked to independently navigate the site using the computer mouse to complete the following three tasks as part of Aim 1 (in a maximum of 20 min): (1) plan a specific transit route from the San Francisco Airport to your hotel at 1 pm tomorrow; (2) consider three different Muni (public transit) routes and stops and chose the best option to travel downtown on the weekend during specified hours and why; and (3) locate the CVS Pharmacy nearest your hotel to pick up a prescription before your medical appointment; The letter from the doctor's office detailing the tasks and appointment information was available throughout task completion. Participants were instructed to tell the examiner when they had completed the first task before moving on. Examiners monitored performance to ensure that no data were lost. As shown in Appendix B, the scoring criteria evaluated various aspects of the navigation process, including 1) task completion, 2) time to complete, and 3) accuracy of responses to examiner questions. Total accuracy scores on the first three transit tasks ranged from 0 to 15 (higher scores indicated better performance; Cronbach's $\alpha = 0.76$) and time to completion (in seconds; Cronbach's $\alpha = 0.66$) served as criterion variables for the hypotheses being tested in Aim 1.

Tasks 1 through 3 were used to examine Aim 1. Here, age group and any relevant covariates served as predictor variables and total accuracy scores on the first three transit tasks, ranging from 0 to 13 (higher scores indicate better performance) and time to completion (in seconds) served as criterion variables.

Intervention. Rooted in Goal Management Theory (GMT; Levine et al., 2000), this brief intervention protocol was specifically designed for the current study. Prior to beginning the navigation task, half (n =18) of the older cohort and half of the younger adults (n = 29) were randomly assigned to receive a brief guided intervention with the aim of facilitating planning and execution of a 4th transportation task detailed above (i.e., navigate a route from your hotel to your medical appointment, making sure to arrive 15 minutes early to complete any necessary paperwork.) After being presented with Task 4, participants in the ***intervention group*** were prompted to stop and think about the task demands, define the main objective, and split the task into steps (i.e., STOP-STATE-SPLIT) before they began navigating a route to their medical appointment. In the "STOP" phase, the examiner instructed participants to "take a moment to think about how they [you] would complete the task." Here, the goal was to allow the individual time to organize their thoughts and develop a mental plan. Immediately following, in the "STATE" phase, participants were asked to verbalize the main goal of the measure. Examiners were permitted to prompt participants two times only if the response does not reflect an accurate understanding of the task. In addition to the "letter" from the doctor's office (Dr. Navigation) provided to all study participants, adults in the intervention group received a “Helpful Tips to Navigate Your Appointment” flyer (Appendix C). In the “SPLIT” phase, participants were prompted to review the tips and reminded that the task might be achieved across multiple steps. Rather than freely initiating the task, participants were asked, “Where would you go first on the website?” Individuals in the intervention condition were again be directed to the “Helpful Tips” sheet, which described functions of specific tools on the transit site to facilitate successful route planning (e.g., “The trip planner provides directions to and from specific locations”). This phase aimed to provide structure and reduce the demands of an overall assignment to smaller, more manageable subtasks. After being directed to the “Helpful Tips” document, participants were instructed to continue navigating a route and to inform the examiner when they completed the task.

Following the Task 4 prompt in the ***control condition***, participants are provided with a pamphlet outlining Dr. Navigation’s practice, allowed time to review the office brochure, and ask questions pertaining to Dr. Navigation’s work before they began mapping a route to the appointment. After allowing 30 seconds for any questions, the examiner asked the participant to begin mapping a route to the medical appointment using only the information they had been presented (the letter from Dr. Navigation and the pamphlet). No other instruction or guidance was given. Table 2 depicts the procedural similarities and differences between the control and experimental conditions.

Time to completion (in seconds) and accuracy scores on Task 4 (range from 0-3 with higher scores indicating better performance) were evaluated to assess Aim 2. The separation of the tasks used to examine the individual aims prevented contamination from experimental material and allowed for an initial assessment of internet function before the intervention is implemented. Complete scoring criteria are shown in Appendix C. To investigate the intervention hypotheses (Aim 2), the intervention or control condition, age group, and relevant covariates served as predictors, and total planning scores and the overall accuracy on task number four of the transit planning paradigm were examined as the criterion variables across the total sample.

Sample Characterization

Demographic History. Participants completed a 15-item self-report questionnaire which included questions pertaining to demographic background (e.g., age, gender) and brief health history, including “yes” or “no” inquiries of past serious medical conditions (e.g., In your lifetime have you ever had an opened or closed head injury?). Participants also completed the Self-Administered Comorbidity Questionnaire (Sangha, Stuck, Liang, Fossi, and Katz, 2003). The measure allows participants to note the presence of several common medical conditions, whether or not the condition is treated, and their perception of its impact on function. Responses were used to characterize the study sample and were evaluated as possible covariates for statistical analyses. Among the study sample, total conditions reported ranged from 0-6, total conditions treated ranged from 0-5, and 39% of participants who noted medical conditions reported that the condition impacted their functioning.

Employment. Participants indicated whether they were unemployed, working part-time, or working full-time at the time of assessment. Participants who reported current gainful employment also provided their current occupation. To assess the possible influence of occupation-related knowledge on search performance outcomes, two independent raters coded each occupation as “technology,” “health,” or “other” field. The designation of technology or health field was based on the estimation that the requirements (i.e., education, training) for the reported position likely involved specific exposure or knowledge beyond what is learned without specialized training. Two raters coded the occupations of the final sample independently with an initial Kappa Agreement of .84 (95% CI = 74-93). For cases in which raters differed, items were discussed, and a category agreement was reached. Examples of occupations that were coded in "technology" included media coordinator and sales associate, process development, and application development, whereas examples of occupations that were coded in "health" included cardiac catheterization secretary, emergency medical technician, and medical scribe.

The Wide Range Achievement Test Version-4 (WRAT-4). The Reading subtest of the WRAT-4 (Wilkinson & Robertson, 2006) is a widely used single-word reading task. In the current study, the WRAT-4 was used to generate an estimated reading grade level for each participant. The total score reflects the total number of words that were correctly pronounced, which is then converted to a grade level equivalent. Grade equivalent ranged from 6.1 to 12.9 among the study sample.

Montreal Cognitive Assessment (MoCA). The MoCA (Nasreddine et al., 2005) is a widely used, 30-point screening measure to detect cognitive impairment. The test assesses domains of attention, executive function, memory, language, visuospatial ability, and orientation. Administration is completed in approximately 10 ten minutes. Scores range from 0 to 30, with higher scores indicating better performance. Total scores within the study sample ranged from 21-30. Normative data outlined in Rossetti et al., 2011 (grouped by age and education) were used to characterize the sample.

Internet Use Questionnaire. General internet use was measured using an approach outlined and supported by Baggio Iglesias, Berchtold, & Suris (2017). Participants were asked three questions related to how often they use the internet in the previous 30 days, how much time is spent on the internet on an average weekday, and how much time is spent on the internet on an average weekend day. Weekly use was assessed for inclusion criteria, as described above. From these responses, a single score that accounted for quantity and frequency was calculated, which ranged from 0 to 63, with higher scores indicating more frequent use (Cronbach's $\alpha = 0.71$). Total scores were used descriptively and evaluated as a possible covariate for statistical analyses. Internet use characteristics are displayed in Table 3.

Internet Anxiety Questionnaire. Internet anxiety was measured using an internet anxiety questionnaire (Joiner, Brosan, Duffield, Gavin, & Maras, 2007). This brief questionnaire comprised of 6 questions about anxiety related to internet use (e.g., "I always feel anxious when using the internet" and "my anxiety about using the internet bothers me.") that are rated on a five-point Likert scale from 0 (strongly disagree) to 4 (strongly agree). One item ("It is easy for me to use the internet") is reverse coded to ensure that higher scores indicated higher internet-related distress. Among the study sample, total scores ranged from 2-18 (Cronbach's $\alpha = 0.71$).

Diagnostic and Statistical Manual of Mental Disorders Level 1 Cross-Cutting Measure (DSM-5 CCM). Participants were also administered the Diagnostic and Statistical Manual of Mental Disorders (5th Ed.; American Psychiatric Association, 2013) Level-1 Cross-Cutting Symptom measure, which was used to provide a measure of current mood symptoms. The adult version of the measure consists of 23 questions that assess 13 psychiatric domains, including depression, anger, irritability, mania, anxiety, somatic symptoms, inattention, suicidal ideation/attempt, psychosis, sleep disturbance, repetitive thoughts and behaviors, and substance use. Each item is rated on a 5-point scale ranging from 0 (none or not at all) to 4 (severe or nearly every day). The items assessing for suicidal ideation was removed from the standard protocol, resulting in a modified scale with possible scores ranging from 0 – 88. Among the study sample, total scores ranged from 0-43, with a Cronbach's alpha of 0.84.

Barret Impulsivity Scale (BIS-11). The Barret Impulsivity Scale (BIS-11; Patton, Stanford, and Barratt, 1995) is a 30-item self-report instrument designed to assess the personality or behavioral construct of impulsiveness, with higher total scores indicating greater impulsivity. Factor structure from the Patton et al., (1995) manuscript revealed three second order and six oblique first-order factors. Identified second-order factors include Attentional, Motor, and Non-planning elements. Total scores on the BIS-11 were evaluated as a possible covariate in overall analyses and considered individually as they relate to transit task 4. Total scores within the current sample ranged from 44-88 (Cronbach's $\alpha = 0.70$).

