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Destination Memory Accuracy in Younger and Older Adults

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DESTINATION MEMORY ACCURACY
IN YOUNGER AND OLDER ADULTS

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Few studies have directly examined destination memory, the ability to remember with whom information was shared. The current study replicated and extended previous research (i.e., Gopie, Craik, & Hasher, 2010; Gopie & MacLeod, 2009) and examined the effects of age (younger and older) and varied attentional resources on destination memory as well as a potential strategy (i.e., mental imagery) to improve destination memory.

Using E-Prime software, participants (N = 192) told facts to celebrity faces in one of four conditions (i.e., control, internal focus of attention, external focus of attention, associative mental imagery) using random assignment. Similar to previous research, results indicated that older adults had lower destination memory accuracy than younger adults, which was driven by a higher level of false alarms. Additionally, younger adults were significantly more confident in accurate answers (i.e., hits and correct rejections), whereas older adults were significantly more confident in inaccurate answers (i.e., false alarms), indicating that older adults are more likely to withhold information from people because they think that they have already shared the information.

Destination memory also varied by condition. Accuracy was lowest when participants' attention was directed internally and significantly improved when participants utilized provided associative imagery strategies. Contrary to expectations, the use of imagery did not differentially improve destination memory for older adults. However, when imagery strategies were used there was no age difference in false alarms or high-confidence inaccurate answers. Furthermore, an

exploratory analysis found no difference in destination memory between younger and young-old adults (aged 65-74) when imagery strategies were used, yet older-old adults (aged 75+) did significantly worse than the other two age groups.

Overall, the results suggest that not only are older adults more likely than younger adults to commit destination memory errors, they also are less accurate in confidence judgments related to those errors. However, the use of associative memory strategies may help improve destination memory across age groups, the accuracy of confidence judgments in older adults, and also may decrease, or potentially eliminate, age-related destination memory impairment, particularly in young-old adults.

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CHAPTER I

INTRODUCTION

Remembering with whom we have shared information is an important part of everyday life. It has the potential to affect relationships, medical care, and problem solving. No one wants to be known as the person who repeatedly tells the same story without regard for whether the listener has already heard the story. Medical providers cannot adequately diagnose and treat patients if they do not have all the relevant information (e.g., if patients think they have told the provider their symptoms but have not). When consulting with a colleague or friend regarding a problem, explaining the situation concisely without repeating information is respectful of the other person's time. To function well in each of these scenarios, a person needs to be able to remember what information has been shared and with whom. The act of remembering the destination of information is called destination memory (Gopie & MacLeod, 2009).

The term, destination memory, was first used by Gopie and MacLeod (2009), who defined it as the processes involved in remembering an association between information shared and with whom the information was shared. They posited that source memory (a well-studied construct) and destination memory (a newly-defined construct) are related components of the episodic memory system, but that they differ fundamentally due to the direction of information transfer (i.e., input vs. output). In particular, source memory is driven by information input (i.e., remembering where information originated; see Johnson, Hashtroudi, & Lindsay, 1993), whereas destination memory is driven by information output (i.e., remembering with whom information was shared). For example, when source memory fails, a person may remember hearing some news but not know how reputable the news is because the source of the news is not remembered. On the other hand, when destination memory fails, a person may repeat that news multiple times to the same people, potentially resulting in avoidance by others who do not want to hear the same stories over and over.

Although people of all ages are susceptible to lapses in destination memory, destination memory errors appear to be particularly relevant for older adults. In addition to anecdotally being described as a common problem for older adults, empirical evidence suggests that older adults are more likely than younger adults to repeat items on memory tests (Jennings & Jacoby, 1997; Koriat, Ben-Zur, & Sheffer, 1988; Skladzien, 2010). Furthermore, repetitious conversational behavior may also contribute to negative age-related perceptions of older adults (Bieman-Copland & Ryan, 2001). Thus, it is important to understand destination memory failures and determine ways to prevent them, particularly for older adults.

Results from two seminal studies by Gopie and colleagues (Gopie et al., 2010; Gopie & MacLeod, 2009) indicate that destination memory errors occur in both younger and older adults, with older adults committing more errors than younger adults. They proposed that these errors may be affected by limited attentional resources and age-related changes in cognitive control (Gopie et al., 2010; Gopie & MacLeod, 2009). However, prior to the current study, research had not directly examined the effect of varying attentional demands on destination memory in older adults. Thus, an opportunity existed to replicate and extend the original work of Gopie and colleagues. The current study examined age differences in destination memory and explored conditions that could potentially affect destination memory performance (e.g., varying attentional resources). Additionally, to explore a means to improve destination memory, the usefulness of an associative memory strategy was investigated.

The following sections provide an overview of the literature related to episodic memory and aging, with a focus on associative memory, as well as a summary of the relation between attentional resources, associative memory, and aging. Literature related to strategies for improving episodic memory in older adults is also explored. Finally, the two existing studies on destination memory are reviewed in detail because the current study is a replication and extension of them.

Episodic Memory and Aging

Destination memory is part of the episodic memory system (i.e., memory for personal experiences; Tulving, 2000) given that it is autobiographical (i.e., recollecting with whom certain information was shared). Thus, in order to understand age-related changes in destination memory, it is important to first understand age-related changes in episodic memory. Of the various memory systems outlined by Tulving (2000; procedural memory, the perceptual representational systems, working memory, semantic memory, and episodic memory), episodic memory shows the greatest age-related decline (Luo & Craik, 2008).

Chalfonte and Johnson (1996), in a study about age-related differences in episodic memory, suggested that episodic memory involved not only remembering the features of an event (e.g., what occurred and where), but also the binding together of those features into a complex memory. In a series of experiments, they tested participants' ability to remember individual features (e.g., pictured objects), as well as various associations (e.g., between the objects and their location on a two-dimensional grid). They placed 30 colored line drawings (e.g., a book drawn in red and a sun drawn in green) in a grid that contained 49 squares. To determine whether age differences in episodic memory could be attributed to individual features, a binding deficit, or both, the researchers instructed younger and older adults to study either a particular feature (e.g., the item, the item color, or the item location) or bound features (e.g., item and location on the grid or item and color) and then tested whether they could remember what they had been instructed to remember (intentional learning). In a subsequent experiment, participants were instructed to study one particular feature (e.g., the item color) but were instead tested on the bound information (incidental learning). Feature memory (i.e., memory for individual test components) was age equivalent in two experiments (i.e., for color and item); however, there was an age-related deficit for feature memory in one experiment (i.e., location). Across experiments, an age-related binding deficit was present; older adults were less able to remember the bound information than younger adults, under both intentional and incidental learning conditions. Thus, results suggested that compared to younger adults, older adults have more difficulty with episodic memory when the situation requires combining various features of an event into a complex memory.

Building on the work of Chalfonte and Johnson (1996), Naveh-Benjamin (2000) proposed the associative deficit hypothesis (ADH) as an explanation of older adults' deficient episodic memory performance. Similar to the age-related binding deficit described by Chalfonte and Johnson, Naveh-Benjamin's ADH suggests that much of older adults' poorer episodic memory performance is due to a deficiency in creating and retrieving links between units of information (e.g., between a pair of words). In a series of experiments, Naveh-Benjamin tested memory for individual items (e.g., words, nonwords, or fonts) as well as memory for associated items (e.g., word pairs, word-nonword pairs, and word-font pairs). Consistent with the ADH, older participants performed significantly worse on the associative measure (e.g., memory for word pairs) than younger participants, even when no age differences were seen in performance on the item measure (e.g., memory for words). Furthermore, the associative deficit was always present for older adults no matter the stimuli (e.g., word pairs, word-nonword pairs, and word-font pairs). Follow-up studies confirmed the ADH with additional types of stimuli (e.g., picture pairs, Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003; name-face pairs, Naveh-Benjamin, Guez, Kilb, & Reedy, 2004; and dynamic displays of people performing actions, Old & Naveh-Benjamin, 2008b).

Consistent with Naveh-Benjamin’s ADH, a meta-analysis by Old and Naveh-Benjamin (2008a) that examined 90 episodic memory studies found an age-related associative deficit across multiple types of associative memory (i.e., source, context, temporal order, location, and word pairs). The meta-analysis identified significant age-related declines for associative and item memory, with the age-related decrement being significantly greater for associative memory. Results were significant across five out of six types of associative memory, including source (e.g., memory for which word was spoken by which voice), context (e.g., memory for which word appeared in which font), temporal order (e.g., memory for which word was viewed first), location (e.g., memory for where on a screen a word appeared), and item pairs (e.g., memory for which two words appeared together). An earlier meta-analysis of 46 studies that focused on source memory (Spencer & Raz, 1995) found similar results: age-related decrements in associative memory were reliably greater than age-related decrements in item memory. It seems clear from the weight of the aforementioned evidence (e.g., Chalfonte & Johnson, 1996; Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008a; Spencer & Raz, 1995) that an age-related associative deficit exists. The next logical step is to examine what might be causing that deficit.

A number of theories have been proposed to explain age-related memory deficits, some of which suggest possible causative factors for the age-related associative deficit. In their review, Luo and Craik (2008) discuss four theories worth considering regarding aging and memory: general slowing, less efficient inhibitory processes, reduced cognitive control, and reduced attentional resources (for other summaries, see Balota, Dolan, & Ducheck, 2000; Salthouse, 2004). The general slowing theory suggests that aging is accompanied by a decrease in processing speed, which adversely affects memory performance (e.g., Balota et al., 2000; Salthouse, 1996). In fact, Salthouse (1996) posited that the relation between age and memory is almost entirely mediated by processing speed based on a series of path analyses. Although a number of studies indicate that processing speed typically declines with age (e.g., Balota et al., 2000; Salthouse, 1996; Schaie, 1989), Luo and Craik identify several shortcomings with the general slowing theory as it relates to memory impairment, including the fact that age-related declines are also evident in tasks that do not have an obvious speed component. Additionally, Luo and Craik point out that unlimited processing time during encoding (e.g., self-paced study) does not improve older adult memory performance, even though it does improve memory performance in younger adults. Furthermore, in a destination memory experiment (i.e.,Gopie et al., 2010), unlimited processing time during encoding was also insufficient to equalize older and younger adult performance; although there was no time limit to process associations, there was still an age-related decrement in destination memory when younger and older adults were compared.

A second theory regarding age-related declines in memory posits that memory impairment in older adults is due to difficulty inhibiting irrelevant information in working memory (e.g., Hasher & Zacks, 1988; Zacks, Hasher, & Li, 2000). Specifically, Hasher and Zacks (1988) hypothesized that an inability to exclude irrelevant information could affect the ability for relevant information to enter working memory. However, as Luo and Craik (2008) and McDowd and Shaw (2000) point out, experimental data on inhibition are inconsistent, and do not appear to sufficiently explain age-related differences in memory. For example, Rouleau and Belleville (1996) found that younger and older adults were equally distracted by irrelevant auditory information while performing a digit-span task. Furthermore, inhibitory efficiency was found to be equally impaired in younger and older adults in a recent study that used a retrieval-induced forgetting paradigm (i.e., the repeated retrieval of certain information inhibits the retrieval of less well-learned information; Gómez-Ariza, Pelegrina, Lechuga, Suárez, & Bajo, 2009). Another potential issue with the inhibition theory is that what constitutes irrelevant information is debatable as perceptions about what information is valued may be different for older adults compared to younger adults (e.g., A. D. Castel, 2008; Kensinger, 2009; Rahhal, May, & Hasher, 2002). Furthermore, there is no evidence to suggest that inhibitory processes affected older adults' destination memory performance in Gopie et al.'s (2010) study. Participants were tested individually in an experimental setting (i.e., possible distractions were likely limited), and although older adults were impaired in destination memory (i.e., associative memory for face-fact pairings) when compared to younger adults, both groups had similar item memory (e.g., for individual faces and facts).

Although slower processing speed and an inability to inhibit irrelevant information may help explain other cognitive deficits, they do not appear to be the most likely candidates for age-based differences in destination memory. Conversely, reduced cognitive control and reduced attentional resources are two theories regarding age-related memory decrements that do appear to offer explanatory power regarding associative memory performance and aging (Luo & Craik, 2008), and, in particular, destination memory (Gopie et al., 2010; Gopie & MacLeod, 2009). Furthermore, the theories of impaired cognitive control and reduced attentional resources are likely complementary because age–related changes in cognitive control may be partially explained by reduced attentional resources (Balota et al., 2000).

Cognitive Control and Attentional Resources

The cognitive control theory (Luo & Craik, 2008) is also referred to as the dual-process model, or the theory of automatic and consciously-controlled memory processes (e.g., Jennings & Jacoby, 1997; Light, Prull, La Voie, & Healy, 2000; Yonelinas, 2002). The theory differentiates between familiarity, which is thought to be an automatic process, and recollection, which is thought to be a controlled form of memory (Yonelinas, 2002). Specifically, the theory suggests that automatic processing (e.g., recognizing that information is familiar) is largely unaffected by age, whereas controlled, effortful processing (e.g., recalling details of an experience) is adversely affected by age (Jennings & Jacoby, 1993, 1997; Light et al., 2000).

Jennings and Jacoby (1997) suggest that the cognitive control theory can be used to explain repetitive storytelling. They posit that automatic processes (i.e., familiarity) make it easy for a person to recall and want to share a particular story, but that a failure or reduction in controlled processes (i.e., conscious recollection that the story was already told to a particular audience) can cause the story to be repeatedly told to the same person. Jennings and Jacoby designed an experimental protocol that examined repetition of studied and unstudied words across increasing delays in an attempt to understand what might account for possible age differences in repetitive storytelling. Younger and older adults were given a list of words to study and were then given a recognition test that included old (i.e., studied) and new (i.e., not studied) words. During the test phase, old words were presented once and new words were presented twice, with the repeated new word occurring after a certain number of intervening items. Participants were warned that new words would be repeated during the test phase and that old words would be presented only once. The researchers posited that repeated presentation of new test items would function similarly to repeated stories.

Consistent with the notion that older adults rely more heavily on familiarity (i.e., automatic processing) than recollection (i.e., controlled, effortful processing), Jennings and Jacoby (1997) found that older adults committed significantly more repetition errors than younger adults (i.e., they were more likely to state that a new word was an old word when it was presented in the test list a second time). Furthermore, older adults' ability to correctly recollect repetition items (i.e., recollect that a new word was a new word) was impaired early in the protocol, even when only a few items intervened between the first and second presentation of a new word. The finding that older adults are more likely to commit repetition errors has been replicated across studies (Chua, Schacter, & Sperling, 2009; Dodson, Bawa, & Krueger, 2007; Skladzien, 2010). One possibility for why older adults rely more heavily on automatic processes than controlled, effortful processes might be a reduced level of attentional resources.

As a possible explanation for age-related changes in memory, Craik and Byrd (1982) proposed that just as physical energy declines with age, so does mental energy. They defined mental energy as a limited supply of attentional, or processing, resources. Specifically, they suggested that reduced attentional resources could be a major factor in age-related decrements in episodic memory. Consistent with Craik and Byrd's theory of limited attentional resources, many researchers have explored the relation between attentional resources and associative memory performance (e.g., A. Castel & Craik, 2003; Kilb & Naveh-Benjamin, 2007; Kim & Giovanello, 2011; Naveh-Benjamin et al., 2004; Troyer, Winocur, Craik, & Moscovitch, 1999). One common experimental protocol uses a divided attention approach in which participants are asked to engage in two types of tasks simultaneously (i.e., a primary task that tests associative memory and a secondary task that reduces participants' ability to pay attention to the primary task). The purpose of a divided attention approach is to reduce the amount of available attentional resources to determine whether having fewer attentional resources available affects an individual's memory performance.

In a study designed to assess whether reduced attentional resources would adversely affect source memory (i.e., often investigated as a type of associative memory), Troyer et al. (1999) tested younger adults' memory for items and for source under three conditions: full attention (FA), divided attention (DA) using a finger-tapping task, and DA using a visual reaction time task. For the primary task, a word list was presented, and participants were told to learn the words as well as which voice (e.g., male or female) presented each word. Participants in the DA conditions also performed a secondary task (e.g., a finger-tapping task in which they had to sequentially tap the letters “g,” “h,” “j,” and “k” on the keyboard with the fingers of their right hand) during the learning and test phases. The researchers found that divided attention significantly reduced both item and source memory accuracy, but source memory accuracy was most impaired. Thus, results support the notion that associative memory is particularly impaired by a reduction in attentional resources when compared to item memory (see also A. Castel & Craik, 2003; Troyer & Craik, 2000). Because the data support the idea that reduced attentional resources detrimentally affect associative memory performance, the next logical question is whether reduced attentional resources could explain age-related differences in associative memory.

To investigate this idea, researchers have attempted to replicate the age-related deficit in associative memory by dividing younger adults' attention during encoding (e.g., Cooper & Odegard, 2011; Kilb & Naveh-Benjamin, 2007; Kim & Giovanello, 2011; Naveh-Benjamin et al., 2004). The approach was based on the premise that if a reduction in attentional resources is the cause of older adults' associative deficit, then younger adults under a DA condition should mirror the performance of older adults (i.e., exhibit a greater decline in associative memory performance when compared to item memory performance; Cooper & Odegard, 2011; Kilb & Naveh-Benjamin, 2007; Kim & Giovanello, 2011; Naveh-Benjamin et al., 2004). The evidence using this experimental approach is mixed. For example, Naveh-Benjamin et al. (2004) and Cooper and Odegard (2011) found that contrary to predictions, dividing younger adults' attention did not result in the expected decrement in associative memory, but instead resulted in a general decline in memory performance (i.e., impairing associative memory and item memory equally). Similar results were found in Kilb and Naveh-Benjamin (2007) who tested both younger and older adults under FA and DA conditions. Specifically, using a secondary task to divide attention during the study phase did not affect younger adults' associative memory to a greater degree than item memory. Conversely, Castel and Craik (2003) tested younger adults using a DA condition and found a greater decline in associative versus item memory, consistent with the associative deficit seen in older adults.

Confronted with the conflicting empirical evidence, Kim and Giovanello (2011) hypothesized that the mixed findings regarding attentional resources and age-related decrements in associative memory might be an experimental issue driven by the use of inadequate secondary tasks that did not properly stress the attentional resources needed for associative memory tasks. Specifically, they posited that the secondary tasks typically used in divided attention studies (e.g., finger-tapping) draw on general attentional resources rather than attentional resources required for associative processes. Based on this assumption, Kim and Giovanello devised a secondary task that required relational processing. Younger adults were tested for item memory using words and associative memory using word pairs. There were three attentional conditions: FA and two DA tasks. Face pairs were used for the divided attention tasks. Thus, participants in the DA conditions were exposed to both word pairs (for the primary associative memory task) and face pairs (for the secondary divided attention task). Word pairs were presented for four seconds, and face pairs were presented for two seconds, which means that two face pairs were seen during each word pair. The first divided attention task required item processing (DA-I), and the second required relational processing (DA-R). Specifically, the DA-I task required participants to determine the location of the male face in the face pair, and the DA-R task required participants to compare the age of the two faces and detect the location of the older face.

As Kim and Giovanello hypothesized, younger adults' associative memory was more impaired than item memory under the DA-R task, which suggests that previous secondary tasks may not have been appropriately capturing relational processing demands, and also that the age-related deficit in associative memory could possibly be ascribed to reduced attentional resources. Given the uniqueness of their approach, and to address possible questions about task difficulty between the DA-I (locate male face in face pair) and DA-R (estimate age of faces and locate older face) conditions, Kim and Giovanello (2011) subsequently tested a more difficult divided attention item-based task (DA-IH) in which the time available for each task was cut in half. Consistent with earlier results, the harder DA-IH task did not selectively affect associative memory, suggesting that task difficulty was not the cause of the earlier finding that replicated older adults' associative deficit in younger adults through the use of a relationally-driven secondary task.

To expand on their findings and increase the generalizability of their work, Kim and Giovanello (2011) conducted a second experiment that was similar to the first, with two exceptions. First, they changed the DA-R task to a numbers-based task (it was a visually-based task previously) to see if different stimuli would deliver similar results. Additionally, in order to be able to make a direct comparison between the age-related associative deficit typically seen in older adults and the experimentally-induced deficit seen in younger adults in the first experiment, a group of older adults (FA condition) was added to the second experiment. Thus, in the second experiment, the DA-I and DA-IH tasks required participants to detect the odd number in a number pair, and the DA-R task required participants to compare the two numbers and choose which number was larger. As before, the DA-IH task mirrored the DA-I task, but the time available for each task was cut in half. As hypothesized, the pattern of results for older adults (FA condition) and younger adults (DA-R condition) was similar; both age groups had a disproportionate deficit in associative memory as opposed to item memory, a pattern not seen in the other conditions. Overall, their results suggest that reduced attentional resources are a possible factor in associative memory deficits. Although much of the literature reviewed thus far treats attentional resources as a unitary construct, clearly there are different components of attention that could be encapsulated within the notion of attentional resources. One approach that provides a helpful framework for addressing associative memory deficits is to think about limited attentional resources in the context of working memory capacity.

Several recent studies have explored the possible contribution of working memory deficits to age-related differences in associative memory. For instance, Chen and Naveh-Benjamin (2012) conducted a series of computer-based experiments using face-scene pairings to examine item and associative memory in younger and older adults over multiple time periods. Participants were made aware of the nature of the testing. Results from the study supported Chen and Naveh-Benjamin’s hypothesis that age-related associative deficits occur not only over the long term, but also in working memory. They pointed out the potential usefulness of focusing on improving encoding and discussed the possible value that associative strategies could add during the encoding process. In a separate study, Bender and Raz (Bender & Raz, 2012) explored whether reduced working memory capacity and maladaptive beliefs about memory strategies were related to poor associative memory performance. Participants were aware of the nature of the memory task, which consisted of learning word-list pairs. Participants also answered questions about memory strategy efficacy beliefs. Results indicated that both working memory capacity and metacognitive beliefs about memory strategies were related to associative memory performance. Extrapolating from these results, limited attentional resources (i.e., reduced working memory capacity) may help explain the age-related differences found in destination memory (Gopie et al., 2010), a type of associative memory.

Before discussing strategies, another area worth exploring in the context of working memory capacity and associative memory performance is the differential load that monitoring inputs (i.e., source) and outputs (i.e., destination) appear to place on working memory (Gopie, 2008). Several studies have demonstrated that associative memory is adversely affected when actions are self-performed (i.e., monitoring outputs) rather than performed by others (i.e., monitoring inputs; Engelkamp, Zimmer, & Denis, 1989; Koriat, Ben-Zur, & Druch, 1991). For example, Koriat et al. (1991) had participants either perform a task, such as raising a hand, or observe others performing the same task in one of two locations. In comparison to observing others, personally performing the task enhanced memory for the task (i.e., item memory), but adversely affected memory for the location of the task (i.e. associative memory). Similarly, in a study of pairs of imagined self-performed or other-performed actions (e.g., yawning and hammering), Engelkamp et al. (1989) demonstrated that imagined self-performed acts also selectively impaired associative memory compared to imagined other-performed acts. Thus, shifting attention away from oneself appears to improve associative memory.

One explanation for these findings is that performing an act or imagining performing an act requires additional self-generated processes that can draw attention away from the processing of associative relations (Zimmer & Engelkamp, 1989). Gopie (2008) posits that when attentional resources are internally focused (e.g., when sharing personal information), then fewer attentional resources are available to encode the external environment (e.g., with whom the personal information is being shared). This possible explanation is consistent with a source memory experiment by Johnson, Nolde and De Leonardis (1996), in which participants' source memory improved when the participants focused externally on the speaker's feelings rather than internally on their own feelings about statements that were being read (e.g., Halloween is a dangerous holiday). Thus, it can be inferred that destination memory may be more impaired when sharing personal information than when focusing on external information (Gopie & MacLeod, 2009). However, whether an internal or external attentional focus differentially affects destination memory in younger and older adults has yet to be examined in the literature.

Of the four reviewed theories regarding aging and memory (i.e., general slowing, less efficient inhibitory processes, reduced cognitive control, and reduced attentional resources/ working memory capacity), the review of the literature suggests that differences in cognitive control (e.g., Jennings & Jacoby, 1993, 1997; Light et al., 2000) attentional resources (e.g., A. Castel & Craik, 2003; Craik & Byrd, 1982; Kim & Giovanello, 2011), and even more specifically, reduced working memory capacity (e.g., Bender & Raz, 2012; Chen & Naveh-Benjamin, 2012) are likely involved in age deficits in associative memory. It also seems likely that limited attentional resources explain performance differences in destination memory, specifically. Furthermore, it appears that the self-generated processes involved in destination memory create an additional draw on attentional resources (e.g., Engelkamp et al., 1989; Gopie &

MacLeod, 2009; Koriat et al., 1991). What has not yet been examined in the present literature, however, is what type of strategy might increase older adults' destination memory performance.

Strategies to Improve Memory Performance

Memory strategies are cognitive techniques that individuals can use to enhance memory performance above and beyond an otherwise expected outcome (Bjorklund & Douglas, 1997; Gross, 2011). They are often an important tool for older adults because their use can help compensate for age-related declines in memory performance (Hertzog, Kramer, Wilson, & Lindenberger, 2008). A number of studies have explored older adults' usage of memory strategies (e.g., Dunlosky & Hertzog, 2000; Hertzog, McGuire, & Lineweaver, 1998; Kilb & Naveh-Benjamin, 2007; Naveh-Benjamin, Craik, Guez, & Kreuger, 2005) and whether there are ways to improve the memory performance of older adults (e.g., Baltes, Sowarka, & Kliegl, 1989; Cooper & Odegard, 2011; Naveh-Benjamin, Brav, & Levy, 2007; Rabinowitz, Ackerman, Craik, & Hinchley, 1982; Verhaeghen, Marcoen, & Goossens, 1992).

There is some evidence that suggests that older adults do not spontaneously use memory strategies as frequently (Hertzog et al., 1998; Naveh-Benjamin, 2000) or as effectively (e.g., Dunlosky & Hertzog, 2000; Kilb & Naveh-Benjamin, 2007) as younger adults. For example, Hertzog et al. (1998) found that older adults were less likely to use integrative (i.e., relational) memory strategies when compared with younger and middle-aged adults (i.e., only 35% of older adults reported using relational strategies as compared to 49% of younger adults and 58% of middle-aged adults). Similarly, Naveh-Benjamin (2000), when testing the ADH, found that older adults were less likely than younger adults to use any type of associative strategy. Additionally, when older adults did use a strategy, it tended to be a less effective one (e.g., rehearsal) rather than an integrative strategy (e.g., combining the paired items in a sentence). Additionally, Dunlosky and Hertzog (1998) noted that age-related memory differences may be due to older adults' less efficient use of strategies. Results across studies appear to suggest that older adults are less likely to automatically use memory strategies, and if they do use a strategy, the strategies used by older adults tend to be less effective than the strategies used by younger adults.

Although older adults may use cognitive strategies less frequently and effectively than younger adults, older adults do tend to perform better when instructed to use a strategy than when they are not explicitly told to use a strategy (e.g., Naveh-Benjamin et al., 2007; Naveh-Benjamin et al., 2005). In a series of studies by Naveh-Benjamin and colleagues (2007; 2005), half of the participants were told to study word pairs for an upcoming test but were not given a particular strategy (intentional condition/encoding), and the other half were told that previous research had demonstrated that memory performance could be improved by meaningfully relating the members of word pairs through either the creation of a sentence that linked the words or an interactive mental image of the two words (strategy condition/encoding). The participants in the strategy condition were strongly encouraged to use either of the two relational strategies. Naveh-Benjamin and colleagues' results indicated that younger and older adults benefited equally from strategy instructions (i.e., improved associative memory) when compared to the intentional condition without strategy instructions; however, the associative deficit older adults typically experience when compared to younger adults was still present. In the 2007 study, Naveh Benjamin et al. added an additional condition in which participants were told to use a relational strategy (e.g., either the creation of a sentence that linked the words or an interactive mental image of the two words) during both encoding and retrieval (strategy condition/encoding and retrieval). In this condition, the associative deficit older adults typically experience when compared to younger adults was almost eliminated. The studies by Naveh-Benjamin and colleagues confirm that older adults' memory performance can benefit from strategy use, and may benefit even further when reminded to use an appropriate strategy during both encoding and retrieval.

A number of studies have explored how to improve the memory performance of older adults through the use of memory strategies (e.g., Baltes et al., 1989; Cooper & Odegard, 2011; Naveh-Benjamin et al., 2007; Rabinowitz et al., 1982; Verhaeghen et al., 1992). One interesting question is whether older adults need to be explicitly trained in the use of cognitive strategies or are capable of learning useful memory strategies on their own. Baltes, Sowarka, and Kliegl (1989), in an investigation of older adults' ability to strengthen problem-solving skills, examined whether a five-session cognitive training program would produce superior results to self-guided practice. They found no difference, suggesting that with appropriate information, older adults are capable of improving cognitive skills on their own. Similarly, Cooper and Odegard (2011) examined younger and older adults' ability to use new knowledge to guide associative memory. Specifically, participants were tested on their ability to associate words with location on a computer screen (i.e., word-location pairings, in which each word was presented in a specific quadrant on the computer screen). Unbeknownst to participants, categories of related words were used, and the probability that each category of related words was presented in a particular part of the computer screen was fixed by condition. Although participants were not informed of the experimental structure, both younger and older adults were able to recognize that related words were more likely to appear in the same quadrant and use that knowledge to improve the accuracy of their associative memory performance. The fact that older adults can learn and utilize memory strategies independently suggests that if an associative strategy is identified that works well for older adults, then it should be possible to transfer that learning into real-world situations.

A particularly promising memory strategy appears to be the use of mental interactive imagery (e.g., Rabinowitz et al., 1982; Verhaeghen et al., 1992). Using mental imagery to remember associations has been found to be useful in general (Dirkx & Craik, 1992) and also for older adults specifically (Rabinowitz et al., 1982; Verhaeghen et al., 1992). In a meta-analysis of 67 studies related to improving memory in older adults, Verhaeghen et al. (1992) found that older adults benefited from mental imagery memory training when compared to pre-test, control, and placebo groups. All but two of the studies in the meta-analysis used mental imagery methods (e.g., method of loci). No differences were found between subsets of memory training techniques (e.g., method of loci, face-name association techniques). Furthermore, in a study not included in the meta-analysis (Rabinowitz et al., 1982), older adults were able to overcome the age-related associative deficit when instructed to form an interactive image of pairs of unrelated words during encoding. Similar to the findings by Naveh-Benjamin and colleagues (Naveh-Benjamin et al., 2007; Naveh-Benjamin et al., 2005), Rabinowitz et al. (1982) found that older and younger adults improved memory performance equally when instructed to find a commonality between items. However, older adults improved memory performance to a greater extent than younger adults when asked to use interactive mental imagery, thereby overcoming the associative deficit older adults typically experience when compared to younger adults. Given that older adults benefit from using associative memory strategies, but are less likely to use them than younger adults, it is worth exploring whether destination memory can be improved through the use of a strategy. Based on the reviewed studies, it appears that the use of mental imagery is an appropriate place to start.

Destination Memory

As a relatively new concept, the research that has specifically examined destination memory is scarce, but growing. In addition to the two initial studies by Gopie and colleagues (Gopie, Craik, & Hasher, 2011; Gopie & MacLeod, 2009), three studies have been conducted recently. In the first investigation, Gopie and MacLeod (2009) conducted three experiments to assess destination memory, using younger adults from an undergraduate subject pool. Results demonstrated that destination memory was more error-prone than source memory, sharing personal rather than general information decreased the accuracy of destination memory, and shifting focus externally improved destination memory. All three experiments used a computer-based protocol in which facts (e.g., women live seven years longer than men do) and faces of famous people (e.g., Angelina Jolie) were paired and presented.

Their first experiment compared destination and source memory in a between-subjects design. For the study phase in the destination memory condition, participants saw a fact on the screen, read it silently, pressed a spacebar, and then told the fact to a famous face. This procedure was repeated 50 times with 50 different facts verbalized to 50 different faces. For the study phase in the source memory condition, the procedure was the same except that participants were “told” the facts by famous people (i.e., they saw the face first, then the fact). In the recognition memory test phase, participants were presented with facts, faces, and face-fact pairings and asked if they have seen the fact, face, or face-fact pairing previously. The results of the first experiment suggested that destination memory accuracy was 16% worse than source memory accuracy.

Gopie and MacLeod’s second experiment explored how manipulating the degree of self-focus might affect destination memory. This hypothesis was addressed in a between-subjects design by having participants share either personal facts (e.g., my age is ___) or general facts (e.g., women live seven years longer than men do) with famous faces. As the authors hypothesized, sharing personal facts rather than general facts did worsen destination memory. They suggested that increasing internal focus (i.e., sharing personal facts) reduced the amount of attentional resources available for the associative memory task (i.e., face-fact pairings), thereby worsening destination memory.

In their third experiment, Gopie and MacLeod (2009) explored the impact of shifting focus externally on destination memory. Using a between-subjects design, participants either stated the name of the famous person prior to telling the general fact to the famous person (e.g., Angelina Jolie, women live seven years longer than men do) or did not state the name of the person. Stating the name of the person prior to telling them a fact, or shifting attention externally, did improve destination memory. They suggested that shifting attention externally increased the amount of attentional resources available for the associative memory task, thereby increasing destination memory.

Expanding upon Gopie and MacLeod's work, Gopie, Craik and Hasher (2010) explored age differences in destination and source memory by comparing younger and older adults. They used a similar experimental protocol to the previous study and demonstrated that, consistent with the previous study, destination memory was less accurate than source memory. This finding was evident for both younger and older adults. Additionally, although item memory (i.e., memory for individual facts and individual faces) was comparable among the two age groups, destination memory was 24% worse for older adults compared to younger adults. No age-related difference was found for source memory.

The current study's hypotheses and research questions were based on the work summarized thus far. Subsequent to the beginning of the current study, three additional works have been published that explored destination memory. Two studies by El Haj and colleagues (El Haj, Postal, & Allain, 2011; El Haj, Postal, Le Gall, & Allain, 2013) compared destination memory in younger adults, older adults, and patients with mild Alzheimer's Disease. They also explored possible executive functioning correlates of destination memory. In their 2013 study they also examined destination memory under enacted (i.e., telling facts to faces) versus imagined (i.e., imagining telling facts to faces) conditions. The protocol was similar to that of Gopie and colleagues because they tested for the association between faces and facts. However, the trials were administered by the researcher, item memory was not assessed, and the enacted and imagined conditions were conducted within subjects one week apart.

Across studies El Haj and colleagues found an age/disease effect (i.e., destination memory accuracy was lowest in patients with Alzheimer's Disease, second lowest among older adults, and highest in younger adults). Furthermore, in their 2013 study, El Haj et al., found that participants performed significantly worse in the imagined condition (i.e., imagining telling facts to faces, which they equated with internal memory processes) compared to the enacted condition (i.e., telling facts to faces, which they equated with external memory processes). Therefore, similar to Gopie and colleagues, internal focus negatively affected destination memory performance when compared to external focus. Additionally, both studies identified several executive functioning measures that were significantly correlated with destination memory performance, namely inhibition (Stroop), shifting (Plus-Minus), and binding (Binding) tasks. Of the three predictive measures, the Stroop was most strongly correlated with destination memory, $r = -.39$ in the enacted condition and $r = -.43$ in the imagined condition. The authors hypothesize that their results suggest that declining inhibitory processes may be driving age-related destination memory changes. Of course, caution is indicated due to the correlational nature of their analyses; it is also possible that other unmeasured variables may be correlated with destination memory changes.

In a third recently completed destination memory master's thesis, Germino (2012) compared destination and source memory, with the objective of exploring the attentional demands of the two types of memory. The study utilized a novel protocol in which participants engaged in pre-scripted virtual conversations involving the exchange of facts (participants were told they were testing questions for an online quiz show). Participants' memory for the virtual conversations was then measured (i.e., item - the facts; task designation - were they told a fact or did they tell a fact; and context - with whom was the fact exchanged). To manipulate attentional demands, the level of fact rehearsal was manipulated (i.e., participants were given the opportunity to rehearse some facts once and some facts three times). All variables were measured within subjects. In brief, the study found that 1) increased item rehearsal did not improve hits but did increase false alarms, 2) participants were better able to remember to whom they had told facts than who had told them facts (task designation) and 3) there was an interaction between context (with whom the fact was exchanged) and rehearsal, in which increased rehearsal impaired source memory but not destination memory. In explaining the interaction, the author hypothesized that perhaps the person's role (i.e., telling a fact to someone or hearing a fact from someone) affected successful encoding. To continue that thought further, perhaps in the more active role of imparting information, the participant was more effortful, which may have led to a deeper level of processing (Craik & Lockhart, 1972).

Study Rationale and Specific Aims

Destination memory is an under-studied construct with real world implications, particularly for older adults. Knowing whether certain information has been shared with another person is important (e.g., not sharing crucial information with a medical provider could affect medical care). Additionally, repetitious conversational behavior may contribute to negative age-related perceptions of older adults (Bieman-Copland & Ryan, 2001). Thus, it is important to verify that destination memory impairment is an issue for older adults. Secondly, if an age-related deficit is identified, it is worth exploring what might cause the deficit in order to find potential ways to improve it. Although limited attentional resources may explain age-related memory differences (A. Castel & Craik, 2003; Craik & Byrd, 1982; Kim & Giovanello, 2011) and may negatively affect destination memory in younger adults (Gopie & MacLeod, 2009), researchers have not yet examined the effect of attentional resources on destination memory in older adults. Finally, although research suggests that associative strategies may improve older adults' memory (Naveh-Benjamin et al., 2007; Naveh-Benjamin et al., 2005; Rabinowitz et al., 1982; Verhaeghen et al., 1992), researchers have not yet explored how to prevent or ameliorate possible destination memory deficiencies in older adults.