Episodic Memory Composite

All participants were administered laboratory-based measures of episodic memory. Raw scores (described in detail below) on the total for trials 1-4 and long delay free recall from the Short Form of the California Verbal Learning Test- Third Edition (CVLT-3; Delis, D. C., Kramer, J. H., & Ober, B. A., 2017) were converted into sample-based z-scores to represent immediate memory and delayed memory respectively. These two, sample-based z-scores, were averaged to create an episodic memory composite for use in the analysis of Aim 1 hypothesis 2, thus reducing the likelihood of type 1 error.

California Verbal Learning Test- Third Edition Short Form (CVLT-3). The CVLT-3 is a recent revision of the CVLT-II; however, all the target words from List A and List B remain the same. The test includes two lists, each of which consists of 16 words drawn evenly from four semantic categories. The individual was presented with the target list (List A) over four learning trials, immediately followed by one presentation of the interference list (List B). Immediately after the presentation of List B, short-delay free-and cued-recall trials for List A are administered. After a 20-minute delay, during which nonverbal tasks are administered, long delay free and cued recall of List A is assessed. Trials 1-4 Total Immediate Recall and total score on Long Delay Free Recall were used in the calculation of the memory composite.

Embedded Prospective Memory (PM) Measure (Beaver & Schmitter-Edgecomb, 2017). At the beginning of testing, all participants were informed that the examiner would like to see how well they are able to remember to do something in the future without being reminded. The participants were told that they need to remind the experimenter to record the clock time on several occasions within the hour. Participants were informed that after they complete an activity, the examiner would ask them to rate how much mental effort they felt the activity required on a scale from 0% (little mental effort) to 100% (significant mental effort). It was explained to participants that completing the mental effort rating would serve as their cue to tell the experimenter to record the current clock time. The testing paradigm did not begin until the participant has stated that they understand the instructions for the task. Once the task began, there was no additional reference to the PM measure, but the mental effort rating scale remained within view of the participant. This paradigm was completed three times within the session. Participants were noted to "pass" the PM trials if they correctly followed the prompt at the correct time for at least one of the three administrations throughout the testing session; all others were labeled as PM "fail."

Executive Function Composite

All participants were administered 20 Questions and Trail Making Subtests (Condition 4) of the Delis Kaplan Executive Functions System (DKEFS; Delis Kaplan, & Kramer, 2001) as well as the action fluency test (Piatt, Fields, Paolo, & Tröster, 1999), and the AMAP: Heyne

Adaptation (modeled after Sanders & Schmitter-Edgecombe, 2012) in order to comprehensively measure the domain of executive functions. Each of the raw scores from the main variables on each test, described in further detail below, was converted to a sample-based z-score. An executive function composite score was calculated from the average of the four sample-based z-scores. The creation of a single composite score allowed for comprehensive measure of executive functions for use in the analysis of Aim 1 hypothesis 2 while reducing the risk of type I error.

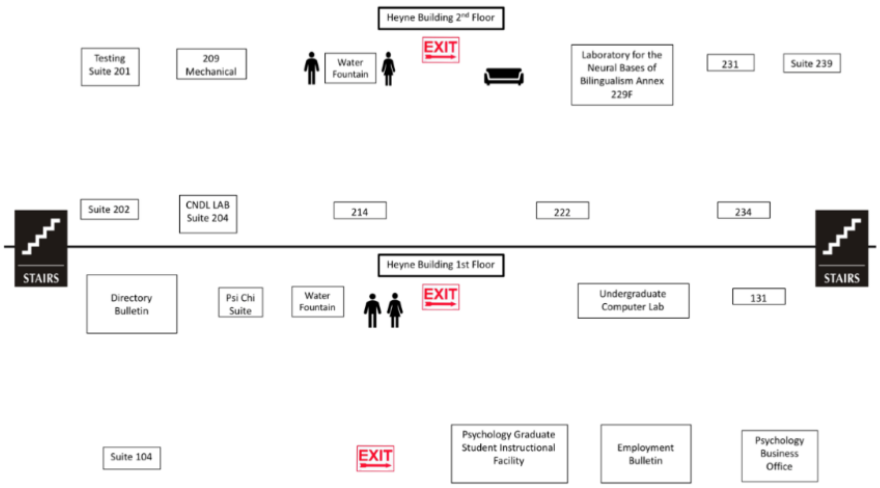
Delis- Kaplan Executive Function System (DKEFS) 20 Questions Test (Delis, Kaplan, & Kramer, 2001). This test measures the key executive functions of categorical processing, abstract thinking, and the utilization of feedback for effective strategy use in problem-solving. The materials consist of a stimulus page depicting colored pictures of 30 common objects (e.g., car, apple, tree, knife, elephant, and stove). The objective is to ask the fewest number of yes/no questions to identify an unknown target object selected by the examiner from the group of 30 objects. This procedure is repeated over four consecutive trials, each with a different unknown target object. The total questions asked score is a global achievement measure of performance. However, a problem that can occur if an examinee by chance guesses the correct object after asking only one or two highly concrete questions. For this reason, the total weighted achievement score provides a second measure of global achievement that takes into account when more or fewer questions than the optimal range are asked (e.g., less than four questions or more than ten questions). The total weighted achievement raw score is the sum of weighted achievement scores for all four items and can range from zero (the correct object was never identified across all four items) to 20 (correct objects were identified after four or five questions for each of the four items) and was included in the executive function composite.

Delis-Kaplan Executive Function System (DKEFS); Trail Making Test (TMT). This subtest of the DKEFS contains five conditions that are designed to measure multiple aspects of motor functioning and flexibility of thinking on a speeded visuomotor task. The first condition of the TMT, a measure of visual scanning, requires participants to mark all threes among a display of numbers on a page. The second condition of the TMT, a measure of processing speed, requires participants to connect a series of numbers on a page as quickly as they can. The third condition of the TMT, another measure of processing speed, requires participants to connect a series of letters on a page as quickly as they can. The fourth condition, a measure of set-shifting, requires participants to connect a series of numbers and letters on a page, switching between a number and a letter in numerical and alphabetical order (e.g., 1-A-2-B-3-C). The fifth condition, a test of simple motor speed, requires participants to trace over a dotted line on a page as quickly as they can, making sure they touch each circle along the route. The total time to complete the task is the primary measure generated from each condition. Total Time to complete Condition 4 was used in the executive composite.

Action fluency. The action (verbal) fluency test (Piatt, Fields, Paolo, & Tröster, 1999) requires participants to generate as many action words (i.e., verbs) as possible in 60 seconds. The total number of unique words generated in 60 seconds was included in the executive composite. The action fluency task has shown adequate test-retest reliability and construct validity (Woods et al., 2005).

AMAP: Heyne Adaptation. Modeled after the AMAP task (Sanders & Schmitter Edgecombe, 2012), in the Heyne Adaptation task, participants were given a map layout of the Heyne Building on the University of Houston campus with a list of 8 activities to be completed and seven locations to be visited (Figure 1).

Participants were instructed to plan a route through the building that would allow them to complete the requested tasks and visit each location in the most efficient manner. Specifically, they were asked to "plan a route that requires you to stop at each designated location the least amount of times. While the tasks may require that you stop in a location more than once, we would like you to create a plan that makes the most efficient use of your time." The examiner noted the location of the start point (testing suite) and allowed participants ten minutes to develop a planned route using the map layout. Participants were provided with pen/paper and instructed to write out their plan to accomplish the tasks. All participants notified the examiner once they have formulated a plan (within the allotted five minutes) and stated their plan aloud for the examiner to transcribe. Following the planning stage, participants were given ten minutes to accomplish the tasks. Participants were escorted by an examiner (they were instructed not to engage in conversation with the examiner during this time to avoid distraction) and allowed to carry their written plans and maps with them during task execution.



Task List

-Pick up a watering container from CNDL Suite 204

-Use the upstairs water fountain closest to the restrooms to fill the watering container about a quarter of the way

-On the first floor, "Employment" bulletin board located near the Psychology Department Business Office Room 126, take one of the "Experiment A" posts

-Water the plant in Suite 204 and leave the watering container next to the plant

-Return to the testing room once you've completed all other tasks

-Enter the Psychology Department Business Office Room 126 and take one of the "Experiment B" posts from the counter.

-On the second floor, place the "Experiment A" sheet in the envelop located on the door of Suite 239D, which reads "Professor Woods"

-Return the "Experiment B" slip to the examiner upon your return to the testing room

-On the first floor "Directory Bulletin located near the Psi Chi office, find and make note of the 5-digit extension for Dr. Steven Woods [**Clinical Neuropsychology (Concentration of Clinical)**].

Figure 1. AMAP: Heyne Adaptation

Route execution was noted by the examiner for qualitative evaluation. Accuracy of AMAP completion was assessed by locations visited (i.e., all locations once with the exception of the CNDL suite), successfully completed tasks, and time. Total accuracy scores ranged from 0-10 with higher scores indicative of better performance and were used as a naturalistic measure of executive function to examine hypothesis two of aim 1. The scoring criterion is displayed in Appendix D.