The objective of the current study was to replicate and extend the original work of Gopie and colleagues (Gopie et al., 2010; Gopie & MacLeod, 2009) by examining age differences between younger and older adults in destination memory across four task focus conditions (i.e., general, self, refocus, imagery). The general condition, which compared destination memory performance in younger and older adults, was designed to replicate the work of Gopie et al. (2010), and was considered the control group in the current experiment. The self and refocus conditions expanded on Gopie and MacLeod's work by exploring how manipulating attentional resources (i.e., internal vs. external focus) affected destination memory performance in younger and older adults. The self condition increased the load on attentional resources by having participants focus internally (i.e., sharing personal facts). The refocus condition shifted participants' attention externally (i.e., saying the famous person's name prior to sharing a fact with them). Examining the influence of varied attentional resources on destination memory performance was previously studied by Gopie and MacLeod in younger, but not older, adults.

To further extend Gopie and colleagues' research on destination memory, an imagery condition was explored in the study. The objective was to examine whether providing older adults with an associative memory strategy could boost destination memory performance. To assess the effect of strategy utilization on destination memory and to eliminate any potential strategy production differences between younger and older adults, participants were provided with specific visual strategies to use for each general fact. Also, it is worth noting that the previous destination memory studies were conducted as a set of sequential experiments (Gopie et al., 2010; Gopie & MacLeod, 2009). The current study evaluated age differences across all four conditions in one experiment to make the results more comparable across conditions. There were three research questions:

RQ1 was "Are There Age Differences Between Younger and Older Adults in Destination Memory?"

A main effect for age was expected: it was anticipated that older adults would be more impaired on destination memory than younger adults. The main effect for age was predicted based on the weight of the evidence regarding an age-related associative deficit (e.g., Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008a), the fact that destination memory is associative in nature, and Gopie et al.'s (2010) finding regarding age differences in general destination memory.

RQ2 was "Will Varying Attentional Resources Affect Destination Memory?"

A main effect for task focus was anticipated. Specifically, destination memory was expected to be weakest in the self condition, stronger in the general condition, even stronger in the refocus condition and strongest in the imagery condition.

Part of the main effect for task focus (i.e., weaker in the self condition and stronger in the refocus condition) was predicted based on the literature that suggests that shifting focus either internally or externally during an associative memory task appears to alter the attentional resources available to encode the external environment (Engelkamp et al., 1989; Koriat et al., 1991). Additionally, Gopie and MacLeod's (2009) findings support the prediction of a main effect for focus. Specifically, in their experiments among younger adults shifting focus internally (i.e. the self condition) worsened destination memory performance and shifting focus externally (i.e., the refocus condition) improved destination memory performance among younger adults).

RQ3 was "Will the Use of Imagery Reduce the Associative Deficit Typically Seen Among Older Adults?"

The anticipated main effect for task focus was due to the attentional manipulations discussed above and also the exploratory imagery condition. Imagery was expected to be the strongest of the four task focus conditions based on the fact that destination memory is a type of associative memory and mental imagery to remember associations has been found to be useful in prior research (Dirkx & Craik, 1992; Rabinowitz et al., 1982; Verhaeghen et al., 1992). Furthermore, an interaction effect was anticipated; it was predicted that younger adults would outperform older adults in the general, self, and refocus conditions; whereas, the imagery condition was expected to diminish the age differences found in destination memory. Studies suggests that older adults are less likely than younger adults to spontaneously use associative memory strategies (Naveh-Benjamin, 2000), yet older adults seem to benefit from using memory strategies (e.g., Naveh-Benjamin et al., 2007; Rabinowitz et al., 1982; Verhaeghen et al., 1992), particularly when the strategies are relational (Naveh-Benjamin et al., 2007). The interaction effect was predicted based on the evidence that younger adults were likely to outperform older adults in the general, self, and refocus conditions (e.g., Engelkamp et al., 1989; Gopie et al., 2010; Koriat et al., 1991); however, it was expected that the use of strategies (i.e., the imagery condition) would reduce these age differences (Rabinowitz et al., 1982) to a nonsignificant level.

CHAPTER II

METHOD

The study's methodology was designed to be a partial replication and extension of two previous research studies on destination memory (Gopie et al., 2010; Gopie & MacLeod, 2009). Building on a protocol developed by Gopie and MacLeod (2009), younger and older adult participants told general (e.g., women live seven years longer than men do) or personal facts (e.g., my age is ___) to pictures of famous peoples' faces (e.g., Angelina Jolie). Each famous person was told one unique fact. The ability to remember to whom particular facts were told (i.e., face-fact pairings) is how destination memory was assessed. The ability to remember individual faces and individual facts is how item memory was assessed. Although destination memory accuracy was the dependent variable of interest, item memory accuracy was included to ensure that any differences in destination memory were not driven by differences in item memory.

Design

The design of the study was a 2 (age: young, old) x 4 (task focus: general, self, refocus, imagery) x 3 (memory type: face-fact pairings, faces, facts) mixed factorial ANOVA with age and task focus as between-subjects variables and memory type as a within-subjects variable. The dependent measure was corrected recognition data (i.e., the proportion of hits minus the proportion of false alarms) for memory type (face-fact pairings, faces, facts), where a hit represents a correct "yes" response and a false alarm represents an incorrect "yes" response.

Task Focus Conditions

General. In the general condition, younger and older participants told general facts (e.g., women live seven years longer than men do) to pictures of famous people. This condition was designed to directly replicate the format of previous destination memory research studies (Gopie et al., 2010; Gopie & MacLeod, 2009) and acted as a control group in the study.

Self. In the self condition, younger and older participants told personal facts (e.g., my age is ____) to pictures of famous people. The objective of this condition was to assess whether an internal focus would adversely affect destination memory by shifting attentional resources away from the associative task (Koriat et al., 1991). The self condition was designed to expand on previous research; the influence of self focus on destination memory has previously been tested among younger, but not older, adults (Gopie & MacLeod, 2009).

Refocus. In the refocus condition, younger and older participants said the famous person's name before telling the person a general fact (e.g., Angelina Jolie, women live seven years longer than men do). The refocus condition was designed to assess whether shifting focus externally (i.e., to the famous person) would strengthen destination memory by shifting attentional resources to the associative task and increasing the contextual information of the memory trace (Koriat et al., 1991). The refocus condition expanded on previous research; the influence of an external focus on destination memory had previously been tested among younger, but not older, adults (Gopie & MacLeod, 2009).

Imagery. In the imagery condition, younger and older participants were provided with a particular associative memory strategy for each fact and asked to use the strategy while telling each person a general fact. For example, for the fact "a dime has 118 ridges around the edge," participants were told to imagine seeing a dime on the person's head when telling the person the fact. To assess the effect of strategy utilization and to eliminate any potential strategy production differences between younger and older adults, participants were provided with specific visual strategies to use for each general fact. This condition was designed to assess how using a specific associative memory strategy would affect destination memory performance.

Materials and Measures

Prescreen

Potential older adult participants were asked several questions when initially contacted. In addition to scheduling considerations, they were asked about their age, vision, native language, and whether anything would prevent them from being able to read/see English items on a computer screen and press keys on a keyboard. Due to the nature of the study, anyone with significant vision, language, or computer usage limitations was not considered for further participation. Two older adults were eliminated at the prescreen stage due to vision concerns.

Face and Fact Pools

One 60-item face pool and two separate 60-item fact pools (i.e., general and self) were used in the study. The 60-item face pool consisting of pictures of famous faces (e.g., Angelina Jolie; see Appendix A for names) and was used in all task focus conditions. One 60-item fact pool, consisting of general facts (e.g., women live seven years longer than men do; see Appendix B), was used for three task focus conditions (i.e., general, refocus, and imagery). A second 60-item fact pool, consisting of personal facts that participants customized (e.g., “my age is ___;” see Appendix C), was used for the self focus condition. Specific faces and facts were chosen for inclusion based on the results of a pilot study conducted prior to the main study.

Face and fact pools pilot study. The purpose of the pilot was to ensure that the 60-item face and fact pools (i.e., faces, general facts, personal facts) used in the main study were age equivalent across younger and older adults. The study was fielded via Qualtrics, an online survey program. The 35 participants were recruited via personal contacts and included 21 younger (eligible ages 18-30, *M* = 19.22 *SD* = 0.44, range = 19-20) and 14 older (eligible ages 65+, *M* = 71.57, *SD* = 6.35, range = 66-88) adults.

Each participant in the pilot study was presented with 80 items each for the face pool, general fact pool, and the personal fact pool, from which 60 items were chosen for each pool. To replicate and expand on previous destination memory research, the facts and faces used in previous research studies (Gopie et al., 2010; Gopie & MacLeod, 2009) were included as part of the pilot when appropriate (e.g., Canadian-specific celebrities unknown to most people in the United States, and facts targeted towards younger adults were excluded from the pilot). Faces were judged on recognition (e.g., participants were given four names for each photograph and asked to choose the name of the person in the photograph; there also was an option to choose "I don't know"). General facts were judged on interest (e.g., very uninteresting, uninteresting, interesting, very interesting), and personal facts were judged on ease of completion (e.g., very difficult, difficult, easy, very easy). Specific items were chosen for each pool based on equivalent performance among younger and older adults. When age equivalency was met for more than 60 items, then items with lower overall scores were eliminated (e.g., faces with lower recognition accuracy). All analyses were evaluated at 95% confidence level.

Pilot results – faces. For the face pool, a chi-square analysis revealed that there were no statistical differences in recognition between younger and older adults for 61 out of 80 items. For the 60 items chosen, total sample recognition accuracy ranged from 40-100%, with 58 of the 60 items in the 60-100% accuracy range, and 48 of the 60 items in the 80-100% accuracy range. Of the 20 discarded items, 19 items were eliminated based on the size of statistical difference between younger and older adults to control for age bias in familiarity. The remaining eliminated item was chosen because it was lowest in total sample recognition accuracy of the 61 items with no statistical difference in recognition between younger and older adults. Of note, there were 9 faces with 100% recognition by both younger and older adults.

Pilot results – general facts. For the general fact pool, the independent samples *t*-test revealed that there were no statistical differences in interest between younger and older adults for 75 out of the 80 items. The 20 discarded items were eliminated based on statistical difference in interest (5 items); close to statistical difference in interest (2 items); low interest (8 items); and inaccuracy (5 items were identified as inaccurate facts after the pilot test was completed). For the 60 items chosen, total sample interest means ranged from 2.20 (SD = 0.83) to 3.11 (SD = 0.87) on a 4-point scale (i.e., 1 = very uninteresting, 2 = uninteresting, 3 = interesting, 4= very interesting). These results suggest that the facts were relatively neutral statements.

Pilot results – personal facts. For the personal fact pool, the independent samples *t*-test revealed that there was no statistical difference in ease of completion between younger and older adults for 69 out of the 80 items. The 20 discarded items were eliminated based on statistical difference (11 items) and difficulty of completion (9 items). For the 60 items chosen, total sample ease of completion means ranged from 2.83 (SD = 0.92) to 3.94 (SD = 0.24) on a 4-point scale (i.e., 1 = very difficult, 2 = difficult, 3 = easy, 4 = very easy). These results suggest that the personal fact were relatively easy to complete for the participants.

Imagery Strategies

Participants were provided with specific associative imagery strategies to use for each face-fact pairing in the imagery task focus condition. Strategies were described to the participants as mental images. For example, for the fact “a dime has 118 ridges around the edge,” participants were told to imagine seeing a dime on the person’s head when telling the person the fact (see Appendix D). Imagery strategies were developed by the researcher and informally reviewed by 2 older and 2 younger adults for clarity and ease of use.

Controlling Program

The experiment was conducted on IBM-compatible computers, and the controlling program was written in E-Prime (Schneider, Eschman, & Zuccolotto, 2002). This program was based on the programs used in previous research (Gopie et al., 2010; Gopie & MacLeod, 2009). Similar to Gopie and colleagues' research, the facts and faces were presented in the center of the computer screen. To improve readability for older adults, the facts were presented in 18-point lowercase black font and both facts and faces were presented against a white background (Gopie presented facts using 14-point white font on a black background).

Destination Memory

Destination memory was operationally defined as the ability of participants to remember to whom (i.e., which faces) they told which facts. After the participants told 50 facts to 50 faces, they were presented with either the destination memory recognition test or the item memory recognition test (counterbalanced design). For the destination memory recognition test, participants were presented with 20 old face-fact pairings (i.e., intact pairings that occurred in the study phase) and 20 new pairings (i.e., mismatched pairings containing items that appeared in the study phase, but were paired with different items in the study phase). See Figure 1 for additional details. The participants indicated (i.e., definitely no, unsure no, unsure yes, or definitely yes) whether they previously saw each face-fact pairing. Similar to Gopie's research studies, destination memory was assessed by comparing corrected recognition data for face-fact pairings, which was operationally defined as the proportion of hits minus the proportion of false alarms. Hits were defined as correct "yes" responses (i.e., old pairings that were correctly identified as having been seen previously), and false alarms were defined as incorrect “yes” responses (i.e., new pairings that were incorrectly identified as having been seen previously). For instance, if out of the 20 old pairings, a person correctly identified 10 as having been seen previously, the person’s proportion of hits would be .50 (10 divided by 20) and if out of the 20 new pairings the same person incorrectly identified 5 as having being seen previously, the person’s proportion of false alarms would be .25 (5 divided by 20). Thus the person’s corrected recognition score would be .25 (.50 – .25).

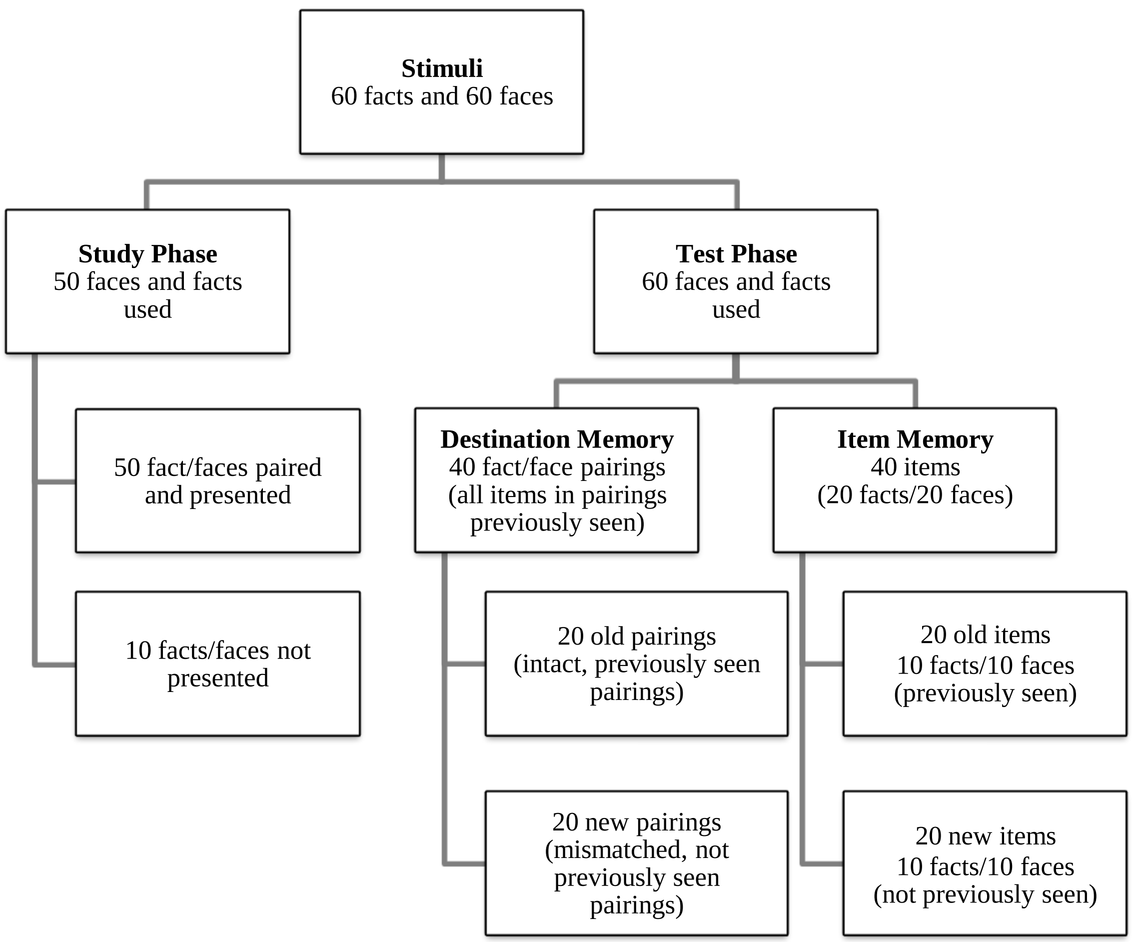

Figure 1. Presentation of face and fact stimuli in study and test phases. In the test phase, the presentation order of destination memory and item memory was counterbalanced across participants.

Item Memory

Item memory was operationally defined as the ability to recognize individual faces and individual facts, independent of the pairings. After the participants told 50 facts to 50 faces, they were presented with either the destination memory recognition test (i.e., pairings) or the item memory recognition test in a counterbalanced design. For the item memory recognition test, they were presented with 20 facts and 20 faces; 10 of each were seen by the participants in the study phase, and 10 of each were not seen in the study phase. See Figure 1 for additional details. The participants indicated (i.e., definitely no, unsure no, unsure yes, or definitely yes) whether they had previously seen each fact or face one at a time.

Similar to destination memory, item (faces, facts) memory was assessed using corrected recognition data, which was operationally defined as the proportion of hits minus the proportion of false alarms. Hits were defined as items (faces, facts) that were correctly identified as having been seen previously, and false alarms were defined as items (faces, facts) that were incorrectly identified as having been seen previously. Although item memory was not a focus of this study, data were collected to verify that any significant destination memory differences were operating independently of item memory. Although the literature is mixed on age-related item memory deficits (for a review of multiple studies, see Old & Naveh-Benjamin, 2008a), a nonsignificant result for item memory was expected based on Gopie et al.'s (2010) findings. Specifically, they found a significant age difference in destination memory performance (i.e., older adults' performed significantly worse than younger adults on destination memory), but item memory was unaffected by age.

Exit Questionnaire

An exit questionnaire was used to determine age, gender, level of education completed, and ethnicity in order to describe the sample. Native language and self-reported vision also were verified. Participants also were asked if they had any difficulty reading the information on the computer screen or understanding the instructions (Appendix E). Any participants who indicated they had difficulty were asked follow-up questions prior to their departure to clarify whether they understood the nature of the task.

Mini Mental Status Exam (MMSE)

Older adults were assessed for cognitive impairment using the MMSE (Folstein, Folstein, & McHugh, 1975). The MMSE is an 11-question measure that tests five areas of cognitive functioning: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is broadly used as an indicator of cognitive impairment (Mitchell, 2009). McDowell, Kristjansson, Hill, and Hébert (1997) found adequate internal consistency ($\alpha = .78$) of the MMSE when used as a screening test for cognitive impairment and dementia. Test-retest reliability was reported at .887 (Folstein et al., 1975). In a recent meta-analysis, Mitchell (2009) analyzed the results from 34 dementia studies and five mild cognitive impairment studies. In memory clinic settings, the MMSE had a pooled sensitivity of 79.8%, specificity of 81.3%, positive predictive value of 86.3%, and negative predictive value of 73%, suggesting that the MMSE was a sufficient assessment of memory impairment for this study. No participants scored below the pre-determined cutoff value of 24.

Participants

A total of 192 participants were tested. Younger adults (*N* = 96) were randomly selected from Indiana University of Pennsylvania's subject pool (i.e., undergraduate students currently enrolled in a General Psychology course for whom participation in the study partially fulfilled the research requirement of the course). Older adults (*N* = 96) were volunteers from the community recruited through local advertising, participant referral, and personal contacts. As a participation incentive, older adults were given the opportunity to have their names placed in a drawing for a $25 gift card; a drawing was conducted after the completion of data collection.

Inclusion Criteria

There were four main inclusion criteria. Participants had to: (1) meet age requirements (i.e., younger: 18-30, older: 65+); (2) be able to read and comprehend material written in English; (3) be able to adequately see faces and facts on a computer screen; and, (4) be able to press keys on a computer keyboard. Additionally, older adults were assessed for cognitive impairment using the Mini-Mental Status Exam (MMSE; Folstein et al., 1975), a commonly used screener for cognitive impairment in clinical settings as well as in cognition studies with older adult participants (Mitchell, 2009; Tombaugh, McDowell, Kristjansson, & Hubley, 1996). A score of 23 or lower is widely accepted as an appropriate cutoff score for cognitive impairment (Mitchell, 2009). Participant MMSE scores ranged from 25 to 30 (*M* = 29.13, *SD* = 1.14), thus all older adults tested met the MMSE inclusion criteria.

In summary, no participants were excluded based on the inclusion criteria; however, it is worth noting that an additional ten participants attempted the study, but were not included in the sample. Specifically, two older adults were unable to complete the study due to computer malfunctions; four older adults voluntarily withdrew from the study, (two withdrew due to frustration and two withdrew due to visual difficulties); and data from four participants (two younger, two older) were discarded based on reported task confusion.

Demographics

The participants in the final sample ranged in age from 18-91 years. Younger adults (*N* = 96) ranged in age from 18-27 years, (*M* = 19.41, *SD* = 1.86), and older adults (*N* = 96) ranged in age from 65-91 years, (*M* = 74.01, *SD* = 6.59). See Figure 2 for a histogram of older adult ages.

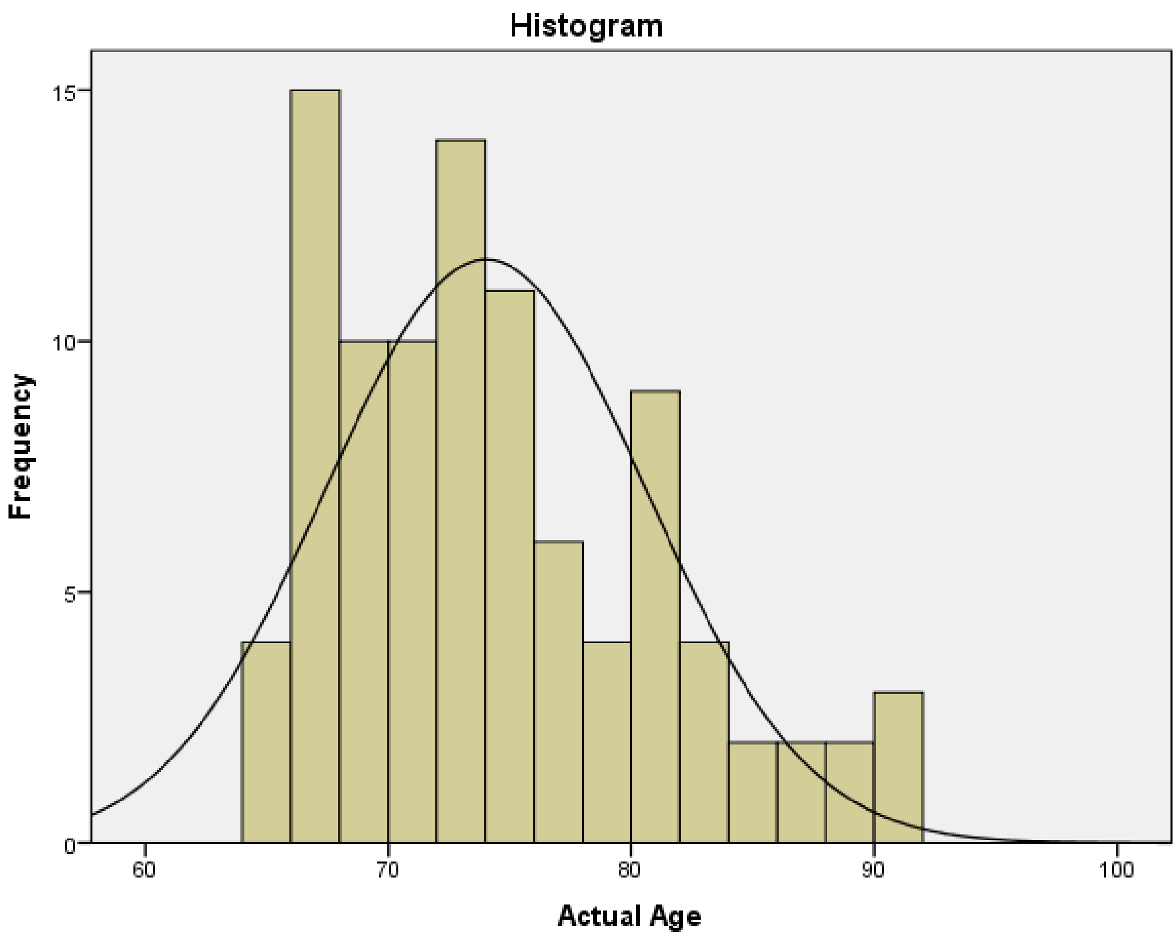

Figure 2. Histogram of ages of older adult participants.

All younger adults were tested on the university's campus (*N* = 96), whereas the older adults were tested either at their own home (*N* = 22) or at someone else's home (*N* = 69). Some older adults (N = 5) were tested on campus. All younger adults were tested in Pennsylvania (N = 96), whereas the older adults were tested in both Pennsylvania (N = 31) and Florida (N = 65). There were no testing effects by location, $t(89) = -1.47$, $p = .15$ (analysis excluded 5 older adults tested on campus), or state $t(94) = -1.04$, $p = .29$, on destination memory for older adults. Therefore, the location of testing did not influence the outcome of the results for older adults. The majority of the younger participants were White (76%), female (63%) and highly educated (M = 12.63, SD = 1.13. The majority of the older participants were also White (98%), female (67%), and highly educated (M = 16.44, SD = 3.54). Younger and older adults differed significantly in years of education, $t(190) = 10.05$, $p < .001$, as is often seen in developmental studies because the younger adults were still pursuing their formal education. However education was not significantly correlated with destination memory, $r(192) = -.12$, $p = .099$. See Table 4 for additional demographic information.

Procedure

Potential participants were prescreened for the inclusion criteria. Those who qualified were individually tested either in a laboratory setting or a location of their choice (e.g., at home). Participants were randomly assigned to condition. Once informed consent was provided, the computerized administration began.

Computerized Administration

Study phase. In a replication of the procedure used in Gopie's studies (Gopie et al., 2010; Gopie & MacLeod, 2009), all participants told 50 facts to 50 faces. Individual items (i.e., faces and facts) were presented in random order and the pairings of faces and facts were also random. The study phase began with brief instructions (Appendix F). Participants were

Table 1

Demographic Characteristics of Participants

	Younger Adults (*N* = 96)			Older Adults (*N* = 96)		
Demographic Variable	*M*	*SD*	*Range*	*M*	*SD*	*Range*
Age	19.41	1.86	18-27	74.01	6.59	65-91
Education	12.63	1.13	12-19	16.44	3.54	7-25
	n	%		n	%	
Gender						
Male	36	37.5		32	33.3	
Female	60	62.5		64	66.7	
Ethnicity						
Caucasian	73	76.0		94	97.9	
African American	19	19.8		0	0.0	
Asian	1	1.0		0	0.0	
Hispanic	1	1.0		2	2.1	
Multi-racial	2	2.1		0	0.0	
State Tested						
Pennsylvania	96	100.0		31	32.3	
Florida	0	0.0		65	67.7	
Testing Location						
Campus	96	100.0		5	5.2	
Person’s Home	0	0.0		22	22.9	
Someone Else’s Home	0	0.0		69	71.9	

instructed to tell facts to faces. Following the instructions, a 1,000-ms black fixation cross was presented on a white background. What happened next, varied by the task focus condition.

General. Following the fixation cross, a general fact was then presented (Appendix B). The participant read the fact silently, and then pressed the space bar, which resulted in a 250-ms blank screen. Next, a picture of a famous face was presented. While speaking aloud, the participant told the face the fact that he or she just read, followed by pressing the space bar. After another 250-ms blank screen, the next fact was presented, followed by the blank screen, and then the famous person's face. This procedure continued until the participant told 50 different facts to 50 different faces. The same procedure was followed for all four task focus conditions with the following exceptions by condition.

Self. Following the fixation cross, the facts presented in the self condition were the personal facts (Appendix C). Participants in the self condition saw the beginning of a fact (i.e., a fact cue) and were instructed to silently read the cue and fill in their answer before pressing the spacebar to display a face. For instance, a 68-year old participant who saw the personal fact, "My age is ___," would have completed the statement in his or her head, pressed the spacebar to display the face, and then said aloud, "My age is 68." The procedure otherwise mirrored the general condition.

Refocus. Following the fixation cross, a general fact was then presented (Appendix B) just as in the general condition. In fact, participants in the refocus condition followed the exact same procedure as participants in the general condition with one difference: participants in the refocus condition were presented with the person's name below the person's picture and were instructed to say the famous person's name aloud prior to telling the person a general fact. To ensure that all participants were equally aware of each famous person's name, the famous person's name was displayed on the screen below the famous person's face. For perspective, Gopie and MacLeod (2009), for their refocus condition, used a familiarization phase in which participants were exposed to the face stimuli and related names prior to beginning the actual experiment. Given that the current study compared participants across four conditions, adding a familiarization phase to the refocus condition would have created unequal exposure to stimuli prior to the experiment or lengthened the experiment across conditions. Displaying the famous person's name on the screen below the famous person's face was a parsimonious solution.

Imagery. Following the fixation cross, participants in the imagery condition were provided with a fact (e.g., a blink lasts 0.3 seconds) and a related mental image (e.g., imagine the person constantly blinking his or her eyes) on the same screen. Participants were told to read the mental image (Appendix D) silently and the fact (Appendix B) silently before pressing the spacebar to display a face. Speaking aloud, the person told the face the fact that he or she just read while using the provided mental image. The procedure otherwise mirrored the general condition.

For all task focus conditions the researcher stayed with the participant through the first pairing to ensure that the participant understood and followed the instructions. The researcher then left the room except in instances where it was not feasible (i.e., when testing participants in their own homes it was not always possible for the researcher to be in a separate room).

Test phase. The test phase consisted of the counterbalanced recognition memory tests, which determined destination memory performance and item memory performance. There were no testing effects by presentation order, $t(190) = 0.05$, $p = .96$. Each recognition memory test began with instructions presented on the screen (Appendix F), and the participant was advised to call the researcher at each instruction screen (only the researcher knew how to advance the program past the instruction screens). As in the study phase, the researcher remained in the room for the first item presented to ensure that the participant understood and was properly executing the written testing instructions.

Destination memory. For destination memory performance, a face and fact were presented simultaneously on the computer screen, with the fact appearing below the face. Participants decided whether they told the fact to the face during the study phase by pressing the number on the keyboard that corresponded to their level of certainty (i.e., 1 = definitely no, 2 = unsure no, 3 = unsure yes, 4 = sure yes). Once a response was made, a 250-ms blank screen was presented, followed by the next pairing. A total of 40 face-fact pairings were presented (i.e., 20 old pairings and 20 new pairings).

Item memory. For item memory performance, 20 facts and 20 faces were presented individually on the computer screen. Participants decided whether they read the fact or saw the face during the study phase by pressing the number on the keyboard that corresponded to their level of certainty (i.e., 1 = definitely no, 2 = unsure no, 3 = unsure yes, 4 = sure yes). Once a response was made, a 250-ms blank screen was presented, followed by the next face or fact. A total of 40 faces and facts were presented (i.e., 10 old facts, 10 new facts, 10 old faces, and 10 new faces). After the participant responded to all face-fact pairings and all individually presented faces and facts, the computerized administration was complete.

Paper Administration

Following the computerized administration, participants completed a brief paper and pencil exit questionnaire. Participants who identified difficulty with the study were verbally asked to describe the nature of the difficulty. Older participants were then assessed for cognitive impairment using the MMSE and given the opportunity to complete an entry for the gift card drawing. Lastly, all participants were provided a copy of informed consent, a debriefing form, and thanked for their participation.

CHAPTER III

RESULTS

The main study analyses are divided into four sections based on the study's design. The first section will review the results of the study from the overall model. The remaining three sections will address the follow-up analyses to the three primary research questions (i.e., age differences in destination memory, effect of varying attentional resources on destination memory, effect of associative memory strategy on destination memory) when appropriate. Alpha was set equal to .05 for all analyses.

Data Management

There were no missing data; the computerized portion of the test required participants to answer each question before proceeding, and the researcher reviewed exit questionnaire data before the participant left. Prior to conducting any analyses, 100% of the manually entered data (i.e., exit questionnaire, MMSE) were checked by a research assistant, and then the data were examined for outliers. Data from 192 individuals were examined using standardized residuals. An outlier analysis was conducted for destination memory, as well as for both components of item memory (faces and facts). No outliers were detected falling outside the range of –3 to +3 (Norusis, 2002).

Overall Results

Consistent with prior destination memory research (El Haj et al., 2011; El Haj et al., 2013; Gopie et al., 2010; Gopie & MacLeod, 2009), the dependent variable calculated for each participant was a corrected recognition score (proportion of hits minus proportion of false alarms). Table 2 presents the means and standard deviations of corrected recognition data for each memory task (i.e., destination memory, face, fact) by age group (i.e., young, old) and task

Table 2

Corrected Recognition Means and Standard Deviations for Condition, Age and Memory Type

			Destination Memory		Item Memory: Face		Item Memory: Fact	
Condition	Age	n	M	(SD)	M	(SD)	M	(SD)
General	Young	23	.44	(.23)	.75	(.21)	.95	(.08)
	Old	24	.20	(.27)	.61	(.33)	.80	(.23)
	Total	47	.32	(.28)	.68	(.28)	.87	(.19)
Self	Young	24	.33	(.24)	.76	(.19)	.93	(.11)
	Old	24	.16	(.20)	.66	(.26)	.88	(.14)
	Total	48	.25	(.23)	.71	(.23)	.90	(.13)
Refocus	Young	24	.37	(.23)	.81	(.18)	.92	(.23)
	Old	24	.21	(.23)	.77	(.23)	.92	(.13)
	Total	48	.29	(.24)	.79	(.20)	.92	(.18)
Imagery	Young	25	.66	(.25)	.84	(.14)	.96	(.09)
	Old	24	.49	(.28)	.71	(.31)	.84	(.27)
	Total	49	.58	(.28)	.78	(.25)	.90	(.21)
Total	Young	96	.45	(.27)	.79	(.18)	.94	(.14)
	Old	96	.27	(.28)	.69	(.29)	.86	(.21)
	Total	192	.36	(.29)	.74	(.24)	.90	(.18)

focus (i.e., general, self, refocus, imagery). To assess for group differences in corrected recognition scores, a 2 (age: young, old) x 4 (task focus: general, self, refocus, imagery) x 3 (memory type: destination, face, fact) mixed factorial ANOVA was conducted with memory type as a within-subjects variable and age and focus as between-subject variables. Mauchly's test indicated that the assumption of sphericity was violated ($\chi^2(2) = 8.80$, $p = .012$); therefore, degrees of freedom for within-subject effects were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .96$).

The overall model revealed a main effect of memory type, $F(1.91, 351.49) = 417.93$, $p < .001$, $\eta_p^2 = .69$ with performance on the destination memory task being significantly lower (*M* = .36, *SD* = .29) than item memory for faces (*M* = .74, *SD* = .24), which was significantly lower than item memory for facts (*M* = .90, *SD* = .18). There was also a significant main effect for age, $F(1, 184) = 29.03$, $p < .001$, $\eta_p^2 = .14$, with older adults (*M* = .61, *SD* = .26 performing significantly worse overall than younger adults (*M* = .73, *SD* = .19). Additionally, there was a main effect for task focus $F(3, 184) = 7.02$, $p < .001$, $\eta_p^2 = .10$, with participants in the imagery condition (*M* = .75, *SD* = .24) performing significantly better than the refocus (*M* = .67, *SD* = .21), general (*M* = .63, *SD* = .25), and self (*M* = 62, *SD* =.20) conditions. The main effects of age and task focus were qualified by interactions between age and memory type, $F(1.91, 351.49) = 3.66$, $p = .029$, $\eta_p^2 = .02$, and between task focus and memory type, $F(5.73, 351.49) = 9.50$, $p < .001$, $\eta_p^2 = .13$. The age and task focus interaction was not significant, $F(3, 184) = 1.07$, $p = .361$, $\eta_p^2 = .02$, and the three-way interaction was not significant, $F(5.73, 351.49) = .22$, $p = .97$, $\eta_p^2 = .00$. Overall model results are presented in Table 3.

Table 3

Analysis of Variance Examining Group Differences in Corrected Recognition Scores

Source	*Df*	*MS*	*F*	*η*	*p*
Age	1	2.14	29.03	.14	.00
Task Focus	3	0.52	7.02	.10	.00
Memory Type	1.91	15.56	417.93	.69	.00
Age x Task Focus	3	0.08	1.07	.02	.36
Age x Memory Type	1.91	0.14	3.66	.02	.03
Task Focus x Memory Type	5.73	0.35	9.50	.13	.00
Age x Task Focus x Memory Type	5.73	0.01	0.22	.00	.97

The follow-up analyses described below for the two significant two-way interactions (i.e., age by memory type, task focus by memory type) were analyzed through linear contrasts to ensure that identified differences in destination memory performance were not simply due to differences in item memory performance.

Research Question Results

RQ1 was "Are There Age Differences Between Younger and Older Adults in Destination Memory?"