Statistical Analyses

Primary Analyses and Hypotheses

Outliers were transformed such that scores that were beyond the 95^{th} percentile were replaced with scores at the 95^{th} percentile. Little's MCAR test (SPSS) was used to determine if missing data were missing completely at random, and an expectation-maximization method was used to impute missing data for outcome variables. The data imputation was conducted in SPSS. Minimal missing data was imputed for the following variables: BIS-11, Internet Anxiety Questionnaire, individual items on the transit task, transit time completion, and AMAP time to completion. Results reported below did not differ when analyses were performed without imputed data. All descriptive variables were assessed as possible covariates (e.g., education, ethnicity, gender, estimated verbal IQ, current symptoms of depression and anxiety, BIS-11 total scores, computer use anxiety). Descriptive characteristics were included as covariates in the models if they are significantly associated with transit task accuracy and differ between groups at a critical alpha level of 0.10. All primary analyses were conducted in JMP Pro version 13.0, and the critical alpha level for hypothesis testing was set at 0.05. The G*Power 3.1 statistical package (Buchner, Faul, & Erdfelder, 1997; Erdfelder, Faul, & Buchner, 1996) was used to calculate the statistical power of each analysis. Specifically, F-test post hoc calculations were generated considering sample size, associated df, and a critical alpha level of .05 to determine the power to detect omnibus group differences.

Aim 1 Hypothesis 1: Older adults would demonstrate poorer performance when navigating the live transit site, as evidenced by lower accuracy scores and longer completion times as compared to their younger counterparts.

The primary aim concerning possible age differences on a transportation paradigm was investigated via multiple linear regressions among the total sample (N = 90). Total accuracy and completion time on the combined first three transit navigation tasks were investigated separately as criterion variables. The predictor variables included the two-level age group (older and younger adults) and the dichotomous after PING rate (high/low). The sample (N = 90) provided power (1- β = .) to detect medium effect sizes for an ANOVA at an alpha level of .05.

Aim 1 Hypothesis 2*: *Internet navigation performance on the transportation paradigm would be associated with executive function, episodic memory, and prospective memory.

This potential relationship was examined among the total study sample (N = 90) whereby the executive function and episodic memory composites, and PM performance were included as potential predictors of total accuracy and speed of completion on the combined first three navigation transit tasks. Results of G*Power analyses indicated adequate power (1- β = .88) to detect medium effect sizes in a linear regression with three predictors at an alpha level of .05.

Aim 2 Hypothesis 1: It was hypothesized that total scores on planning for task 4 would be influenced by age and experimental condition. Specifically, we anticipated main effects of age such that older adults would demonstrate poorer performance on planning compared to younger participants. Main effects of intervention were also expected, such that individuals in the intervention condition would earn higher scores on the planning total than those in the control condition. Lastly, we expected to observe an intervention-age interaction, such that the difference in total planning scores between older adults who receive the intervention and those who do not would be greater than the difference in performance between younger adults in the experimental versus control conditions.

Planning performance was examined via multiple linear regression among the total study sample (N = 90). Multiple linear regression was performed whereby two-level between-subject factors, one randomized (intervention condition) and one naturalistic (age group), and their interaction term (age by intervention condition) were entered as predictors of the planning total for task number four.

Aim 2 Hypothesis 2: It was also hypothesized that by supporting the underlying executive mechanisms that facilitate planning and execution via the proposed experimental intervention (e.g., maintaining an objective, identifying steps), will promote better performance on an online navigation task. Specifically, we anticipated main effects of intervention, such that individuals in the intervention condition would perform better on the transportation task than those in the control condition. Main effects of age were also expected, such that older adults, in general, would earn lower scores on the transportation task compared to younger adults. Further, we expected to observe an intervention-age interaction, such that the difference in performance between older adults who receive the intervention and those who do not would be greater than the difference in performance between younger adults in the experimental versus control conditions.

To investigate this secondary aim, a multiple linear regression was performed whereby two-level between-subject factors, one randomized (intervention condition) and one naturalistic (age group), and their interaction term (age by intervention condition) were entered as predictors, and the overall accuracy on task number four of the transit planning paradigm was examined as the criterion across the total sample. Results of G*Power analyses provided reasonable power ($1-\beta = .82$) to detect of small-to-medium effects in an ANCOVA with four groups at an alpha level of .05 and 0 covariates.

Results

Aim 1 Hypothesis 1 Total Scores. The overall model examining the effect of age group on total scores for transit tasks 1-3 was significant (Adj R^2 = 0.23, $p < .0001$). Within this model, age group emerged as the only significant contributor: older adults (β = -3.33, $p < .0001$, 95% CI [-4.72,-1.95) scored significantly lower on the first three transit tasks compared to their younger counterparts (univariate Cohen's d = 1.09). The speed of internet connection (after PING) was not a significant predictor of transit task 1-3 performance (β = -0.18, $p = 0.107$, 95% CI [-0.40, 0.04]). Results are shown in Figure 2a.

Aim 1 Hypothesis 1 Time to Completion. Similarly, the overall model examining the effect of age group on total scores for time to complete transit tasks 1-3 was significant (Adj R^2 = 0.21, $p <$ .0001). Within this model, age group again emerged as the only significant contributor where older adults (β = 139.57, $p < .0001$, 95% CI [84.72,194.41]) took a significantly longer time to complete the first three transit tasks compared to the younger cohort (univariate Cohen's d = 1.00). The speed of internet connection (after PING) was not a significant predictor of transit task 1-3 performance (β = -3.50, $p = 0.423$, 95% CI [-12.12, 5.13]). Results are shown in Figure 2b.

Aim 1 Hypothesis 2 Total Scores. The overall model examining the potential relationship of episodic memory, prospective memory, and executive functioning on transit tasks 1-3 total score was significant (Adj R^2 = 0.20, $p < .0001$). Within this model, the episodic memory composite emerged as the only significant contributor: higher scores on the episodic memory composite (β = 1.56, $p = .0005$, 95% CI [0.70, 2.42]) predicted better performance on the first three transit tasks (univariate r = 0.341). PM performance (univariate Cohen's d = 0.222) and the executive functioning (univariate r = 0.168) composite were not significant contributors to this model (ps >. 05). Table 4 depicts the correlation matrix detailing relationships between transit tasks 1-3 and cognitive composites. Table 5 details outcomes of the above-described regression analyses.

Aim 1 Hypothesis 2 Time to Completion. The overall model examining the potential relationship of episodic memory, prospective memory, and executive functioning on the completion time of transit tasks 1-3 was significant (Adj R^2 = 0.10, p = .006). Within this model, the episodic memory composite emerged as the only significant contributor: higher scores on the episodic memory composite (β = -38.06, p = .032, 95% CI [-72.73, -3.40]) yielded faster completion times on the first three transit tasks (univariate r = 0.217). There were no significant effects of the executive functioning (univariate r = 0.143) composite or PM performance (univariate Cohen's d = 0.148) on completion time for these tasks (ps>.05). Table 4 depicts the correlation matrix detailing relationships between transit tasks 1-3 and cognitive composites. Table 5 details outcomes of the above-described regression analyses.

Aim 2 Hypothesis 1. Linear regression with planning performance as the criterion variable and age group, intervention group, and the age by intervention condition interaction term as predictor variables was performed to evaluate the first hypothesis of Aim 2. Table 6 details transit Task 4 planning and total performance across intervention and age cohorts. The overall model was significant (Adj R^2 = 0.15, p = .0007). Within this model, age group (β = -1.65, p = .001, 95% CI [-2.64, -0.66]), intervention condition (β = -1.82, p = .0003, 95% CI [-2.76, -0.87]), and the age by intervention interaction term (β = 2.16, p = .003, 95% CI [0.75, 3.58]) emerged significant predictors of planning performance on transit task 4. Specifically, older age was associated with lower planning scores (Cohen's d = 0.341). Individuals in the intervention condition earned higher planning scores than those in the control group (Cohen's d = 0.441). The age group by intervention condition interaction was also significant within this model, such that the intervention condition was more beneficial in the younger group (p = 0.0003, Cohen's d = 1.09) than in the older group (p = 0.511; Cohen's d = 0.209). Results are shown in Figures 3a and 3b.

Aim 2 Hypothesis 2. Linear regression with accuracy on task 4 as the criterion variable and age group, intervention group, and the age by intervention condition interaction term as predictor variables was performed to evaluate the second hypothesis of Aim 2. The overall model was significant (Adj R^2 = 0.10, p = .009). Within this model, none of the predictor variables entered emerged as significant contributors to accuracy on transit task 4 (ps > .05). Results are shown in Figure 4.

Discussion

Over the past 15 years, innovations in internet technology have drastically changed how people navigate their day-to-day world. The internet has become a significant home management tool and is increasingly becoming indispensable to daily activities. Still, there are considerable risks involved when using the internet. For example, as the use of ride-hailing applications such as Uber and Lyft increase, misidentification of drivers, erroneous selection of destinations, and mismanagement of charges for transportation services may present challenges to online users. Accordingly, internet navigation difficulties can represent a serious barrier to optimal daily functioning, particularly to older adults, who may have difficulty using this quickly advancing technology. The current study aimed to examine the effects of older age on internet navigation skills using an online transit planning paradigm. Findings indicate that older age was associated with significantly lower accuracy and longer time to complete the online transit paradigm. Within the total sample of younger and older adults, an episodic memory composite was significantly associated with internet transit paradigm performance. Lastly, I investigated the efficacy of a brief GMT-based intervention to enhance performance on the transit planning task. While findings showed poorer initial planning performance among older adults and higher planning scores for individuals within the intervention group, these factors interacted such that younger adults benefited more from the GMT- based support than the older participants in this sample. The conceptual and practical aspects of these findings are outlined in detail below.