Unlike Gopie et al.'s (2010) study, which found a nonsignificant age difference in item memory (i.e., memory for faces and facts), younger and older participants in this study differed in item memory as indicated by the age by memory type interaction (see Figure 3). To assess whether younger and older adults differed in destination memory irrespective of item memory differences, a linear contrast was conducted that assessed age differences on destination memory versus age differences on item (i.e., faces and facts) memory performance. The contrast revealed that older adults were more impaired than younger adults on destination memory, above and beyond differences in item memory, $F(1.91, 351.49) = 6.64$, $p < .001$, $\eta_p^2 = .34$.

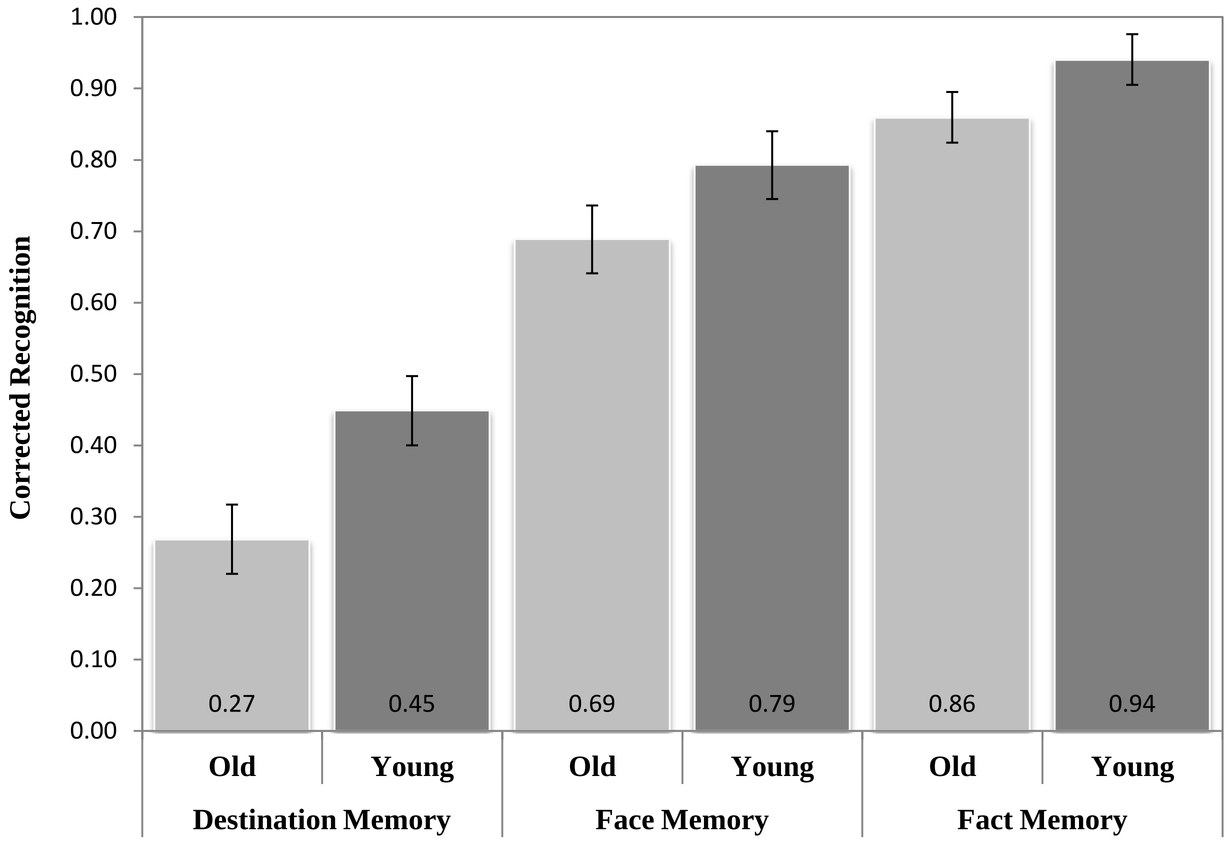

Figure 3. Age x Memory Type interaction. Data are mean corrected recognition scores (i.e., proportion of hits minus proportion of false alarms). Error bars represent standard errors of the mean.

To obtain further information regarding the destination memory discrepancy between older and younger adults, the proportions of hits and false alarms for destination memory accuracy contained in Table 4 were examined in a 2 (age: young, old) x 2 (response: hits, false alarms) mixed factorial ANOVA. There was a significant main effect for response, $F(1, 190) = 338.70$, $p < .001$, $\eta_p^2 = .64$, with the proportion of hits ($M = .70$, $SD = .21$) significantly exceeding the proportion of false alarms ($M = .34$, $SD = .25$). There was no main effect for age,

$F(1, 190) = 1.60$, $p = .21$, $\eta_p^2 = .01$; however, there was a significant age by response interaction, $F(1, 190) = 21.88$, $p < .001$, $\eta_p^2 = .10$ (see Figure 4). Follow-up Bonferroni-adjusted pairwise comparisons revealed a significant difference in false alarms by age $F(1, 190) = 12.46$, $p = .001$, $\eta_p^2 = .06$, with a higher proportion of false alarms for older adults ($M = .41$, $SD = .29$) than younger adults ($M = .28$, $SD = .19$). Conversely, there was a nonsignificant difference in hits $F(1, 190) = 3.66$, $p = .057$, $\eta_p^2 = .02$.

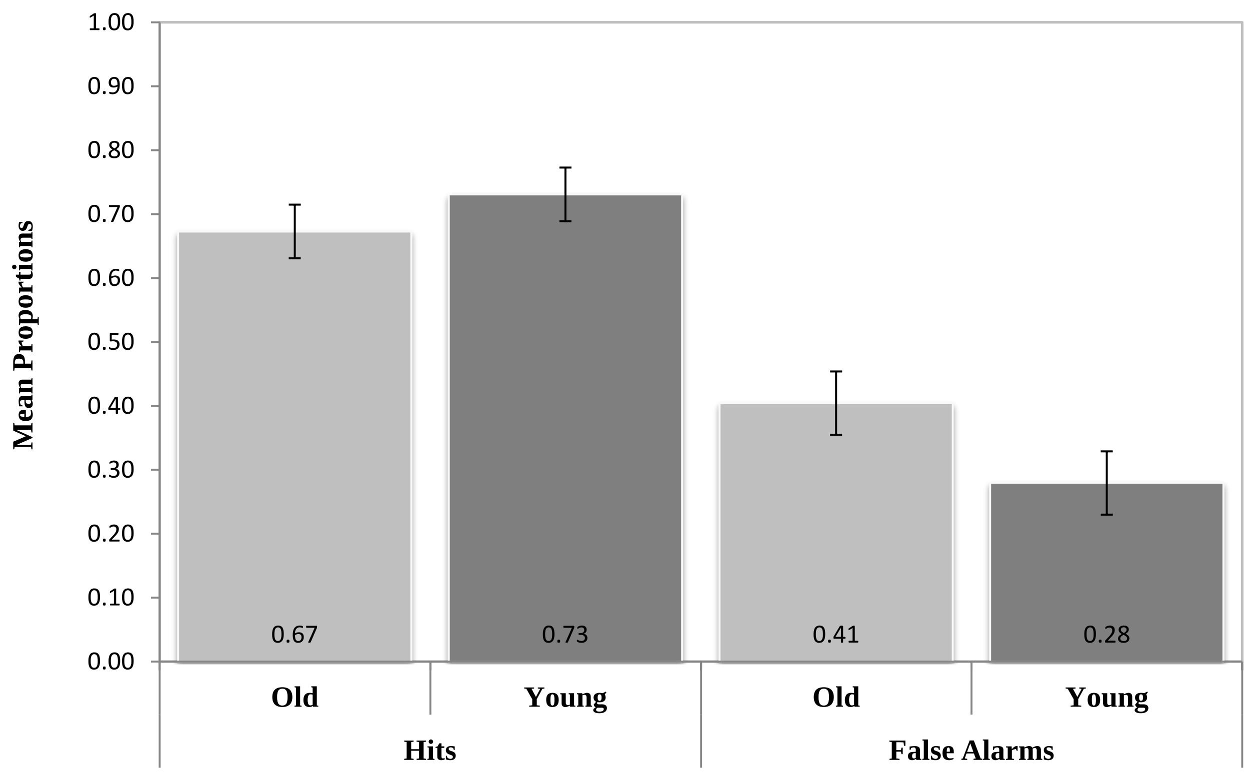

Figure 4. Age x Response interaction for destination memory. Data are mean proportions. Error bars represent standard errors of the mean.

To assess possible awareness of destination memory deficits, high-confidence answers were analyzed (i.e., “definitely no” and “definitely yes”) for hits, misses, false alarms, and correct rejections (see Table 4). Similar to Gopie at al.’s study, item memory confidence for

Table 4

Proportions of Hits, False Alarms, and High-Confidence Responses by Age and Memory Type

			High-confidence responses			
Age and Memory Type	Hit	False alarm	Hit	Miss	False alarm	Correct rejection
Destination						
Old	.67 (.02)	.41* (.03)	.43* (.03)	.12 (.01)	.18* (.02)	.35* (.03)
Young	.73 (.02)	.28* (.03)	.51* (.03)	.09 (.01)	.10* (.02)	.45* (.03)
Face						
Old			.77 (.02)			.76 (.03)
Young			.77 (.02)			.76 (.03)
Fact						
Old			.88 (.02)			.92 (.02)
Young			.95 (.02)			.95 (.02)

Note. The proportions of hits and false alarms were not calculated for item memory (e.g., faces and facts) because destination memory was the outcome of interest. Within high-confidence responses, misses and false alarms were not calculated for item memory because the data were too infrequent to analyze (i.e., all $M < .10$). Significant age group differences are indicated by an asterisk.

faces and facts was analyzed separately from destination memory confidence because item (face and fact) data for misses and false alarms were too infrequent to analyze (i.e., all $M < .10$). A 2 (age: young, old) x 2 (memory type: face, fact) x 2 (high-confidence response: hit, correct rejection) ANOVA revealed a significant main effect for memory type, $F(1, 190) = 128.75$, $p < .001$, $\eta_p^2 = .40$, with participants making significantly more high-confidence responses for facts

(M = .92, SD = .17) compared to faces (M = .76, SD = .24). All other main effects and interactions were nonsignificant, all $F \leq 2.73$, $p \geq .10$, $\eta_p^2 \leq .01$.

For the destination memory confidence analysis, a 2 (age: young, old) x 4 (high-confidence response: hit, miss, false alarm, correct rejection) ANOVA was conducted. Mauchly's test indicated that the assumption of sphericity was violated ($\chi^2(5) = 274.81$, $p < .001$); therefore, degrees of freedom for within-subject effects were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .67$). There was a significant main effect for response, $F(2.02, 382.93) = 146.61$, $p < .001$, $\eta_p^2 = .44$, with all response types being significantly different from each other, all $p \leq .018$. In order from most to least high-confidence responses were hits (M = .47, SD = .26), correct rejections (M = .40, SD = .27), false alarms (M = .14, SD = .20), and misses (M = .10, SD = .12). There was no main effect for age for destination memory high-confidence responses, $F(1, 190) = 1.07$, $p = .30$, $\eta_p^2 = .01$; however, there was a significant age by response interaction, $F(2.02, 382.93) = 8.30$, $p < .001$, $\eta_p^2 = .04$ (see Figure 5).

Follow-up Bonferroni-adjusted pairwise comparisons revealed three significant age differences in destination memory confidence (i.e., hits, false alarms, and correct rejections) Misses were the only response type with non-significant results. Significant results were as follows: high-confidence hits by age, $F(1, 190) = 5.15$, $p = .024$, $\eta_p^2 = .03$, with younger adults (M = .51, SD = .24) having a greater proportion of high-confidence hits than older adults (M = .43, SD = .27); high-confidence false alarms by age $F(1, 190) = 8.08$, $p = .01$, $\eta_p^2 = .04$, with older adults (M = .18, SD = .25) having a greater proportion of high-confidence false alarms than younger adults (M = .10, SD = .13); and high-confidence correct rejections by age $F(1, 190) = 6.53$, $p = .01$, $\eta_p^2 = .03$, with younger adults (M = .45, SD = .26) having a greater proportion of high-confidence correct rejections than older adults (M = .35, SD = .27). Results for high-confidence misses by age were non-significant, $F(1, 190) = 2.70$, $p = .10$, $\eta_p^2 = .01$. In sum, younger adults had a greater proportion of high-confidence hits and correct rejections (i.e., accurate responses) and older adults had a greater proportion of high-confidence false alarms (an inaccurate response).

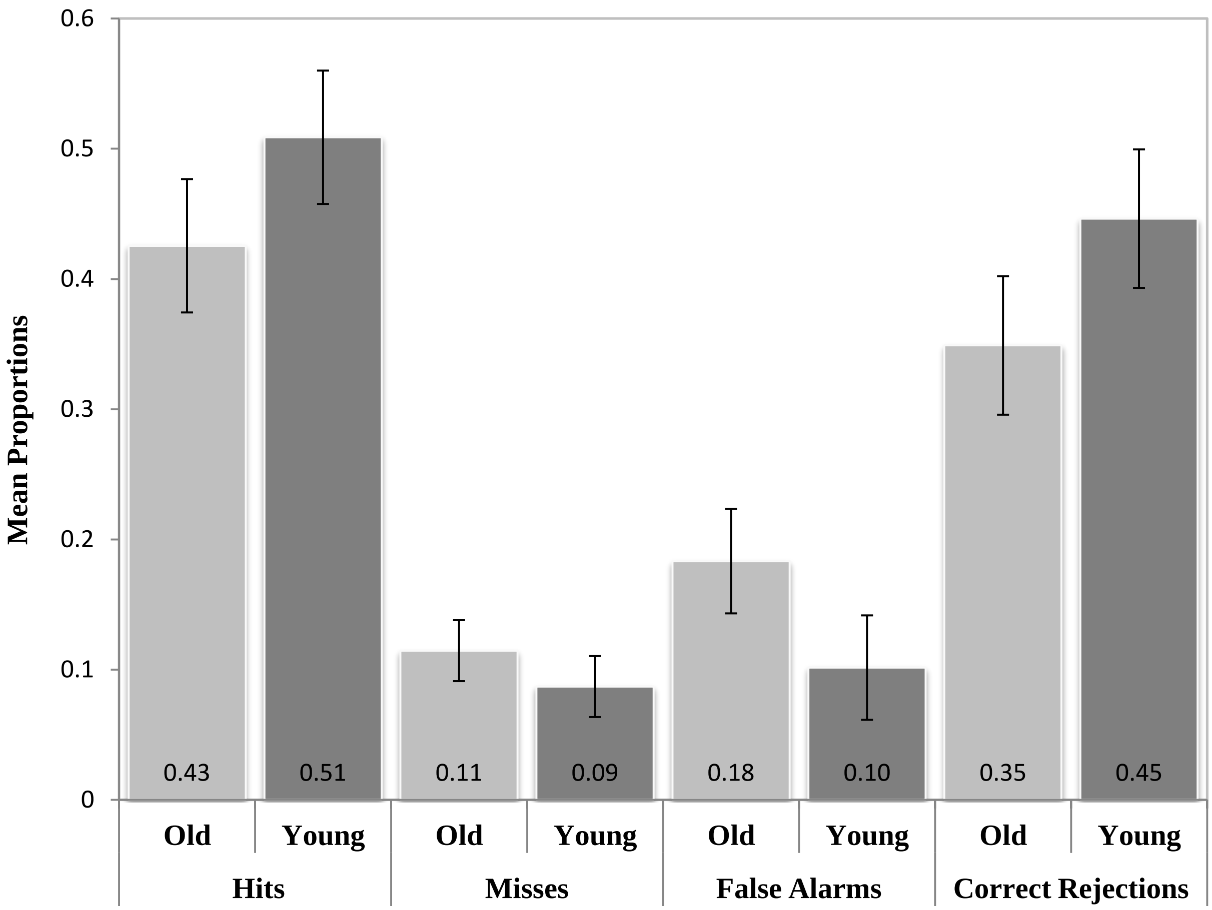

Figure 5. Age x Response interaction for destination memory high-confidence responses. High confidence responses are responses in which the participant answered either "definitely no" or "definitely yes" as opposed to "unsure no" or "unsure yes." Data are mean proportions. Error bars represent standard errors of the mean.

Gopie et al. (2010) also found a main effect for response, no main effect for age, and an interaction effect between age and response. However, their age by response interaction was attributable to an increase in high-confidence misses in older adults. To obtain directly comparable results to Gopie et al.'s study (i.e., only the general condition was tested among older adults in their study), a 2 (age: young, old) x 4 (response: hit, miss, false alarm, correct rejection) was conducted with high-confidence responses for the general condition only, with the age by response interaction being of interest for comparison purposes (see Table 5).

Table 5

High-Confidence Responses by Age for the General Condition

	High-confidence responses			
Age	Hit	Miss	False alarm	Correct rejection
Old	.36 (.05)	.16* (.03)	.20* (.04)	.36 (.05)
Young	.43 (.05)	.06* (.03)	.08* (.04)	.36 (.05)

Note. Significant age group differences are indicated by an asterisk.

Bonferroni-adjusted pairwise comparisons for the age by response interaction in the general condition revealed a significant difference in both high-confidence false alarms and misses (see Figure 6). Results for high-confidence false alarms were $F(1, 45) = 4.23$, $p = .046$, $\eta_p^2 = .09$, with a higher proportion of high-confidence false alarms for older adults ($M = .20$, $SD = .26$) than younger adults ($M = .08$, $SD = .08$), and results for high-confidence misses were $F(1, 45) = 5.13$, $p = .028$, $\eta_p^2 = .10$, with a higher proportion of high-confidence misses for older adults ($M = .16$, $SD = .19$) than younger adults ($M = .06$, $SD = .08$).