Consistent with study hypotheses, older adults earned significantly lower scores on the initial three internet-based transit tasks. These tasks required participants to use the information provided in initial orientation to search GoogleMaps for routes and destinations and answer questions about their choices response to prompts under broad time constraints. Notably, results indicating lower accuracy among older adults were accompanied by very large effect sizes and were not better explained by other factors (e.g., internet speed at the time of testing). Selecting routes is an interesting cognitive task because it necessitates decisions about how to achieve a specific goal (i.e., reach a destination) while satisfying various constraints (e.g., such as avoiding barriers, visiting intermediate locations). Indeed, a number of studies have investigated age differences in learning or memory of routes and have found that older adults tend to perform at lower levels than young adults on many measures (e.g., Caplan & Lipman, 1995; Lipman & Caplan, 1992). Results of the current study are consistent with reported age differences favoring young adults in learning to navigate through real (e.g., Barrash, 1994; Wilkniss, Jones, Korol, Gold, & Manning, 1997), or virtual (e.g., Moffat & Resnick, 2002; Moffat, Zonderman, &

Resnick, 2001), environments. Exploratory and qualitative post hoc examination of data also reveals that total accuracy scores of older adult participants largely reflected partial or inadequate task completion, rather than erroneous responses alone on the initial three transit tasks. At seven points throughout the initial transit tasks, examiners indicated whether or not a participant was able to “complete the task” (scoring criteria shown in Appendix B). A participant was noted to complete the task if they provided a response, even if the response was incorrect. A participant was reported to not complete a task if they were not able to give a response with the allotted time requirement, did not provide an answer at all, or gave up on the task without providing a response. Across 6 of the seven complete/incomplete markers, younger adults were, on average, 14.3 times (odds ratios of observed values ranged from 5.1-29.3), more likely to complete the tasks than older adults in this sample. This finding is consistent with recent research that has shown omission errors are associated with cognitive correlates of episodic memory in individuals with MCI (Schmitter-Edgecombe & Parsey, 2014), and with smaller volume in the hippocampus (Bailey, Kurby, Giovannetti, & Zacks, 2013; Giovannetti, Bettcher, Brennan, Libon, Kessler, et al., 2008). Extending this work, this is the first study to investigate the impacts of age on navigation using a live online transit platform and naturalistic, health-related end-goals.

Older participants were also slower to complete the first three online transit assignments compared to their younger counterparts. Again, results revealed very large effect sizes and were independent of internet speed at the time of testing. Certainly, cognitive literature supports an association between older age and general slowed processing speed. Beyond simple motor speed, the transit tasks 1-3 may be considered fairly complex psychomotor speed task, given the integration motor (e.g., peripheral computer devices) and cognitive (e.g., organizing information, searching the site options) speed elements. Cognitive slowing is partially attributable to multiple age-associated structural and morphological changes to the white and gray matter of the frontal-subcortical loops and the cerebellum, as well as the oxidative stress and inflammation associated with small vessel disease (for a review, see Eckert, 2011). Further, age-related changes in processing speed are strong predictors of poorer everyday functioning in older age (Wahl et al., 2010). There might also be psychological explanations for this finding; for example, older adults might be more careful and cautious in their approach to solving novel problems, weighing accuracy over speed.

Current study findings are commensurate with several general studies of online behavior which report older adults often take more time, find fewer correct answers, and implement less efficient search strategies compared to younger adults when looking for information online (e.g., Aula, 2005, Chevalier, Dommes, & Martins, 2013, Czaja, Sharit, Ownby, Roth, & Nair, 2001). In the current study, the use of a live online transit site to select routes required participants to make decisions about how to achieve a specific goal (e.g., select a route, locate a destination) while operating within the guidelines of a novel platform. Though the first three transit tasks impose slightly more structure than the experimental 4th transit assignment, they are nevertheless considered complex and multifactorial in nature. As such, the transit task placed heavy demands on the processes that allow us to learn and adapt in novel situations, or “fluid abilities” that are subject to decline with age (Garfein, Schaie, & Willis, 1988). Advancing age is associated with the general slowing of cognitive processes, learning inefficiency, poor attentional control, and difficulty in goal maintenance (Charness & Boot, 2009). Thus, it is possible that all or any of these factors may have contributed to poorer accuracy and speed on the initial transit navigation tasks. Neuroanatomical evidence suggests that the ability to successfully, plan, organize, and execute cognitive output with age is associated with shrinkage of the prefrontal cortex (e.g., Raz, Gunning-Dixon, Head, Dupuis & Acker, 1998) and loss of axonal integrity in prefrontal white matter (Valenzuela et al., 2000). Taken together, results revealed that older adult performance was not only slower but less accurate on the live transit task. Findings add to the growing body of literature suggesting that internet functioning is adversely impacted by age and identify online transportation as another aspect of daily functioning to be considered as a point of intervention for older adults.

Studies investigating individual neurocognitive constructs related to internet performance-based tasks report reliable effects of episodic learning and memory and executive functioning (e.g., Czaja et al., 2010; Goverover et al., 2015, 2017; Kordovski et al., in press). Within the current study, executive functioning and episodic memory composites and a PM task were assessed as contributors to performance on the first three transit tasks. Findings show that the episodic memory composite, which assessed one's ability to learn and retain newly presented verbal information, was associated with better speed and accuracy on transit tasks one through three and evidenced medium-sized effects. Certainly, the 'mental tags' in episodic memory-related to information about where, when, and how the information was learned (Reber, 1995), could be helpful in performing structured tasks on a newly introduced online website. Foundational research has shown that although episodic memory involves widespread brain regions (e.g., McClelland, McNaughton, & O'Reilly, 1995), the medial temporal lobes and their connections to the prefrontal cortex, in particular, are vital (e.g., Scoville & Milner, 1957). Of relevance to the current findings, there is also evidence that the role of the hippocampus extends beyond memory into other behaviors, including, during spatial navigation (e.g., Watrous, Fried, & Ekstrom, 2011). Indeed, Sanders and colleagues also reported greater memory performance was associated with higher AMAP task scores (2014). It is important to note that these full group analyses do not provide information regarding the specific mechanisms of episodic memory that support transit task completion. As learning and memory, themselves are complex processes, future studies may examine these questions through a more fine-grained lens to understand how processes of initial learning, learning slopes, retention, recognition, source, etc., may contribute to online navigation tasks. Nevertheless, results suggest that successful use of a novel transit site may have been influenced by one's ability to learn, retain, and use the information presented during the orientation to the site and are consistent with prior work suggesting the role of hippocampal function related to recall and spatial navigation.

The current study revealed a null relationship between the initial transit tasks and prospective memory (PM). In short, PM describes one's ability to carry out a planned action at a designated point in the future (McDaniel & Einstein, 2000), or "remembering to remember." Not unlike executive functioning, PM describes a complex network of neurocognitive skills, which vary from automatic processes that rely on medial temporal lobe systems to highly strategic processes that rely on prefrontal systems (McDaniel & Einstein, 2000). The PM task within the current study was a brief embedded event-based measure, which was scored generally for accuracy (pass/fail). Indeed, previous investigations of PM have shown strong relationships between strategically demanding time-based PM tasks and activities of daily living such as medication management (e.g., Park & Kidder, 1996) by way of measuring the components of PM (e.g., time- vs. event-based cues, Woods et al., 2009). It is possible that the methodology employed to measure PM in the current study did not thoroughly capture specific PM abilities, which may impact daily functioning. In the naturalistic measure of PM adapted from Beaver and Schmitter-Edgecombe (2017), participants are asked to remind the examiner to record the clock time (i.e., the PM intention) whenever the examiner asked a question related to the amount of mental effort a preceding task required (i.e., the PM cue). While PM has been associated with everyday functioning (Beaver & Schmitter-Edgecomb, 2017) and health-related internet search tasks in young adults (Kordovski et al., in press) using this methodology, it was not related to performance on the transit task in the current study and evidenced small effect sizes for completion time and accuracy. As noted above, the pass/fail assessment of PM performance, which was driven by the observed data distributions may have also reduced my power to detect an effect. It may also be the case that completion of transit tasks 1-3 do not significantly depend upon PM ability. The tasks involve the participant being asked to complete an errand or assignment immediately following the examiner's request. Though it is true that information will need to be retrieved to complete tasks successfully across potentially several steps, there is little need to *hold* an intention over time while the individual is actively involved in the task, perhaps reducing the likelihood of losing information to distraction. Still, as PM is a complex, multidimensional cognitive faculty that relies on strategic cognitive aspects of retrospective memory, including intention encoding and retrieval (e.g., Einstein, Smith, McDaniel, & Shaw, 1997), future exploration of how PM relates to online navigation may be beneficial.

As expected, executive functioning demonstrated small-to-medium-sized, positive relationships with time, and accuracy on the initial transit tasks at the univariable level (see Table 4). However, contrary to study expectations, the executive functioning composite was not a significant predictor of accuracy or time to complete online transit tasks within the regression model and was accompanied by small-sized effects. This suggests that the influence of executive functioning is not as contributory to transit task performance when other variables such as learning, and memory are considered. As noted above, when considering the novelty of the task, which necessitates taking in and applying newly presented information in retrospect, the significant influence of episodic memory, beyond that of executive functioning appears reasonable. Still, this null finding was somewhat surprising, as even simple tasks of daily living (e.g., setting a kitchen table) can rely on various executive components (Weintraub, Baratz, & Mesulam, 1982). Just as tasks completed via the internet vary in complexity and processing demands, the umbrella term of executive functioning as a cognitive construct is also multifaceted. The executive functioning composite was comprised of measures that assess abstract reasoning, mental set-shifting with a visuospatial and motor component, verbal cognitive flexibility, and real-world navigation scenario, hypothesized to play a role in searching, planning, and problem-solving online. Indeed, transit tasks one through three required organization of information (e.g., plan to leave the airport in appropriate time without luggage claim), attention to detail (e.g., the route must be wheelchair accessible), and thoughtful recognition of discrepancies between tasks goals and available options (e.g., one of the train options did not operate during the requested time). It may be the case that the neuropsychological tests that comprise the composite may not have measured the executive functions which facilitate online navigation performance. The possibility that the cognitive domains of executive functioning and episodic memory may differentially contribute to online transit task performance across age groups was investigated in exploratory post-hoc analyses. Correlation analyses revealed significant associations between episodic memory and executive functioning composites to transit task speed and accuracy among older adults, but not among the younger cohort (results shown in Table 7) suggesting that age may modulate this relationship. The lack of executive associations in the younger adults is consistent with recent work on Internet search for health information (Kordovski et al., in press) and may suggest that executive dysfunction could mediate the relationship between age and INS. Results of the brief GMT experiment, outline below, also argue against a strong role for executive functions in internet transit navigation among older adults.

Transit Task 4: Experimental GMT Paradigm

The GMT-based intervention aimed to support underlying executive mechanisms that facilitate planning and execution (e.g., maintaining an objective, identifying steps). Planning performance was assessed via the "Stop-State-Split" model of GMT; wherein all participants were asked to verbally describe a plan of action for completing task 4 before initiating the assignment. Findings show that older age was associated with lower total scores, with small to medium-sized effect, on their plan description. Though only a small number of studies have focused on planning performance in older adults, results of the current study are consistent with laboratory examinations showing age differences in planning on the Tower of Hanoi planning task (e.g., Brennan, Welsh, & Fisher, 1997). Findings are also in line with ecological investigations of planning, demonstrating that healthy older adults manifest planning deficits on a Zoo Map Test (Allain et al., 2005) and on a kitchenette meal-preparation task (Godbout, Doucet, and Fioloa, 2000). Given the demonstrated poorer performance on planning measures among individuals with frontal lobe injury (Allain et al., 2002) and the established changes to prefrontal neural systems that take place with age, the association of older age and lower planning performance among our older cohort support literature indicating that increased age adversely impacts cognitive skills involved in the organization of behavior in relation to a specific goal based on a series of intermediate steps (Owen, 1997).

Planning has also been conceptualized as an aspect of personality. Certainly, neuropsychological tests are useful in assessing planning and impulse control as they are repeatable and provide a quantitative measure of behavioral tendencies that comprise broad constructs of planning and impulsivity. However, the extent to which neuropsychological tests assess longstanding planning abilities or more transient aspects of cognitive functioning is not clear. For example, it has been suggested that non-planning impulsiveness, which assesses poorer self- control and lower cognitive complexity, may be associated with poorer performance on tests of planning and impulse control (e.g., Pietrzak, Sprague, & Snyder, 2008). Further, impulse control and planning as a characteristic of conscientious has been shown to increase with age (John & Srivastava, 1999). In the current study, trait-based planning was measured by the BIS-11. Total scores on this self-report questionnaire did not differ between the younger and older cohorts. Further, total scores were not related to planning performance and were accompanied by small effect sizes. This finding is consistent with a study conducted by Pietrzak, Sprague, and Snyder (2008), which reported non-planning impulsivity specifically, was not significantly related to performance on the Zoo Tip Test and suggests that the age differences observed on the planning tasks were not a factor of personality characteristics alone as measured by the BIS-11.

Despite commonly reported strategic deficits observed in frontal systems disorders and aging, few studies have specifically aimed to improve problem-solving and planning abilities. The brief GMT-based support applied in the current study utilized “Stop-State-Split” model (Levine et al., 2007). The goal was to encourage participants, when confronted with a task, to stop and think about the task demands, define the main task, split the complex tasks into subtasks, and monitor their performance. Findings revealed that participants in the intervention condition, regardless of age, demonstrated better planning performance, accompanied by a medium-sized effect compared to controls. Results are consistent with an experimental probe of

GMT among patients with TBI (Levine et al., 2000) as well as with a large-scale rehabilitation trial showing improvement in everyday tasks (e.g., planning and completing a carpool schedule) via GMT among healthy older adults (Levine et al., 2007). Findings suggest that supporting the underlying executive mechanisms which facilitate planning and execution (e.g., maintaining an objective, identifying steps), promote better planning performance. Interestingly, very large-sized effects indicate that younger adults in the current study benefited from this brief GMT-based intervention, more so than older adults for whom effect sizes were minimal. One possible explanation for this finding may draw from the Matthew effect cognitive theory. The Matthew effect (Stanovich 1986) provides a framework to explain the differences in the development of reading, with the idea being that good readers get even better over time or simply put, "the rich get richer." Applied to the current study, it is possible that younger adults, who evidenced higher scores on cognitive composites compared to older adults (*p*s <.05) may have more easily been able to use their available foundation of cognitive ability to take advantage of the cognitive supports offered from the GMT-based intervention. Certainly, as a group, older adults do not perform as well as younger adults on a variety of learning and memory tests (e.g., Henry, MacLeod, Phillips, & Crawford, 2004). A decline in memory function is also among the most common cognitive complaints among older adults, and the rate of acquisition of new information declines across the lifespan (e.g., Haalan, Price, Larue, 2003). As traditional GMT involves training over several weeks, it may be the case that the brevity in approach to the GMT model in the current study impacted its utility among older participants. Consistent with these findings, similar brief GMT-based interventions (e.g., Woods et al. 2020) showed minimal, non-significant benefits in older adults. Post-hoc regression analyses which included the episodic memory composite as a potential predictor of transit task 4 planning indicated episodic memory as a significant contributor of planning scores ($\beta = .468$, $p = .02$, 95% CI [0.063, 0.872]). In a parallel post-hoc analysis, the episodic memory composite ($\beta = 0.363$, $p = .01$, 95% CI [0.085, 0.64]) became the only significant predictor of transit task 4 performance above beyond age group, intervention group and the age by intervention interaction term, suggesting that episodic memory may be a moderator of online transit task performance. Combined with the observed influence of episodic memory on performance on transit tasks 1-3, it is possible that older adults may have benefited from additional learning opportunities and memory supports for such interventions (e.g., spacing, retrieval practice, elaboration).

From a cognitive theoretical perspective, planning can be into two stages: formulation and execution (Grafman, 1989; Shallice, 1982). During the formulation stage, an individual must design a plan, typically incorporating multiple steps, which should logically lead to resolution a given problem. In the current study, one may conceptualize planning scores as representing the formulation stage and performance on task 4 as the execution phase. Results revealed no group differences in task 4 performance between younger and older adults, or between intervention and control conditions. While there was a medium-sized effect of age within this model, it was not a significant contributor to successful task 4 completion. The overall pattern of results observed in the current examination aligns with those presented in the 2005 study conducted by Allain and colleagues noted above. Allain et al. examined age effects on the Zoo Map Test and also indicated that older adults appeared to demonstrate more problems in predetermining a complex course of action aimed at achieving some specific goal than in guiding the execution of complex sequences of actions to a successful conclusion. Sanders and Schmitter-Edgecombe (2012) also reported that older age was associated with poorer formulation accuracy and efficiency but not with execution accuracy or efficiency on a map task. In other words, normal aging may affect the capacity to mentally represent complex plans more than the capacity to execute these plans or perhaps follow instructions. In the context of findings suggesting the importance of episodic memory and learning, one possibility for the null group differences in task 4 performance may be that the first three transit tasks served as "learning trials," which prepared participants for the final experimental assignment. This rationale is consistent with research showing retention of information that is successfully learned is preserved in cognitively healthy older adults (Whiting, Wythe, & Smith, 1997). In this regard, planning may be conceptualized as a form of internal monitoring or metacognition. Support for GMT based intervention in combination with metacognitive training to improve performance on measures of daily functioning has been shown among young adults with HIV and substance use disorders (Casaletto et al., 2016) which preferentially impact frontal striatal regions of the brain (Langford, Hurford, Hashimoto, Digicaylioglu, & Masliah, 2005).

This study is not without limitations that impact interpretation of the findings. As the internet becomes more widely used and integrated into daily activities, the need for understanding ways in which cognition impacts our ability to utilize this technology successfully increases. Thus, investigations of individuals from diverse ethnic and socioeconomic backgrounds are needed. The current sample largely consists of Caucasian women with an average of 15 years of education, which limits the generalizability of the findings to racial and ethnic minorities. The vast majority (90%) of the younger sample were college students compared to 61% of adults aged 25 and above within the U.S. (U.S. Census Bureau, 2018), which may also affect the external validity of current findings. Further, the "Older Adults" included the current study were actually fairly young. The average age of adults in the older cohort 60 years old, many of whom reported still being employed (65%). Together with a higher than typical education, it possible that brain changes expected with age may have less impact on functioning due to cognitive reserve (Katzman, 1993). Likewise, only 20% of participants in the current sample reported household income below $25,000. Recent 2019 reports estimate that 45% of households earning below $30,000 a year do not have access to in-home broadband services or a traditional computer (Auxier et al., Pew Research Center, 2019). As the internet continues to become more ubiquitous, this digital divide in access to online applications is an important consideration as not being familiar with online systems for navigation may influence ADLs. The use of a live website also presented challenges, such as not being able to completely manipulate all study components or having control of visual graphics and icons on the platform. However, this aspect of the study also enhances the ecological relevance of the protocol. It is also important to consider the limitations of GMT as a brief intervention. In its original form, GMT involved “training sessions” usually completed over weeks to allow learning of concepts (Levine et al., 2000). While there was a novelty in the current study’s use of a brief GMT-based model of intervention, findings regarding the efficacy of the intervention may have been limited by adherence to the GMT model. Further, the battery used to evaluate cognitive correlates of INS, included measures which were heavily verbal in nature. A recent brief review of performance-based internet navigation skills revealed visuospatial skills demonstrate reliable associations with internet tasks with generally medium effect sizes (Woods et al., 2019). It is possible that inclusion of measures less dependent on verbal performance (e.g., Rey-O Complex Figure, line orientation) may have provided additional information on organization, strategy, and visual functions that may have influenced transit task performance.