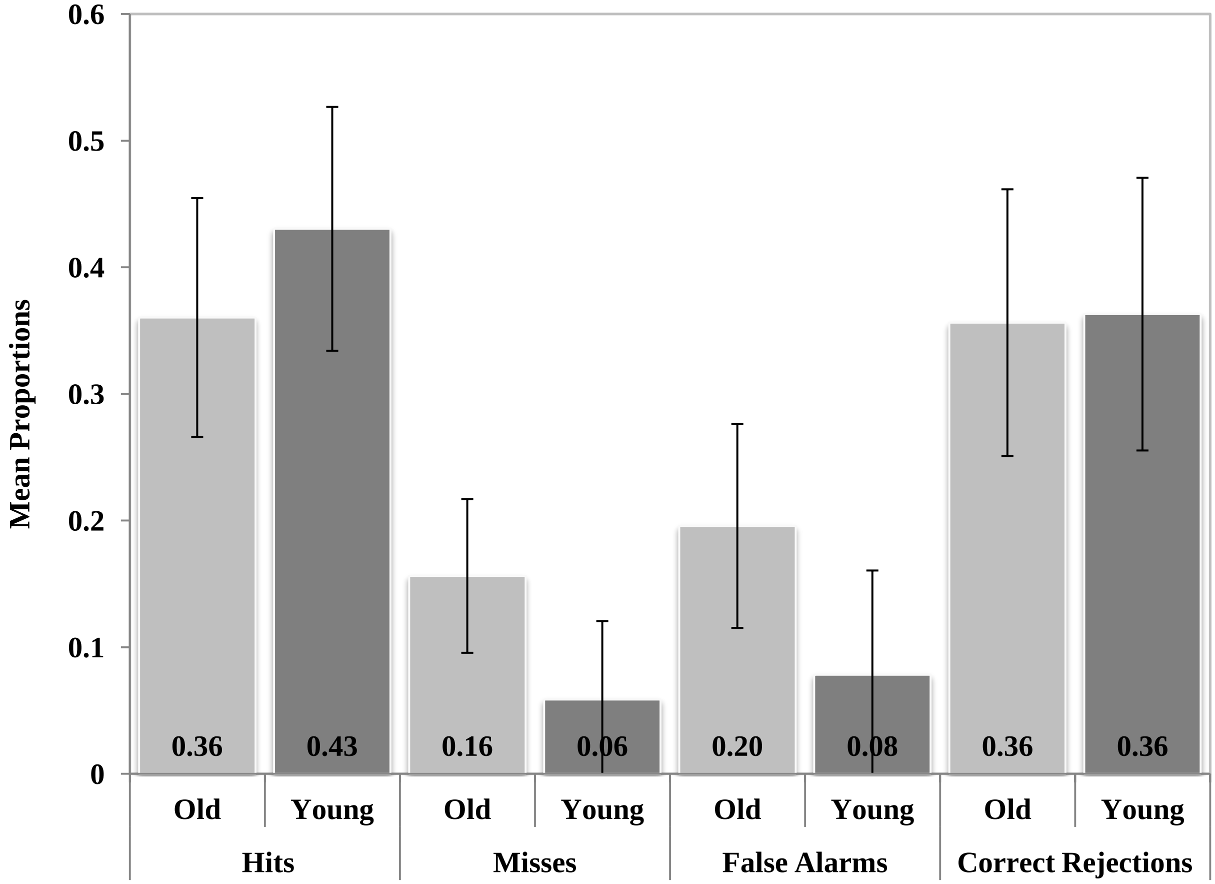

Figure 6. Age x Response interaction for destination memory high-confidence responses in the general condition only. High-confidence responses are responses in which the participant answered either "definitely no" or "definitely yes" as opposed to "unsure no" or "unsure yes." Data are mean proportions. Error bars represent standard errors of the mean.

RQ2 was "Will Varying Attentional Resources Affect Destination Memory?"

The overall analysis revealed a significant task focus by memory type interaction, $F(5.73, 351.49) = 9.50$, $p < .001$, $\eta_p^2 = .13$ (see Figure 7). Based on previous research by Gopie and MacLeod (2009), it was expected that varying attentional resources in the self and refocus conditions would affect destination memory across age groups. Specifically, it was expected that relative to the baseline general condition, destination memory would be weaker in the self condition and stronger in the refocus condition.

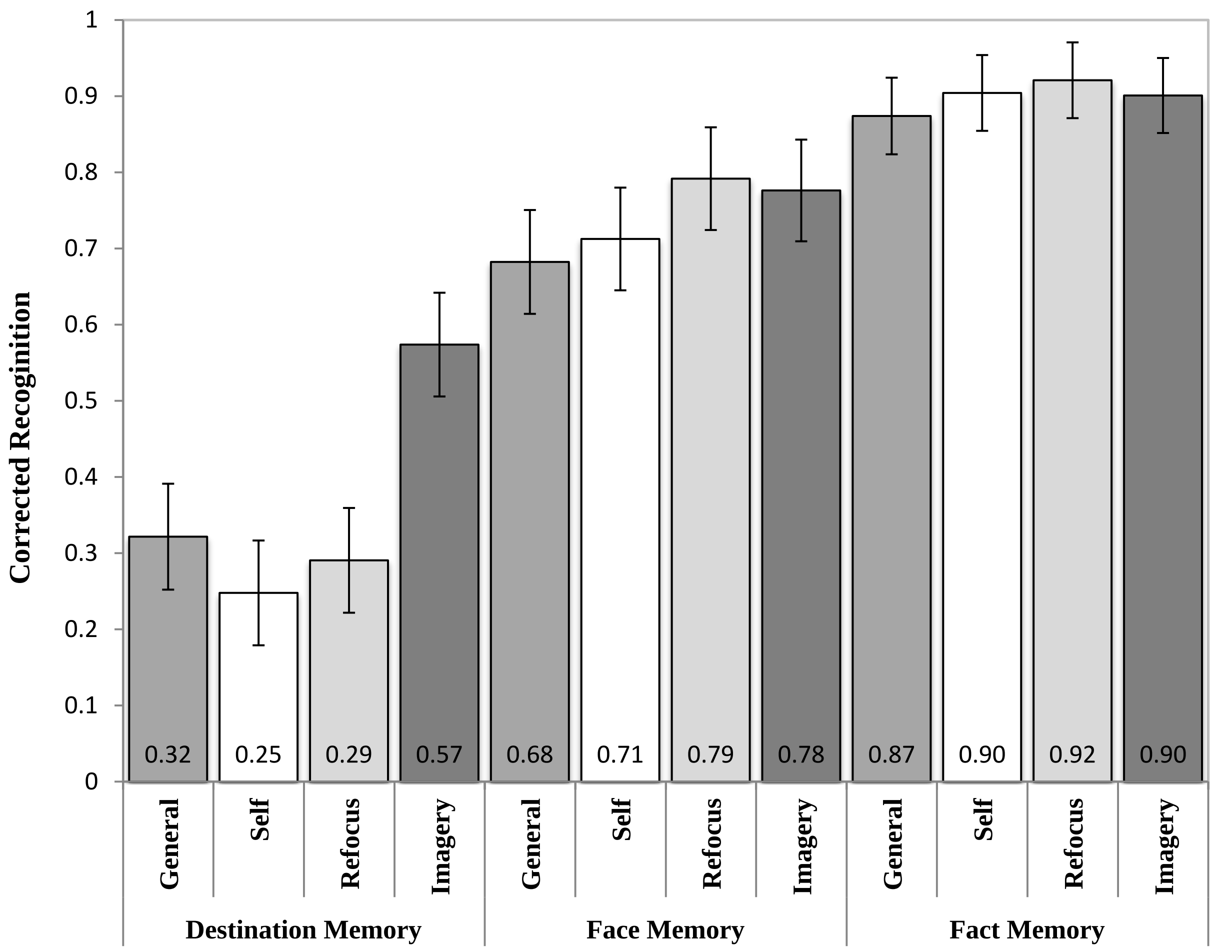

Figure 7. Task Focus x Memory Type interaction. Data are mean corrected recognition scores (i.e., proportion of hits minus proportion of false alarms). Error bars represent standard errors of the mean.

To assess whether there were condition differences in destination memory irrespective of condition differences in item memory, two linear contrasts were conducted that compared the conditions of interest (i.e., self with general, refocus with general) on destination memory performance versus item memory (i.e., faces and facts) performance.

The first contrast revealed that participants in the self condition were more impaired than participants in the general condition on destination memory, after accounting for differences in item memory, $F(5.73, 351.49) = 4.68$, $p < .001$, $\eta_p^2 = .02$, whereas the second contrast between participants in the general and refocus conditions was not significant, $F(5.73, 351.49) = 0.96$, $p = .45$, $\eta_p^2 = .00$.

RQ3 was "Will the Use of Imagery Reduce the Associative Deficit Typically Seen Among Older Adults?"

As mentioned in the overall results, the main effect for task focus was driven by participants in the imagery condition performing significantly better than participants in the other three conditions. Given that there was a significant task focus by memory type interaction, $F(5.73, 351.49) = 9.50$, $p < .001$, $\eta_p^2 = .13$ (see Figure 7), a linear contrast was conducted to assess whether destination memory accuracy in the imagery condition was significantly better than destination memory accuracy in the other conditions after accounting for any differences in item memory. The linear contrast compared the imagery condition to the other three conditions combined. Results revealed that the usage of a provided associative memory strategy (i.e., imagery) significantly improved destination memory accuracy when compared to the other three conditions, irrespective of changes in item memory, $F(5.73, 351.49) = 44.81$, $p < .001$, $\eta_p^2 = .19$.

The overall model's nonsignificant age by condition interaction was unexpected. It had been anticipated that younger adults would outperform older adults in the three other conditions, but that the use of an associative strategy (e.g., imagery) would ameliorate the age-related deficit. To obtain further information regarding how the imagery condition affected destination memory in older and younger adults, the proportions of hits and false alarms for destination memory for the imagery condition were examined in a 2 (age: young, old) x 2 (imagery response: hits, false alarms) mixed factorial ANOVA (see Table 6).

Table 6

Proportions of Hits, False Alarms, and High-Confidence Responses by Age for Destination Memory in the Imagery Condition

			High-confidence responses			
Age	Hit	False alarm	Hit	Miss	False alarm	Correct rejection
Old	.72* (.03)	.23 (.04)	.52* (.04)	.12 (.02)	.09 (.03)	.55* (.05)
Young	.83* (.03)	.17 (.04)	.69* (.04)	.07 (.02)	.08 (.03)	.68* (.05)

Note. Significant age group differences are indicated by an asterisk.

There was a significant main effect for response, $F(1, 47) = 229.76$, $p < .001$, $\eta_p^2 = .83$, with the proportion of hits in the imagery condition ($M = .77$, $SD = .18$) significantly exceeding the proportion of false alarms in the imagery condition ($M = .20$, $SD = .19$). There was no main effect for age, $F(1, 47) = .86$, $p = .36$, $\eta_p^2 = .02$; however, there was a significant age by response interaction, $F(1, 47) = 4.68$, $p = .036$, $\eta_p^2 = .09$ (see Figure 8). Follow-up Bonferroni-adjusted pairwise comparisons revealed a significant difference in hits in the imagery condition $F(1, 47) = 7.68$, $p = .008$, $\eta_p^2 = .14$, with a higher proportion of hits for younger adults ($M = .83$, $SD = .11$) than older adults ($M = .72$, $SD = .16$) in the imagery condition. Conversely, there was no difference in false alarms $F(1, 47) = .99$, $p = .32$, $\eta_p^2 = .02$.

To examine whether the imagery condition specifically affected age-related destination memory confidence, a 2 (age: young, old) x 4 (response: hit, miss, false alarm, correct rejection) was conducted only with high-confidence responses for the imagery condition. Mauchly’s test indicated that the assumption of sphericity was violated ($\chi^2(5) = 62.20$, $p < .001$); therefore, degrees of freedom for within-subject effects were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .68$). Results revealed that in addition to significant main effects for response,

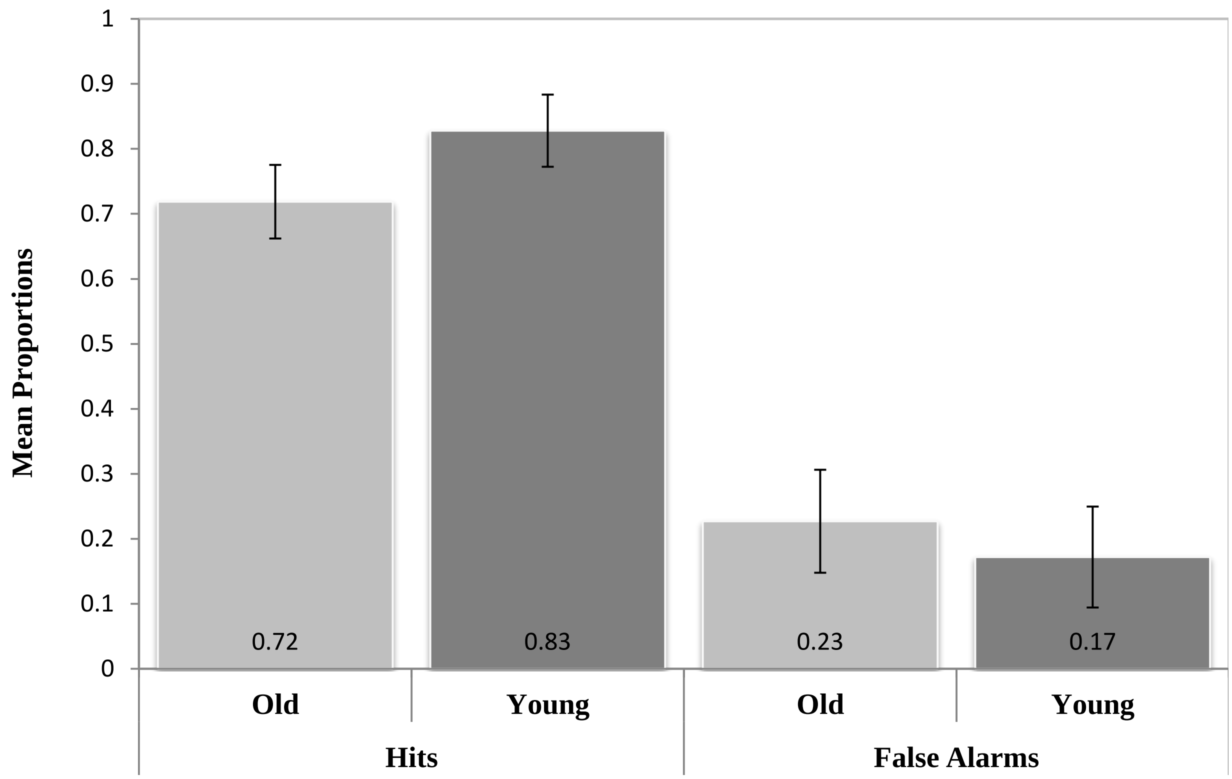

Figure 8. Age x Response interaction for destination memory in the imagery condition only. Data are mean proportions. Error bars represent standard errors of the mean.

$F(2.04, 95.94) = 144.01$, $p < .001$, $\eta_p^2 = .75$, and age, $F(1, 47) = 6.89$, $p = .01$, $\eta_p^2 = .13$, there also was a significant response by age interaction, $F(2.04, 95.94) = 4.88$, $p < .001$, $\eta_p^2 = .09$ (see Figure 9).

Follow-up Bonferroni-adjusted pairwise comparisons revealed two significant age differences (i.e., hits and correct rejections; see Table 6). For high-confidence hits by age in the imagery condition, results were $F(1, 47) = 9.56$, $p < .001$, $\eta_p^2 = .17$, with younger adults ($M = .69$, $SD = .17$) having a greater proportion of high-confidence hits than older adults ($M = .52$, $SD = .22$). For high-confidence correct rejections by age in the imagery condition, results were $F(1, 47) = 4.07$, $p = .049$, $\eta_p^2 = .08$, with younger adults ($M = .68$, $SD = .21$) having a greater proportion of high-confidence hits than older adults ($M = .55$, $SD = .27$). There were no age

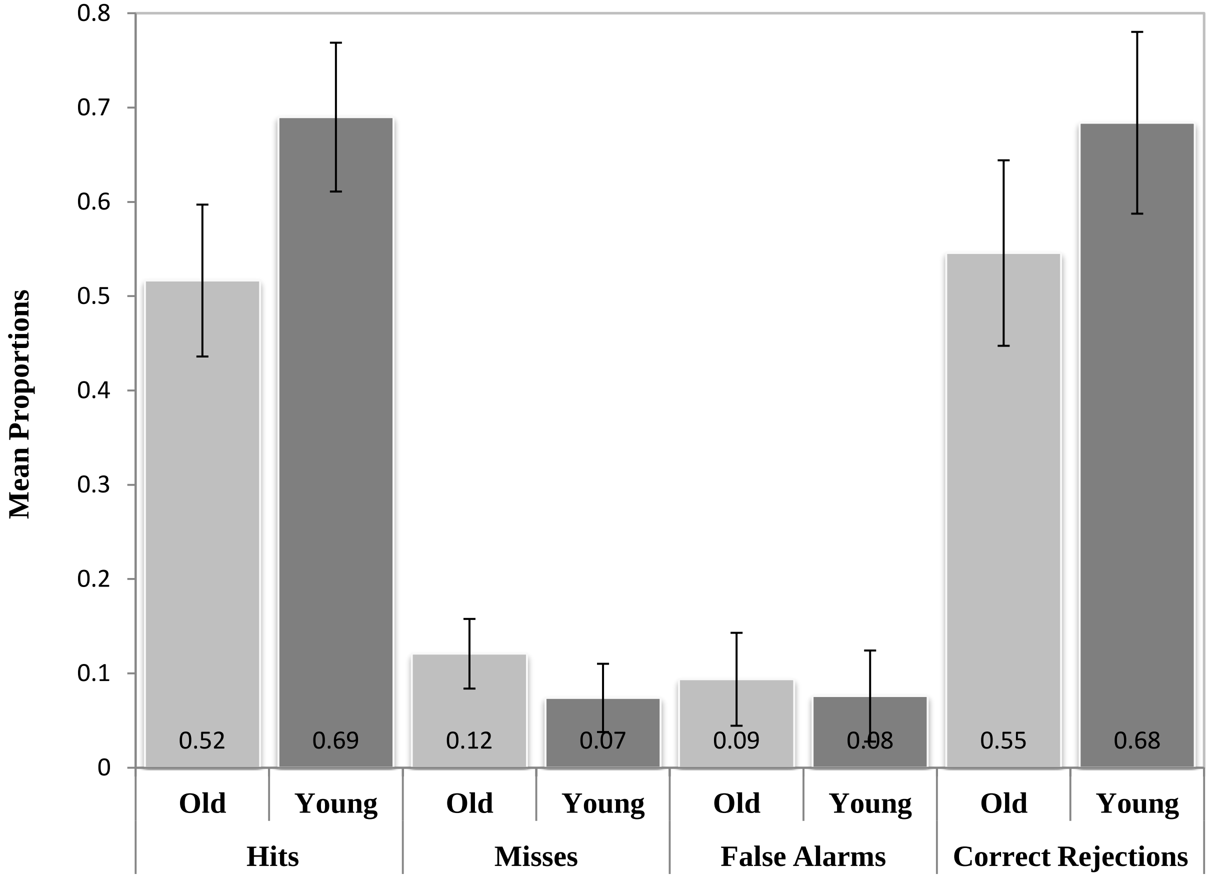

Figure 9. Age x Response interaction for destination memory high-confidence responses in the imagery condition only. High-confidence responses are responses in which the participant answered either "definitely no" or "definitely yes" as opposed to "unsure no" or "unsure yes." Data are mean proportions. Error bars represent standard errors of the mean.

differences in the imagery condition for high-confidence misses, $F(1, 47) = 3.32$, $p = .075$, $\eta_p^2 = .07$, or for high-confidence false alarms, $F(1, 47) = .27$, $p = .61$, $\eta_p^2 = .01$.

Given the exploratory nature of the imagery condition and to obtain further information about possible age-related imagery benefits, the older adult participants were divided into two age groups (young-old: 65-74, $N = 14$, and older-old: 75+, $N = 10$) based on longitudinal research findings that greater cognitive deficits occur after age 74 (Schaie, 1993) and that it is harder to learn and utilize cognitive strategies among the oldest-old (Singer, Lindenberger, & Baltes, 2003). Prior to conducting the desired pairwise comparison analysis (i.e., investigating age differences in only the imagery condition), a 3 (age: young, young-old, older-old) by 4 (task focus: general, self, refocus, imagery) ANOVA was conducted and revealed significant main effects for age $F(2, 192) = 19.33$, $p < .001$, $\eta_p^2 = .18$, with each group differing significantly from the other two groups, and for task focus $F(3, 192) = 14.85$, $p < .001$, $\eta_p^2 = .20$, with results in line with the overall model (i.e., performance on the imagery condition was significantly stronger than in the other three conditions). The age and task focus interaction approached significance, $F(6, 192) = 2.00$, $p = .068$, $\eta_p^2 = .06$ (see Figure 10) and was likely affected by the smaller sample sizes of the two older groups.

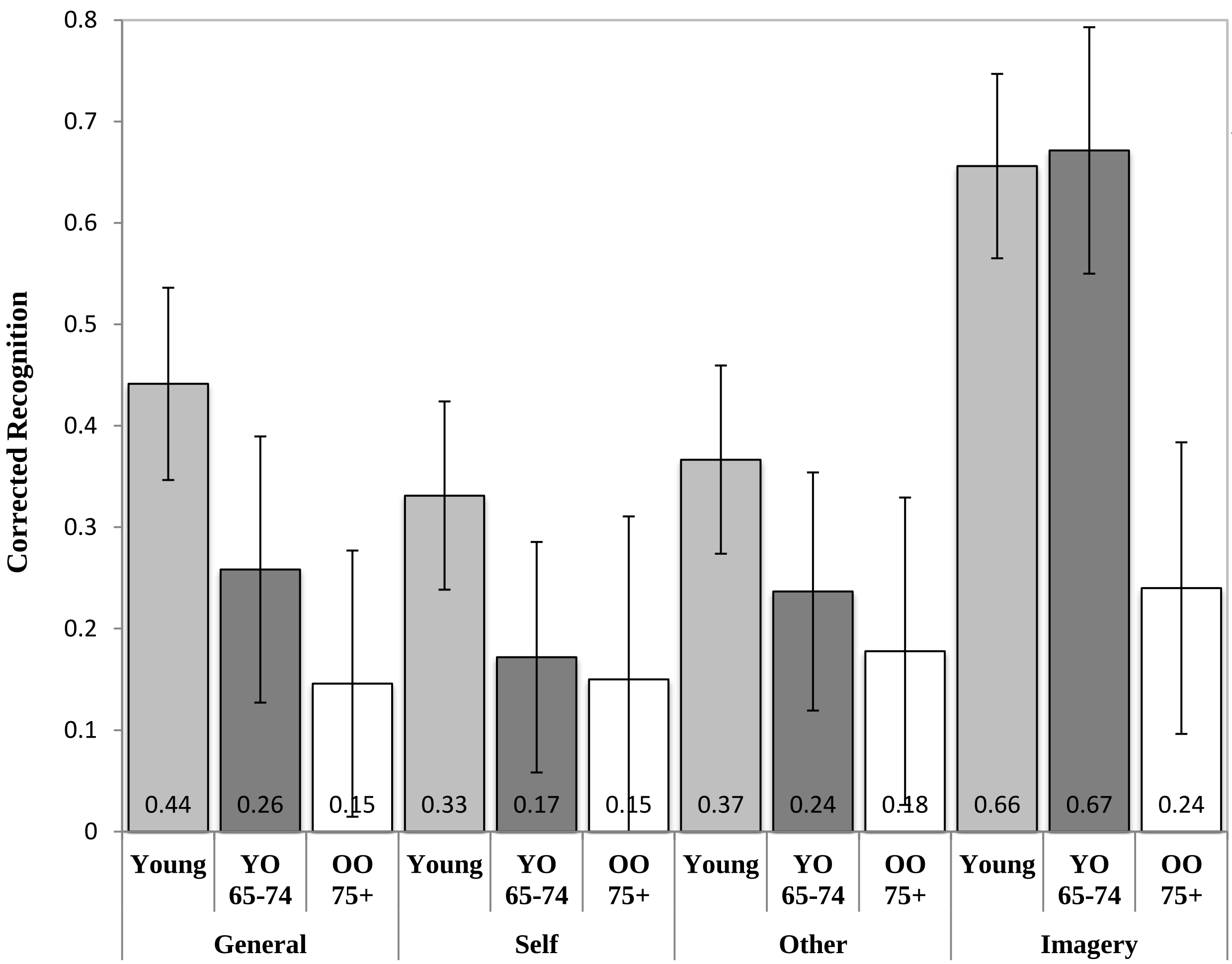

Figure 10. Age x Task Focus interaction for destination memory in three age groups. YO = Young-Old and OO = Older-Old. Data are mean corrected recognition scores (i.e., proportion of hits minus proportion of false alarms). Error bars represent standard errors of the mean.

CHAPTER IV

DISCUSSION

The purpose of the study was to investigate age differences in destination memory and to explore ways to improve it given the possible negative implications of poor destination memory, particularly for older adults. For instance, knowing whether certain information has been shared with another person is important (e.g., not sharing crucial information with a medical provider could affect medical care). Furthermore, repetitious conversational behavior may contribute to negative age-related perceptions of older adults (Bieman-Copland & Ryan, 2001).

Gopie and MacLeod (2009) were the first to identify destination memory as a separate construct from source memory. In Gopie and MacLeod's study they found that destination memory was more fallible than source memory and that varying the task focus (i.e., internal or external) affected destination memory. In a subsequent study, Gopie et al. (2010) compared older and younger adults on destination memory and found an age-related destination memory deficit. Combined, Gopie and colleagues' studies provided the theoretical and empirical foundation for the current study. They provided important information about the effect of varying task focus on destination memory and possible age differences in destination memory; however, their work had not been replicated. Furthermore, no published work has investigated the effect of varying the task focus among older adults or whether the age-related destination memory deficit found by Gopie and colleagues can be ameliorated.

The design of the current study was intended to replicate and extend the work of Gopie and colleagues (Gopie et al., 2010; Gopie & MacLeod, 2009) by examining age differences in destination memory across four task focus conditions in a single experiment. Three of the task focus conditions were previously studied among younger adults, and one of the task focus conditions was a new condition that utilized mental imagery as a possible way to reduce the age-related deficit in destination memory found by Gopie and colleagues. Although destination memory was the main outcome of interest, item memory also was assessed to ensure any identified differences in destination memory were not attributable to differences in item memory. In brief, the results of the current study replicated Gopie et al.'s finding of an age-related destination memory deficit; partially replicated Gopie and MacLeod's findings of the effect of varying attention (i.e., internal or external) on destination memory; and identified an approach (i.e., mental imagery) that improves destination memory and may help ameliorate age differences in destination memory, particularly among the young-old age group.

Age Differences in Destination Memory Accuracy and Confidence

The study's first research question was whether age differences exist between younger and older adults in destination memory. Based on previous research delineating an age-related associative deficit (e.g., Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008a); the fact that destination memory is associative in nature; and Gopie et al.'s (2010) finding regarding age differences in destination memory, it was hypothesized that older adults would be more impaired on destination memory than younger adults. This hypothesis was supported.

Contrary to Gopie and colleagues' findings, however, an age-related deficit in item memory (i.e., faces and facts) was also identified. Given that this study closely replicated Gopie and colleagues design, it was surprising that an age difference in item memory was identified in this study, but not in their study. One possible explanation is that fact memory was at a ceiling in Gopie et al.'s study, although fact memory was quite high in the current study as well. In reviewing the extant literature, it appears that although most studies reliably find an age-related associative deficit, results regarding age-related item memory deficits are mixed (for a review of multiple studies, see Old & Naveh-Benjamin, 2008a). Most importantly, the age difference in item memory found in the current study did not affect the interpretation of the results for destination memory, as the age differences in destination memory existed above and beyond any age differences in item memory. Therefore, destination memory is likely operating independently from, and is more impaired than, basic item memory, particularly for older adults.

To better understand the age-related deficit in destination memory, the proportion of hits and false alarms were assessed. Similar to Gopie et al. (2010), it was found that higher false alarm rates for older adults may be a contributing factor to their destination memory deficit. Other researchers also have found a higher false alarm rate among older adults on associative memory tasks (e.g., Bender, Naveh-Benjamin, & Raz, 2010; Chen & Naveh-Benjamin, 2012; Naveh-Benjamin et al., 2009; Old & Naveh-Benjamin, 2008b). This finding suggests that older adults may be more likely than younger adults to falsely assume they have already shared relevant information with someone when in fact they have not, which could have negative implications in the real world (e.g., withholding relevant and important health information from medical provider).

The next logical question was to assess possible awareness of destination memory deficits by examining high-confidence responses. Results revealed that although younger adults were more confident than older adults in their accurate answers (i.e., hits and correct rejections), older adults were more confident than younger adults in one type of inaccurate answers (i.e., false alarms). Taken together, these findings suggest that older adults not only may be more likely to not share relevant information when needed, they may be more confident that they have shared information when they have not. One possible outcome of these findings is that older adults may be more likely than younger adults to withhold information without realizing it.

Interestingly, in Gopie et al.'s analysis of high-confidence response differences between younger and older adults, they found that older adults had a significantly higher rate of misses (i.e., the other type of inaccurate answer) than younger adults, which might help explain why older adults seem to be more likely to repeat stories than younger adults. A comparable analysis in the current study for the general condition (i.e., the task focus condition most similar to Gopie et al.'s study) found that older adults had both a higher rate of misses and false alarms. The finding that older adults have a tendency to make less accurate confidence judgments than younger adults has been identified in a number of studies (e.g., Chua et al., 2009; Dodson, Bawa, & Krueger, 2007; Dodson, Bawa, & Slotnick, 2007; Shing, Werkle-Bergner, Li, & Lindenberger, 2009). In summary, the current study revealed age-related deficits in both destination memory accuracy and confidence. Specifically, not only are older adults more likely than younger adults to commit destination memory errors, but they also are likely to be less accurate in their confidence judgments related to those errors.

Varied Attentional Resources and Destination Memory Performance

The study's second research question addressed whether varying attentional resources (i.e., task focus) would affect destination memory. This part of the study was designed to replicate and extend two experiments Gopie and MacLeod (2009) had conducted with younger adults, but not older adults. Based on previous research regarding the effect of shifting focus internally or externally during an associative memory task (e.g., Engelkamp et al., 1989; Koriat et al., 1991), and Gopie and MacLeod's findings among younger adults, it was hypothesized that when compared to baseline destination memory (i.e., general task focus) shifting focus internally (i.e., self task focus) would worsen destination memory and that shifting focus externally (i.e., refocus task focus) would improve destination memory. The rationale was that increasing internal focus (i.e., sharing personal facts) would reduce the amount of attentional resources available for the associative memory task (i.e., face-fact pairings) and that shifting attention externally (i.e., stating the celebrity's name) would increase the amount of attentional resources available for the associative memory task. The hypothesis was partially supported.

Participants in the self condition were more impaired than participants in the general condition on destination memory, above and beyond differences in item memory, although the effect size was small. There are a number of possible reasons that focusing internally might negatively affect destination memory. Gopie and MacLeod (2009) suggested that increasing internal focus (i.e., sharing personal facts) reduced the amount of attentional resources available for the associative memory task (i.e., face-fact pairings), thereby worsening destination memory. Several studies have demonstrated that associative memory is adversely affected when actions are self-performed when compared to enacted by others (e.g., Engelkamp et al., 1989; Koriat et al., 1991). Focusing internally also may increase the demand on working memory, which has been tied to age differences in associative memory (e.g., Bender & Raz, 2012; Chen & Naveh-Benjamin, 2012). Another possibility is that some facts may have inadvertently created stereotype threat (e.g., "my age is…"), which may have decreased participants' external orientation and in particular, may have adversely affected older adult performance.

Given the small effect size, it is worth considering what other factors may have affected the results for the self condition. One concern is that some of the facts may have been harder to complete than others (i.e., requiring more thought and leaving less time and energy for encoding), which could have obscured a more robust result. Another possibility is that the task directed participants' attention away from the pairings and toward the facts (i.e., participants had to complete each fact cue before telling the famous person the fact). Anecdotally, participants reported that although it was easy to complete the fact cues (e.g., my age is…), they were focused more on the facts than on the faces. The results support the idea that directing attention away from the associative memory task impairs destination memory across age groups. However, in retrospect, it is unclear whether the participants' attention was distracted by focusing on facts about themselves or by needing to devote attentional resources to completing the fact cues.

The second part of the hypothesis, that shifting focus externally would improve destination memory, was not supported. Contrary to Gopie and MacLeod's results, the general and refocus conditions performed similarly in the current study. There are several potential explanations for the nonsignificant result. One possibility is that the current study examined destination memory accuracy differences above and beyond item memory differences, whereas the previous study did not. Additionally, because Gopie and MacLeod's experiments were conducted sequentially rather than using a repeated-measures design, it is possible that variability in their control group may have inadvertently influenced their results. Specifically, if their control group mean in the refocus experiment (control M =.36, experimental M = .50), had been at the same level as in their self experiment (control M = .45, experimental M = .21), they may not have found a significant result in the refocus condition. For comparative purposes, the control mean for younger adults in the current study was M = .44.

The nonsignificant result for the refocus condition may also stem from a change in the condition's design. For their refocus condition, Gopie and MacLeod exposed participants to a familiarization phase in which participants were presented with the face stimuli and related names in advance of the experiment. In the current study which compared participants across four conditions, adding a familiarization phase to the refocus condition would have created unequal exposure to stimuli prior to the experiment or would have lengthened the time required of participants if a familiarization phase was added for all conditions. Therefore, a more parsimonious approach was used in which the famous person's name was displayed on the screen below the famous person's face. It is possible that the difference in procedure may have reduced the associative memory within the refocus condition because participants had to read and then say the person's name, which may have inadvertently reduced attentional resources for encoding the face-fact association.

A final issue to consider regarding the self and refocus conditions is that in addition to the participant's focus being directed internally (i.e., self) or externally (i.e., refocus), in both instances the participant's focus was being directed toward individual items (i.e., either facts in the case of the self condition or faces in the case of the refocus condition) and away from the association between the items (i.e., the pairings). The third research question was designed to specifically address the associative component of the experiment.

Associative Mental Imagery as an Aid to Improve Destination Memory

The study's third research question addressed whether the use of provided associative imagery strategies as a memory aid would reduce the associate deficit typically seen among older adults. Based on previous research regarding the positive effect of mental imagery on associative memory (e.g., Dirkx & Craik, 1992; Rabinowitz et al., 1982; Verhaeghen et al., 1992), it was hypothesized that the use of provided associative mental imagery strategies would improve destination memory across participants. Furthermore, based on research suggesting that older adults benefit from using memory strategies (e.g., Naveh-Benjamin et al., 2007; Rabinowitz et al., 1982; Verhaeghen et al., 1992) yet are less likely than younger adults to spontaneously use associative memory strategies (Naveh-Benjamin, 2000), it was hypothesized that in addition to improving destination memory across participants, the uses of the provided strategies would diminish the age differences found in destination memory. The first part of the hypothesis (i.e., improving destination memory through the use of provided strategies) was supported. The second part of the hypothesis (i.e., diminishing age differences through the use of provided strategies) was not supported by the main analysis; however several follow-up analyses shed interesting light on age-related differences in the strategy condition. Furthermore, an exploratory analysis supported the second part of the hypothesis within a subset of older adults (i.e., adults ages 65-74).

The study found that the usage of a provided associative memory strategy (i.e., imagery condition) significantly improved destination memory when compared to the other three conditions, above and beyond any differences in item memory. It is worth noting that the effect of the use of mental imagery is likely quite robust, given that the imagery condition could have been further optimized (e.g., the provided strategies were created by the researcher and only informally vetted by a small number of younger and older adults). Furthermore, the use of associative mental imagery strengthened destination memory despite the fact that participants were not told that their memory would be tested. There are several possible explanations for why the imagery condition outperformed the other conditions. For instance, it is possible that the provided mental images, some of which were humorous when randomly paired with certain faces (e.g., imagining a certain politician as Mr. Potato head), may have made the task more engaging and therefore more memorable. A more likely explanation, however, is that the imagery condition directed participants’ attention to the pairings rather than the individual items and did so at a deep level of processing (Craik & Lockhart, 1972). Additionally, participants were asked to focus on the mental images during encoding, which is consistent with research that suggests that the use of associative strategies during encoding is particularly helpful (Bastin et al., 2013; Naveh-Benjamin et al., 2007). In fact, a recent study by Chen and Naveh-Benjamin (2012) revealed that an age-related associative deficit exists in both short- and long-term memory thus highlighting the importance of strengthening the association at all stages of remembering.

The overall model's nonsignificant age and condition interaction was unexpected. It had been anticipated that younger adults would outperform older adults in the three other conditions, but that the use of an associative strategy (e.g., imagery) would ameliorate the age-related deficit (Naveh-Benjamin, 2000; Naveh-Benjamin et al., 2007; Rabinowitz et al., 1982; Verhaeghen et al., 1992). To better understand the mechanism behind the increase in destination memory accuracy in the imagery condition and possible age-related changes, several analyses were conducted. First, the proportion of hits and false alarms for the imagery condition were analyzed. Of particular interest, there were no age differences in false alarms in the imagery condition, contrary to the age differences found in false alarms across conditions in the current study. In other words, the higher false alarm rate for older adults seen in Gopie et al. (2010) and in the overall results of the current study was not present in the imagery condition, specifically. This suggests that the use of mental imagery may help ameliorate the higher false alarm rates for older adults often found among older adults on associative memory tasks (e.g., Chen & Naveh-Benjamin, 2012; Naveh-Benjamin et al., 2009; Old & Naveh-Benjamin, 2008b). Furthermore, when age-related destination memory confidence was examined for the imagery condition, there were no age differences for high-confidence false alarms. This suggests that not only may mental imagery eliminate age-related differences in false alarm rates, but it also may help eliminate differences in confidence for inaccurate answers, particularly when it comes to unintentionally withholding information.

For perspective, one of the reasons the Age x Task Focus interaction was not significant was because destination memory improved for both younger and older adults in the imagery condition when compared to the general condition. Although not reaching the level of statistical significance, a comparison of corrected recognition mean improvements for the imagery condition versus the general condition suggests that older adults (mean improvement of 29%) directionally benefited more from using imagery strategies than younger adults (mean improvement of 22%). The possible utility of imagery as a memory aid for older adults was intriguing. One key question was whether there were subsets of older adults within the current study who may have benefited more or less from the use of imagery as a memory aid.