Nevertheless, improvement in planning performance was observed among the younger cohort, and the current study has several additional strengths to note. This is the first study to examine age differences in an online transit navigation task. Previous investigations have shown age differences in planning and navigation among older and younger adults on more traditional neuropsychological measures (e.g., Brennan, Welsh, & Fisher, 1997; Godbout, Doucet, & Fiola, 2000), though increasingly the field of neuropsychology is moving toward technology-driven assessment delivery which more accurately reflects the heavy use of technology in daily life. The use of a live website was ecologically relevant and practical in that there were no costs accrued in developing a mock or simulated site, and the accessible platform allows for replicability. The intervention itself was also developed with ecological relevance in mind. The “Helpful Tips Handout” aimed to mimic a brief flyer that may be included with information (via email or mail) provided to participants before their visit and serve to reduce the cognitive burden of navigating a novel online system without support. Given results showing the significant influence of episodic memory to transit task navigation and its differential contribution across age groups, perhaps considering a similar GMT-based model wherein participants are provided with additional information or introduction to the purpose of GMT, may increase benefits to older adults. Overall, results of the current study are the first to reveal age-related differences on an online measure of navigation and add to a growing body of literature examining cognitive correlates of internet-based activities of daily living. Further, findings lend support for GMT-based training to improve planning among a healthy adult population and contribute to limited investigations of theory-driven interventions to support executive functioning.

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Table 1. Participant demographic characteristics

Variable	Younger (n=50)	Older (n = 40)	Range	*p*-value
Sociodemographics				
Age (years)	22.4 (3.8)	60.4 (6.2)	18-75	< .001
Education (years)	15.0 (1.4)	15.2 (2.4)	12-20	.810
WRAT-4 Reading Grade	12.1 (1.2)	12.6 (0.7)	6.1-12.9	.047*
Father's education (years)	14.4 (4.1)	13.0 (4.5)	5-20	.119
Sex (% women)	72	65		.477
Race (%)				.001
White	38	68		
Black	6	10		
Hispanic	32	10		
Other	24	5		
Declined	0	5		
Occupation (%)				.824
Employed	68	65		
Technology field	6	12		
Health field	12	8		
Other	82	81		
Average Household Income (%)				.878
Below $25,000/yr	20	18		
Neurocognition				
MoCA (normative z-score)	0.18 (0.9)	0.4 (0.7)	-1.58-1.68	.333
Health				
Total health conditions	0.7 (0.9)	1.7 (1.5)	0-6	.0004*
Any condition reported (%)	46	80		
On treatment (%)	65	69		
Interferes with ADLs (%)	43	25		
Healthcare Provider (% yes)	74%	84%		
Healthcare contacts in past year	3.1 (0.74)	5.7 (0.83)	0-25	.042*
History of psychiatric diagnosis (%)	22	15		.400
DSM-5 CCSM Total (of 88)	16.8 (8.6)	9.2 (10.1)	0-43	<.001

Note. Data represents M (SD) or %. MoCA= Montreal Cognitive Assessment; WRAT = Wide Range Achievement Test; mbps = megabits per second. *Top Uses of Internet indicates one of Top 3 Uses by group. Current mood symptoms based on DSM-5 CCSM = Cross Cutting Symptom Measure criterion.

Table 2. Control and intervention groups procedural steps of the transit navigation task.

Control Condition	**STEP IN PROTOCOL**	**Intervention Condition**
Transit site orientation	1	Transit site orientation
Provided “Letter from Dr. Navigation”	2	Provided “Letter from Dr. Navigation”
Complete Task 1	3	Complete Task 1
Complete Task 2	4	Complete Task 2
Complete Task 3	5	Complete Task 3
Introduce Task 4	6	Introduce Task 4
Provided Pamphlet	7	Provided “Helpful Tips Flyer”
Allowed time for questions and pamphlet review	8	Prompted to begin STOP-STATE-SPLIT
Complete Task 4	9	Complete Task 4

Table 3. Internet Use Characteristics

Variable	Younger (n=50)	Older (n = 40)	Range	*p*-value
Internet Speed at Testing				
Pre PING (ms)	2.5 (1.4)	3.6 (4.2)	1-18	.117
Post PING (ms)	2.4 (0.9)	3.3 (4.6)	1-21	.038*
Internet Use				
Hours per week	50.8 (14.1)	34.6 (20.7)	3.5-63	<.0001*
Internet Anxiety (of 24)	5.8 (3.0)	6.4 (3.6)	2-18	.385
Time spent on Desktop/Laptop (50% or greater)	57	63		.608
Top Uses of Internet (%)				
School/Work Related	92 *	38*		
Email	50 *	63*		
Reading and Reference	26	50*		
Entertainment	54*	10		
Frequency of Use for Directions (%)				.251
Not at all	2	0		
Less than once per week	16	25		
At least once per week	24	15		
Several times per week	34	45		
At least once per day	12	13		
Several times per day	12	3		
Frequency of Google Map Use (%)				.650
Not at all	0	3		
Less than once per week	12	15		
At least once per week	30	25		
Several times per week	32	40		
At least once per day	14	8		
Several times per day	12	10		
Frequency of Ride Share Use (%)				.197
Not at all	44	53		
Less than once per week	52	38		
At least once per week	0	5		
Several times per week	4	5		
At least once per day	0	0		
Several times per day	0	0		

Note. ms = milliseconds. *Top Uses of Internet indicate top 3 uses by group.

Table 4. Matrix depicting correlations between performance on transit tasks 1-3 and components of cognitive composites.

Variable	Transit Tasks 1-3 Total	Transit Tasks 1-3 Time	Executive Functioning Composite	DKEFS 20Q Total WA	DKEFS TMT: 4	Actions Fluency	Heyne Total	Episodic Memory Composite	CVLT Trials 1-4	CVLT Long Delay	PM Total Score
Transit Tasks 1-3 Total	1	1									
Executive Functioning Composite	0.330**	0.268*	1								
DKEFS 20Q Total WA	0.0733	0.065	0.605**	1							
DKEFS TMT: 4	0.258**	0.325**	0.619**	0.124	1						
Actions Fluency	0.273	0.214*	0.770	0.330	0.346	1					
Heyne Total	0.395**	0.167	0.564**	0.176	0.348**	0.220*	1				
Episodic Memory Composite	0.388**	0.252*	0.355**	0.071	0.325	0.270	0.302**	1			
CVLT Trails 1-4	0.481**	0.280**	0.391**	0.098	0.321**	0.332**	0.335**	0.880**	1		
CVLT Long Delay	0.241*	0.183	0.237*	0.012	0.225*	0.152	0.200	0.915**	0.645**	1	
PM Total Score	0.025	0. 124	0.216*	0.145	0.010	0.145	0.246*	0.081	0.067	0.105	1

*p <.05
**p <.01

Table 5. Results of regression analyses examining the relationship between cognitive composites and initial transit task among the total sample.

Transit Task 1-3 Performance	*p*	β	*F*	*df*	*p*	Adj. R^2
Total Scores						
Overall Model			8.33	3	<.0001	0.198
Episodic Memory	0.001	1.56				
Executive Functioning	0.08	1.14				
PM	0.32	0.74				
Total Time						
Overall Model			4.45	3	0.0059	0.104
Episodic Memory	0.03	-38.06				
Executive Functioning	0.16	-36.72				
PM	0.51	19.91				

Table 6. Transit Task 4 planning and total performance across intervention and age cohorts.

Variable	**Younger Controls (n= 21)**	**Younger Intervention (n= 29)**	**Older Controls (n= 22)**	**Older Intervention (n =18)**
Planning Phase				
State initial goal w/o prompt (of 5)		1.9 (1.1)		1.4 (1.1)
Required prompting (%)		97		100
Improved after prompt (%)		54		61
State goal after prompt (of 5)		2.6 (1.0)		2.3 (1.0)
Live Navigation				
Plan total (of 7)	2.7 (1.8)	4.5 (1.5)	3.2 (1.8)	2.8 (1.6)
Completion time (seconds)	122.6 (71.6)	121.6 (48.8)	166.2 (90)	171.2 (72.7)
Accuracy (of 5)	3.0 (1.1)	3.2 (0.9)	2.1 (1.4)	2.7 (1.2)
Trait Planning				
Barratt Impulsiveness Scale (of 120)	61.3 (7.6)	59.7 (8.4)	57.1 (5.6)	61.6 (8.7)

Note. Prompting was only presented to participants in intervention condition.

Table 7. Matrix depicting correlations between transit tasks 1-3 and cognitive composites across age groups.

Variable	Accuracy of Transit Tasks 1 -3	Time to Complete Transit Tasks 1-3	Episodic Memory Composite	Executive Functioning Composite	PM Total Score
Older Adults					
Accuracy of Transit Tasks 1 -3	--				
Time to Complete Transit Tasks 1-3	-0.195	--			
Episodic Memory Composite	0.490†**	-0.196	--		
Executive Functioning Composite	0.358†*	-0.346†*	0.437†**	--	
PM Total Score	0.163	0.034	0.208†	0.369†*	--
Younger Adults					
Accuracy of Transit Tasks 1 -3	--				
Time to Complete Transit Tasks 1-3	-0.070	--			
Episodic Memory Composite	0.143†	-0.140	--		
Executive Functioning Composite	0.075†	-0.011†	0.212†	--	
PM Total Score	-0.154	-0.153	-0.053†	0.059†	--

*p < .05
**p < .01
†Correlations differed (based on z-test) between younger and older adults

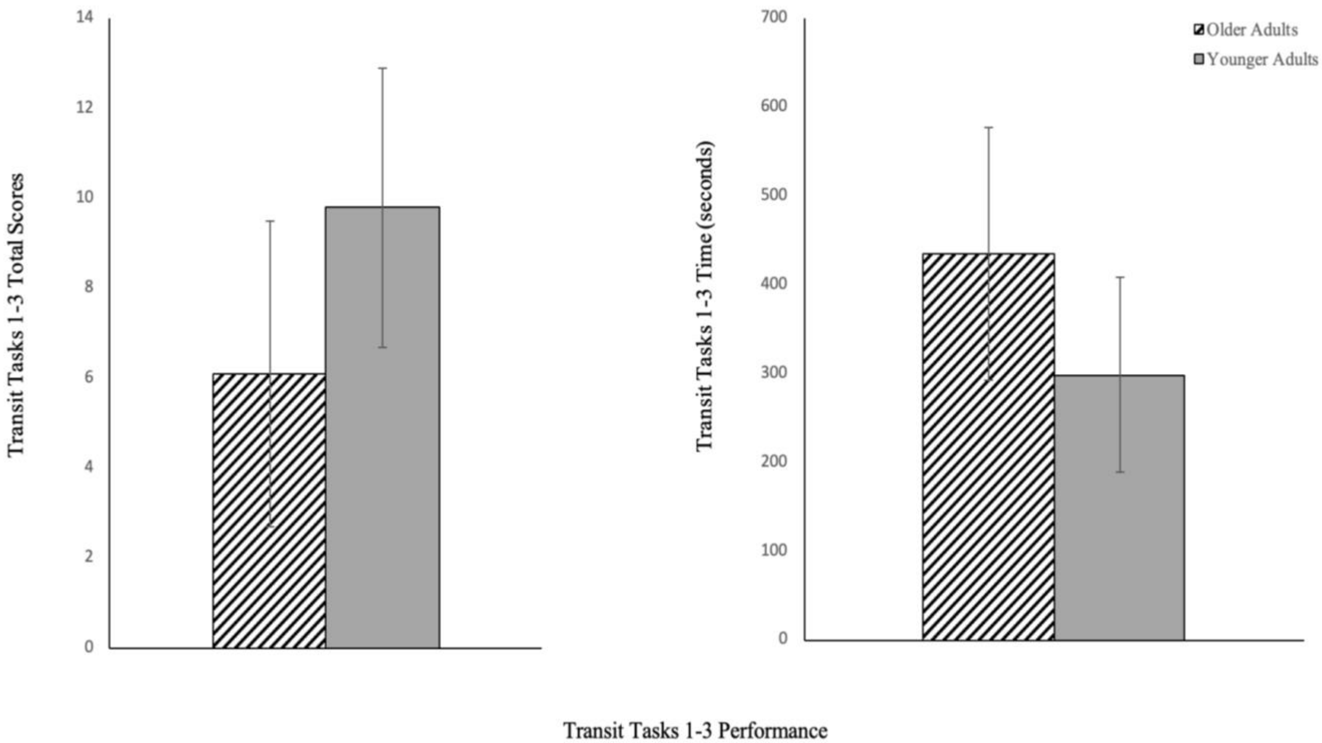


Figure 2a. Total score performance on Transit tasks 1-3 across age.

Figure 2b. Transit tasks 1-3 time to completion across age.

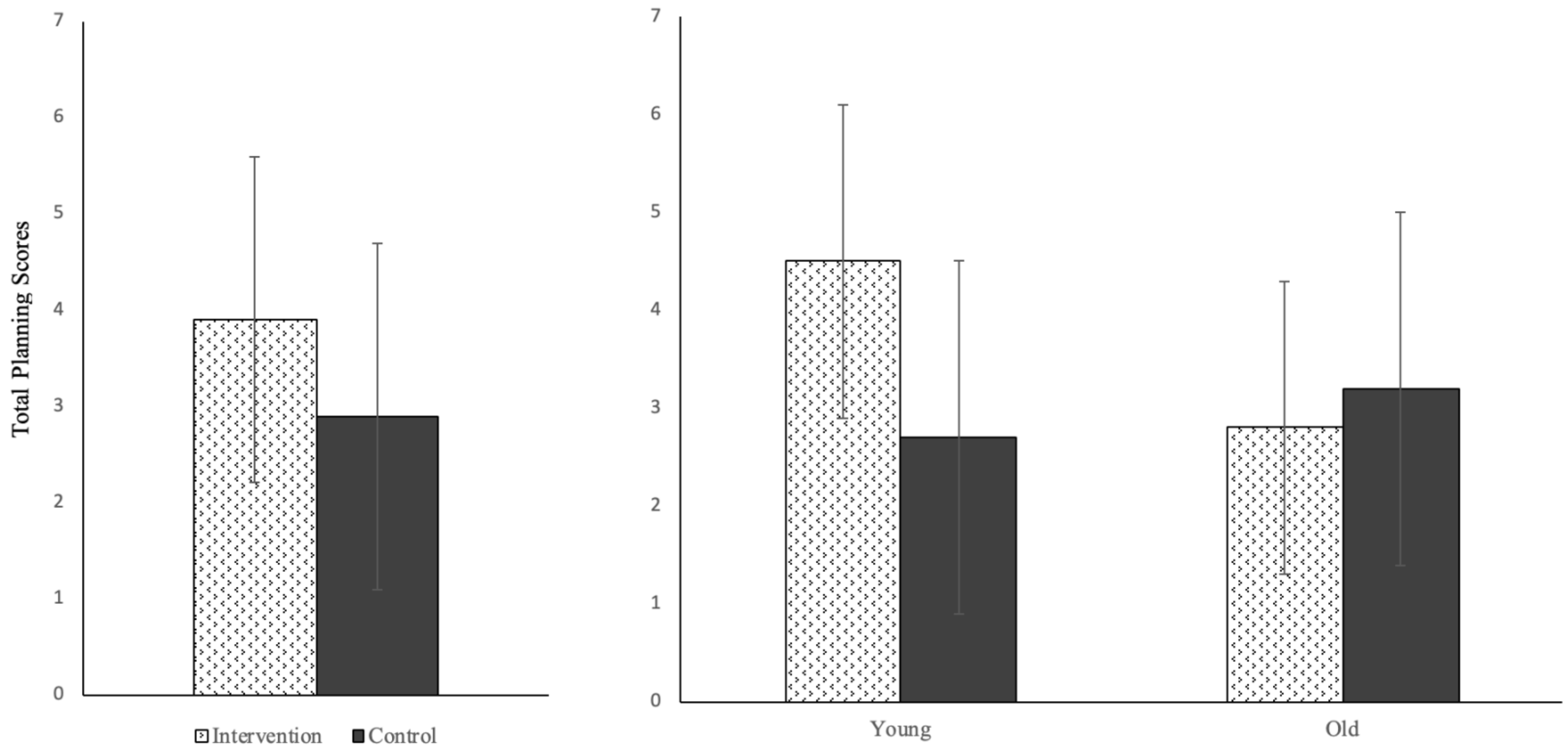


Figure 3a. Total planning scores across intervention groups.
Figure 3b. Total planning scores across age groups.

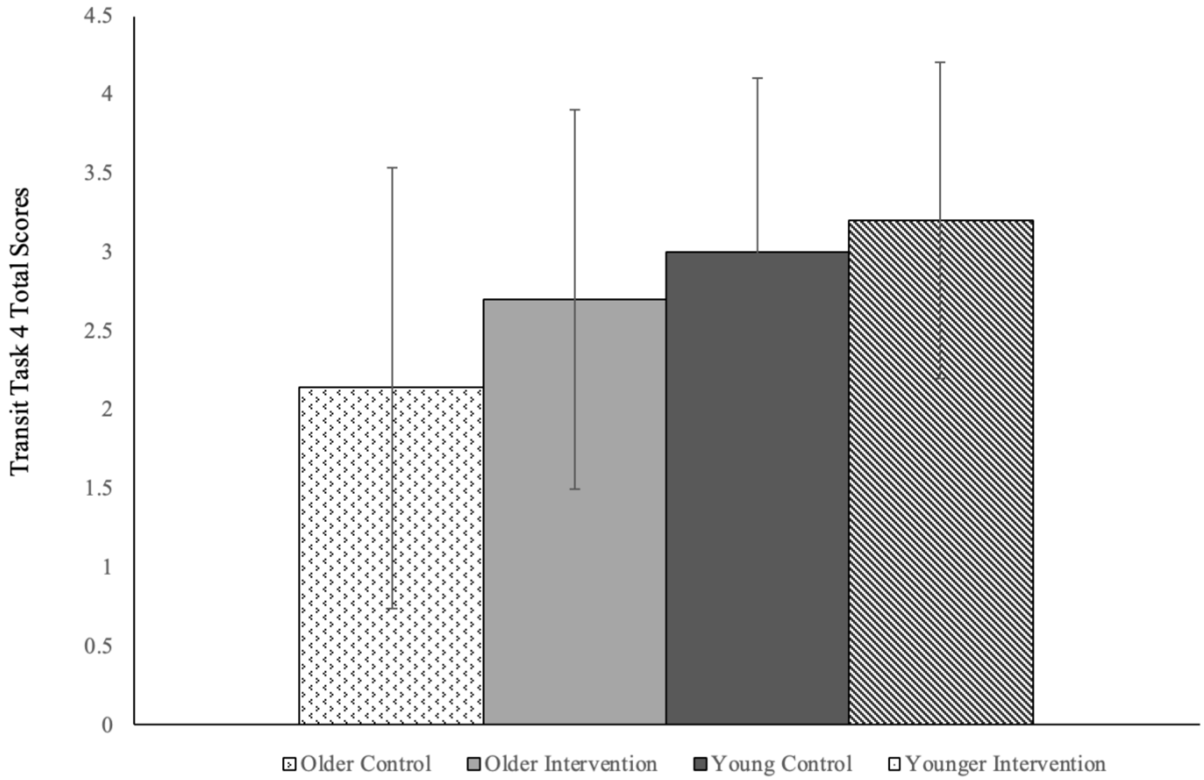


Figure 4. Total scores on transit task four across age group and intervention condition.

APPENDIX A.

UCSF Medical Center
505 Parnassus Ave.
San Francisco, CA
94143

UCSF Medical Center

Dear Patient,

I'd like you to imagine that your home physician has referred you to the University of California San Francisco Medical Center to receive treatment for a recently diagnosed medical condition. The appointment is set for ***Monday morning at 9am***. You have arranged to stay at a nearby hotel. We would like you to use the San Francisco Transit site to navigate routes during your time in the city.

Task one: Arrival

Your first task is to arrange for transportation from the airport to your hotel. Your flight arrives at tomorrow at 1pm and you have not checked any bags. Using the Transit cite, plan a route from the San Francisco Airport to your hotel. Here is the information for your trip:

San Francisco Airport
Hotel: 333 Fulton St – Inn at the opera 94102

Note* Due to current condition, you are using a wheelchair for assistance. Keeping in mind that this may influence your travel time and accessibility, be sure to check that your planned route has options that will accommodate your needs.

Go ahead and begin mapping your route whenever you are ready and please let me know when you have a completed plan.

Task two: Weekend Trip

Let's say you wanted to travel downtown this weekend while you were in the city. Considering the different Muni Routes and Stops available, which would be train would be best, the 14x Mission Express, the 23 Monterey, or the 14 Mission if you were planning to head downtown between the hours of 10am -3pm?

Task three: Nearby Pharmacy

Your Doctor has asked that you begin taking a medication prior to your visit. You will need to stop at CVS to pick up the prescription. Please find the nearest CVS to your hotel.

Task four: Appointment Measure

Finally, we would like you to map a route from your hotel to your medical appointment. Please arrive 15 minutes before your scheduled appointment time to complete any necessary paperwork.

Here are the details for the location of the Medical Center and your hotel:
UCSF Medical Center – 505 Parnassus Ave, San Francisco 94143
333 Fulton St – Inn at the opera 94102

APPENDIX B. Transit Tasks 1-3 Scoring Criteria

Transit Tasks 1-3

Study ID: ___________ Date: ________________

Task one: Ask the questions in Bold.

1. Did they choose the correct day using the drop-down option? (Tomorrow. e.g., if you test on a Wednesday, the Participant should select Thursday) 1 0

2. Did they change the time for departure using the drop-down option? 1 0

3. Did they select a wheelchair accessible route using the drop-down option? 1 0

4. **"What time will you depart the airport?"** ___________________

Does the departure time they verbally state match the departure time on the trip description? (Note: This may be different from the time they have selected in the dropdown box) Y N

Did they choose a reasonable departure time?

Departure time is unreasonable for task (from 1pm- 115pm; after 330pm)	0
Departure time is reasonable, though unlikely, (116pm-129pm; 230 to 330pm)	1
Departure time most appropriate (130pm to 215pm)	2

Were they able to complete the task? Y N

5. **"What is the cost of this trip?"** ___________________

$12. 35, $12.40, $9.65 (Check for accuracy to see if this matches the screen) 1 0

Were they able to complete the task? Y N

6. **"When will you arrive at the hotel?"** ___________________

APPENDIX B. Continued

Transit Tasks 1-3

Arrival time is unreasonable for task (from 130pm-2pm; after 415pm		0
Arrival time is reasonable, though unlikely (201pm-209pm; from 301pm-414pm)		1
Arrival time is most appropriate (from 210pm to 3pm)		2
Were they able to complete the task?	Y	N

7. **"How long is the trip?"** ____________________

35-50 minutes (Check for accuracy)	1	0
Were they able to complete the task?	Y	N

Task 1 Total (of 9) = ____________________

Time to complete: ____________________

Task Two

1. Did the participant look at all three options? (14 Mission, 14x Mission Express, & 23 Monterey) 1 0

2. **"Which route did you choose?"** ____________________

14 Mission	1	0
Were they able to complete the task?	Y	N

3. **"Why did you choose this route?"** ____________________

Incomplete, inaccurate reason for route choice: Incorrect choice		0
Incomplete, partially accurate answer: Correct choice, incorrect reason (e.g. "14 Mission because it was faster")		1
Correct, thorough answer: "14 Mission because it is the only route that has service to Downtown during the specified times."		2
Were they able to complete the task?	Y	N

Task 2 Total (of 4) = ____________________

Time to complete:

APPENDIX B. Continued

Transit Tasks 1-3

Task Three

1. Did they use the "nearby" option?	1	0
2. "Which CVS location did you choose?"		
499 Haight St. 1285 A Sutter St. 995 Market St.	1	0

Task 3 Total (of 2) = ____________

Time to complete: ____________

Were they able to complete the task? Y N

Total Transit Score (of 15) = ____________

APPENDIX C. Transit Task 4 Scoring Criteria

Transit Task 4

Study ID: ________________ Date:_________________

INTERVENTION PARTICIPANTS START HERE

WHAT IS YOUR GOAL?	**w/o pmt.**	**aft. pmt.**
Map/Navigate a route		
from my hotel		
to my medical appointment		
using the transit website		
and arrive 15 minutes prior to the scheduled time		

Total (of 5) = ________ ________

Did Participant require a prompt for Goal? **Y** **N**

If yes, did they improve after prompt? **Y** **N**

CONTROL PARTICIPANTS START HERE

Participant Plan

I would use the "Trip Planner"	
and enter the hotel into the "depart from" area	
and the medical center into the "destination" area	
click "let's go"	
Set my arrival time for Monday	
15 minutes prior to the scheduled time	
select "wheelchair accessible" in options	

Total (of 7) = _______

Notes:

APPENDIX C. Continued

Transit Task 4

1. Did they select a wheelchair accessible route using the drop-down option? DO NOT PROMPT	1	0
2. Did they choose the correct day using the drop-down option? Monday	1	0
3. Did they choose the change the time using the drop-down option?	1	0

4. "What time will you arrive?" ________________

Is the estimated time of arrival at least 15 minutes before the scheduled appointment and no more than 30 minutes before the appointment?	1	0
Does the departure time they verbally state match the departure time on the trip description? (Note: This may be different from the time they have selected in the dropdown box)	Y	N

5. "What is the cost to get to and from your appointment?"

$5.50	1	0
Task 4 Total (of 5) =	________________	
Time to complete:	________________	
Were they able to complete the task?	Y	N

APPENDIX D. Helpful Tips Flyer

Helpful Tips to Navigate Your Appointment Arrival

San Francisco is a large city and we understand that many of our patients may be seeking services from out of state. To help make your travel a bit easier, UCSF has provided from quick, go-to tips for navigating the Muni System.

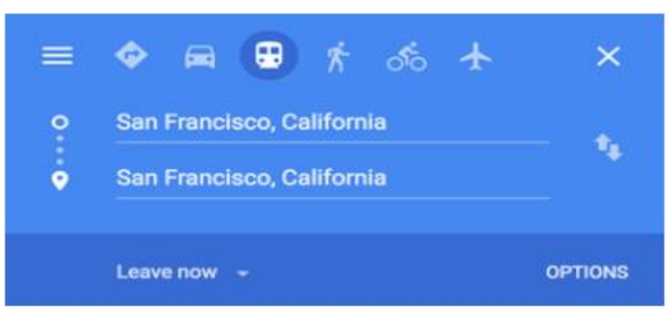
<u>You may ask yourself:</u>

Q: From the Main transit website, what would be your first step?

A: Remember the trip planner is a simple way to find directions to and from specific locations.

Q: Are there time/mobility/accessibility restrictions that I need to keep in mind?

A: Recall that the tabs "leave now" and "options" tabs allow you to select accommodations for your trip.



APPENDIX E. AMAP Scoring Criteria

Heyne Stops	
1.	8.
2.	9.
3.	10.
4.	11.
5.	12.
6.	13.
7.	14.

Total Time: ____________________

1. In all locations only once except 204?	1	0
2. Pick up correct Exp. A Form?	1	0
3. Pick up correct Exp. B Form?	1	0
4. Did they deliver the correct form to SPW? (Exp. A)	1	0
5. Did they return the correct slip to examiner? (Exp. B)	1	0
6. Did they fill up water container at the correct fountain?	1	0
7. Did they return water container?	1	0
8. Did they water the plant?	1	0
9. Did they return to test room at end?	1	0
10. Did they tell examiner the Police Phone Number?	1	0
Total (x/10) =		

Able to complete without prompt? Y N