Based on longitudinal research findings that suggest that greater cognitive deficits occur after the age of 74 (Schaie, 1993) and that it is harder to learn and utilize cognitive strategies among the oldest-old (Singer et al., 2003), an exploratory analysis divided older adult participants into two age groups (young-old: 65-74, and older-old: 75+) and then compared on the destination memory for only the imagery condition. Results revealed that the imagery condition eliminated the age-related difference in destination memory for young-old adults. Specifically, there was no age difference in destination memory between the younger adults and the young-old adults yet both had significantly stronger destination memory than the older-old adults. It should be noted that these results should be interpreted with caution; the sample sizes for the two older adult groups were small (i.e., 14 young-old and 10 older-old) and thus the groups were more susceptible to possible individual differences. However, it seems likely that the poor destination memory performance of the older-old age group lowered the overall performance of older adults to such an extent that it created an age difference within the imagery condition, contrary to what was expected in the current study.

When taken as a whole, the findings of the current study support that destination memory impairment exists in older adults and that destination memory impairment is separate from, and greater than, any underlying item memory impairment. Furthermore, not only are older adults more likely than younger adults to commit destination memory errors, but they also are likely to be less accurate in their confidence judgments related to those errors. Additionally, the study suggests that strategies aimed at improving destination memory should focus on the association rather than item components; and also that the use of associative memory strategies has the potential to decrease, and potentially eliminate, age-related destination memory impairment and may help improve the accuracy of confidence judgments, particularly in young-old adults.

Strengths

The present study has several notable strengths that are important to consider. From a design standpoint, by replicating and extending previous research, it was possible to compare results to prior work in this relatively new area. Additionally, the use of an a priori power analysis ensured that sufficient sample sizes were obtained, and none of the planned analyses were limited by power issues.

The study provided valuable information about destination memory by demonstrating the robustness of age differences in destination memory across conditions and highlighting the importance of focusing on the associative portion of the task when devising possible methods for improving destination memory. Assessing high-confidence responses across multiple conditions added a layer of insight about how destination memory errors may affect everyday behaviors (e.g., repeating stories or withholding valuable information). The current study also introduced a new approach to consider for improving destination memory, namely, the use of mental imagery. Lastly, the study offered an intriguing look into how age-related decrements in destination memory may differ between two groups of older adults.

Limitations and Future Research

There are several limitations that are worth noting regarding the current study. First, the sample used was a convenience sample, which may limit generalizability. For instance, younger participants received course credit for participating, which may have influenced their interest and engagement. Older adult participants were recruited through advertising, announcements, and personal contacts; however, most came from personal contacts, which also may have influenced their interest and engagement. Additionally, the sample was predominantly Caucasian, which may limit generalizability to other ethnic groups. Furthermore, all participants were tested in Pennsylvania and Florida, and also were highly educated, both of which may have limited generalizability. Future research should strive to attain a more diverse sample; however, the current study demographics are typical of participants in cognitive aging research. Second, older adults were treated as a homogeneous population in terms of their age, yet there appear to be destination memory differences among subsets of older adults. Therefore, future research should examine destination memory performance in more specific older adult age groups (e.g., 65-74, 75-84, and 85+). Third, the study's design, although more ecologically valid than some associative memory protocols (e.g., word list pairs), does not model the actual sharing or withholding of personal information or stories with multiple other people. One opportunity for future research would be to develop a protocol that better mirrors people's actual destination memory experiences (e.g., participants tell their own stories or share information with people they know rather than celebrities).

Fourth, in retrospect, it appears that the two conditions designed to assess the effect of attentional resources on destination memory (i.e., self and refocus) may have had other than the intended effects. Although the conditions did shift the participant's attention (i.e., internally or externally), they also inadvertently may have focused the participant's attention onto the items (i.e., faces or facts) and thus shifted the participant's focus away from the associative pairings. Future research should consider alternative attentional manipulations.

Although not necessarily a limitation of the current study, an opportunity exists for future researchers using a similar protocol to strengthen some of the stimuli, namely the face pool and the imagery strategies. Although the pilot test results revealed no statistically significant differences in recognition between age groups for the 60 faces used in the face pool, five of the faces were not well recognized by either age group (60% or less recognition across groups). Replacing the five less well-known faces would improve recognition across age groups. Future research should address whether the familiarity of faces and/or facts affects destination memory. If familiarity of faces does affect destination memory, replacing the pictures of famous people with pictures of ordinary people would ensure that the stimuli are equally unfamiliar to all participants. Using pictures of ordinary people might improve ecological validity (i.e., the pictures would be more similar to real-life people); however, it might also increase the difficulty of the task and overload working memory (i.e., the participants would not be able to rely on pre-existing familiarity to identify with whom they shared information). Regarding the imagery strategies, the provided strategies were created by the researcher and only informally vetted by a small number of younger and older adults. Preparing and piloting multiple strategies to identify the best strategy for each fact likely would enhance the effect of the imagery strategies on destination memory.

There are a number of other possible future directions worth considering that are not directly related to the limitations of the current study. Although new as a focal area, destination memory research is supported by a large body of studies about associative memory, cognitive processes, and age-related memory changes, which means that there are many possible research directions. One area that certainly bears further study is how destination memory changes across the lifespan, which would require longitudinal research. Clearly there is a difference between younger and older adults on destination memory performance, and it seems likely that there is a difference between young-old and older-old adults, so these subsets of older adults should be assessed further. It may also be worth exploring destination memory in middle-age adults, which has not yet been done. Furthermore, the underlying mechanisms of age-related destination memory differences are still undetermined and are likely multi-factorial (e.g., changes in cognitive control, working memory, inhibition). Although there have been several interesting studies recently regarding age-related working memory deficits (e.g., Bender & Raz, 2012; Chen & Naveh-Benjamin, 2012), there is still much to be learned. Lastly, exploring how to improve destination memory certainly is worthy of further study. The positive effect of strategy usage raises several intriguing possibilities that have been addressed in recent literature on associative memory and aging, including the importance and relative difficulty of older adults in encoding information (e.g., Bastin et al., 2013; Chen & Naveh-Benjamin, 2012), and the role that maladaptive memory strategy beliefs may apply in age differences in associative memory (Bender & Raz, 2012).

Given the newness of the field, the current research focused on two approaches: the first was to replicate work done previously, which had been built on the theoretical premise that attentional resources are a finite resource and appear to decrease with age. Clearly there are age-related differences in destination memory; however, given that there was not an age by condition interaction in the current study, it is unclear if limited attentional resources adequately explain destination memory age differences or if another approach to representing attention is warranted. Due to the researcher's clinical focus, the second approach was to seek out a likely possibility for enhancing destination memory in older adults, given the negative connotations that sometimes accompany repetitive storytelling and the need to ensure that information is shared when needed (e.g., accurately remembering which information has been shared with multiple providers). It does seem clear that developing approaches that enhance the association of information (e.g., the use of mental imagery) warrants further attention. In particular, opportunities exist to test the efficacy of different types of associative strategies, to have participants generate and use their own strategies, and to assess intentional strategy use (i.e., make the participants aware that their memory will be tested). Should an intentional approach be pursued, it would also be important to assess for participants' memory-related beliefs as a recent study by Bender and Raz (2012) found that maladaptive beliefs about memory strategies accounted for a portion of age-related differences in associative memory. In conclusion, there are a number of promising possibilities to pursue; the key challenge for future destination memory researchers will be to choose what to explore next.

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APPENDIX A

Names of Faces

1. Albert Einstein
2. Angelina Jolie
3. Arnold Schwarzenegger
4. Audrey Hepburn
5. Barack Obama
6. Bill Clinton
7. Bill Cosby
8. Bob Barker
9. Brad Pitt
10. Celine Dion
11. Cher
12. Cindy Crawford
13. Clint Eastwood
14. David Hasselhoff
15. David Letterman
16. Dolly Parton
17. Donald Trump
18. Dr. Phil
19. Drew Barrymore
20. Dustin Hoffman
21. Eddie Murphy
22. Ellen DeGeneres
23. Elvis Presley
24. George Clooney
25. George W. Bush
26. Ghandi
27. Howie Mandel
28. Janet Jackson
29. Jay Leno
30. Jennifer Lopez
31. John F. Kennedy
32. John Travolta
33. Julia Roberts
34. Kate Middelton
35. Larry King
36. Madonna
37. Marilyn Monroe
38. Martin Luther King Jr.
39. Michael Jackson
40. Michelle Obama
41. Mitt Romney
42. Oprah Winfrey
43. Pamela Anderson
44. Paula Abdul
45. Pope John Paul II
46. Prince William
47. Queen Elizabeth II
48. Rosie O'Donnell
49. Samuel L. Jackson
50. Sandra Bullock
51. Sharon Stone
52. Steve Jobs
53. Steve Martin
54. Steven Spielberg
55. Tiger Woods
56. Tina Turner
57. Tom Cruise
58. Tom Hanks
59. Whitney Houston
60. Whoopi Goldberg

APPENDIX B
General Facts

1. 1 billion Valentine's Day cards are sent each year in North America.
2. 12 men have landed on and explored the moon.
3. 15% of a person’s income is spent on transportation.
4. 25% of injuries by athletes involve the wrist and hand.
5. 25% of your bones are in your hands.
6. 33% of accidental deaths occur in the home.
7. 50% of lottery players go back to work after winning the jackpot.
8. 8% of men are color blind.
9. 85% of weddings are held in a synagogue or church.
10. 90 people have been frozen after their death.
11. 93% of all greeting cards are purchased by women.
12. 93% of children go out trick or treating for Halloween.
13. A blink lasts 0.3 seconds.
14. A disposable diaper can hold up to 7 pounds of liquid.
15. A female mouse can produce up to 100 babies a year.
16. A group of rhinos is called a "crash."
17. A person uses 57 sheets of toilet paper each day.
18. A shrimp's heart is in its head.
19. Alaska has 2 times as many caribou as people.
20. American models are skinnier than 98% of American women.
21. An average American eats 60 hot dogs per year.
22. An office desk has 400 times more bacteria than a toilet.
23. Barbie has had over 125 careers.
24. Chewing gum is banned in Singapore.
25. Chopsticks originated from China 4,000 years ago.
26. Clint Eastwood turned down the role of James Bond.
27. Coca Cola originally contained a small amount of cocaine.
28. Dalmatians are born without spots.
29. Dolphins sleep with one eye open.
30. Each day 11 people die from asthma in North America.
31. Elephants mourn their dead.
32. From all the oxygen that a human breathes, 20% goes to the brain.
33. Heinz first started making ketchup in 1876.
34. Hitler was voted Time Magazine's man of the year in 1938.
35. In a year, an American kid eats 46 slices of pizza.
36. In the United States, 33% of land is covered by forests.

37. It takes about 3 hours for food to be broken down in the stomach.
38. Maps were smuggled to allied POWs in monopoly sets during World War II.
39. McDonald's restaurant has over 1.5 million employees all over the world.
40. More people are killed by bee stings than by shark attacks.
41. Mosquitoes can mate in about 15 seconds.
42. Most people cannot sneeze with their eyes open.
43. Mr. Potato Head was the first toy advertised on television.
44. Only 44% of Americans eat breakfast everyday.
45. Only 5% of babies are born on their actual due date.
46. People spend 33% of their life sleeping.
47. People who smoke a pack day on average lose 2 teeth every 10 years.
48. Playdoh started as a wallpaper cleaner.
49. Rats can survive up to 14 days without any food.
50. Roses need 6 hours of sunlight per day to grow properly.
51. Some crocodiles can run as fast as 10 miles per hour.
52. The average North American car contains 300 pounds of plastics.
53. The average person falls asleep in 12 minutes.
54. The life span of a dollar bill is 1 and 1/2 years.
55. The Marlboro man died of lung cancer.
56. The stomach of an adult can hold over 3 pounds of material.
57. The United States Postal Service handles 40% of the world's mail volume.
58. Women live 7 years longer than men do.
59. Women spend 55 minutes per day getting showered and dressed.
60. You can polish your shoes with a banana peel.

APPENDIX C
Personal Facts

1. For breakfast I like eating…
2. I live with...
3. I love eating…
4. I love shopping at…
5. I'd love to travel to…
6. If I had to choose between tea or coffee I would pick…
7. My age is…
8. My birthday is…
9. My eye color is…
10. My father's first name is/was…
11. My favorite color is…
12. My favorite dessert is…
13. My favorite drink is…
14. My favorite homemade meal is…
15. My favorite movie is…
16. My favorite number is…
17. My favorite outdoors activity is...
18. My favorite pet animal is…
19. My favorite pizza toppings are…
20. My favorite restaurant is…
21. My favorite teacher is/was…
22. My favorite thing to do on a Friday night is…
23. My favorite thing to wear is…
24. My favorite type of weather is…
25. My friends and I like to…
26. My funniest friend is…
27. My hometown is…
28. My last vacation was to…
29. My middle name is…
30. My mother's first name is/was…
31. My shoe size is…
32. On Sunday mornings I like to…
33. The character trait I value most in others is…
34. The city I was born in was…
35. The city I'd like to live in is…
36. The fast-food place I like eating at is…
37. The first thing I do in the morning is…
38. The last book I read was…
39. The last chore I did was…
40. The last friend I saw was…
41. The last gift I received was…
42. The last movie I saw was…
43. The last thing I do at night is…
44. The last time I read the newspaper was…
45. The last time I voted was…
46. The last time I watched a political debate was…
47. The name of the last school I attended was…
48. The number of hours per night that I usually sleep is…
49. The number of languages I speak is…
50. The number of pets I currently have is…
51. The number of siblings I have is…
52. The person I admire most is…
53. The person I care most about is…
54. The room I spend the most time in is…
55. The season I like least is…
56. The season I like most is…
57. The street that I live on is…
58. The way I get the news is…
59. This weekend I will…
60. Today the weather is…

APPENDIX D
Imagery Strategies

General Fact	Imagery Strategy
1. 1 billion Valentine's Day cards are sent each year in North America.	Imagine the person surrounded by stacks of Valentine’s Day cards
2. 12 men have landed on and explored the moon.	Imagine the person standing on the moon
3. 15% of a person’s income is spent on transportation.	Imagine the person sitting in a car writing a check
4. 25% of injuries by athletes involve the wrist and hand.	Imagine the person with a broken wrist
5. 25% of your bones are in your hands.	Imagine the person with a skeleton hand
6. 33% of accidental deaths occur in the home.	Imagine the person holding a fire extinguisher
7. 50% of lottery players go back to work after winning the jackpot.	Imagine the person winning the lottery
8. 8% of men are color blind.	Imagine the person is green
9. 85% of weddings are held in a synagogue or church.	Imagine the person being married in a synagogue or church
10. 90 people have been frozen after their death.	Imagine the person standing in a freezer
11. 93% of all greeting cards are purchased by women.	Imagine handing a greeting card to the person
12. 93% of children go out trick or treating for Halloween.	Imagine the person in a Halloween costume
13. A blink lasts 0.3 seconds.	Imagine the person constantly blinking his or her eyes
14. A disposable diaper can hold up to 7 pounds of liquid.	Imagine the person wearing a diaper
15. A female mouse can produce up to 100 babies a year.	Imagine the person surrounded by 100 baby mice
16. A group of rhinos is called a "crash."	Imagine the person with a rhino next to him or her
17. A person uses 57 sheets of toilet paper each day.	Imagine the person wrapped in toilet paper
18. A shrimp's heart is in its head.	Imagine the person holding a shrimp next to his or her heart

General Fact	Imagery Strategy
19. Alaska has 2 times as many caribou as people.	Imagine the person standing next to a caribou (a type of deer)
20. American models are skinnier than 98% of American women.	Imagine the person on a modeling runway
21. An average American eats 60 hot dogs per year.	Imagine the person eating a hot dog
22. An office desk has 400 times more bacteria than a toilet.	Imagine the person backing away from a desk
23. Barbie has had over 125 careers.	Imagine the person surrounded by Barbie dolls
24. Chewing gum is banned in Singapore.	Imagine the person getting a ticket for chewing gum
25. Chopsticks originated from China 4,000 years ago.	Imagine the person eating with chopsticks
26. Clint Eastwood turned down the role of James Bond.	Imagine the person standing with Clint Eastwood
27. Coca Cola originally contained a small amount of cocaine.	Imagine the person drinking a Coke
28. Dalmatians are born without spots.	Imagine the person holding an all-white puppy
29. Dolphins sleep with one eye open.	Imagine the person sleeping next to a dolphin
30. Each day 11 people die from asthma in North America.	Imagine the person at someone’s hospital bed
31. Elephants mourn their dead.	Imagine the person comforting an elephant
32. From all the oxygen that a human breathes, 20% goes to the brain.	Imagine the person with a lung on top of his or her head
33. Heinz first started making ketchup in 1876.	Imagine the person holding a ketchup bottle
34. Hitler was voted Time Magazine's man of the year in 1938.	Imagine the person on the cover of TIME magazine
35. In a year, an American kid eats 46 slices of pizza.	Imagine the person eating a slice of pizza
36. In the United States, 33% of land is covered by forests.	Imagine the person standing in a forest

General Fact	Imagery Strategy
37. It takes about 3 hours for food to be broken down in the stomach.	Imagine the person's stomach is making noises
38. Maps were smuggled to allied POWs in monopoly sets during World War II.	Imagine the person in a striped prison uniform
39. McDonald's restaurant has over 1.5 million employees all over the world.	Imagine the person as a McDonald's employee
40. More people are killed by bee stings than by shark attacks.	Imagine the person running from a bee
41. Mosquitoes can mate in about 15 seconds.	Imagine the person watching mosquitos mate
42. Most people cannot sneeze with their eyes open.	Imagine the person sneezing with his or her eyes closed
43. Mr. Potato Head was the first toy advertised on television.	Imagine the person holding a Mr. Potato Head
44. Only 44% of Americans eat breakfast everyday.	Imagine the person eating breakfast
45. Only 5% of babies are born on their actual due date.	Imagine the person is pregnant
46. People spend 33% of their life sleeping.	Imagine the person asleep in bed
47. People who smoke a pack day on average lose 2 teeth every 10 years.	Imagine the person without his or her front teeth
48. Playdoh started as a wallpaper cleaner.	Imagine the person playing with Playdoh
49. Rats can survive up to 14 days without any food.	Imagine the person feeding a rat
50. Roses need 6 hours of sunlight per day to grow properly.	Imagine the person holding a rose
51. Some crocodiles can run as fast as 10 miles per hour.	Imagine the person running from a crocodile
52. The average North American car contains 300 pounds of plastics.	Imagine the person driving a plastic car
53. The average person falls asleep in 12 minutes.	Imagine the person falling asleep
54. The life span of a dollar bill is 1 and 1/2 years.	Imagine the person holding a dollar bill with an expiration date on it
55. The Marlboro man died of lung cancer.	Imagine the person looking at a Marlboro ad

General Fact	Imagery Strategy
56. The stomach of an adult can hold over 3 pounds of material.	Imagine the person with a bigger stomach
57. The United States Postal Service handles 40% of the world's mail volume.	Imagine the person as U.S. postal worker
58. Women live 7 years longer than men do.	Imagine the person talking to his or her mother
59. Women spend 55 minutes per day getting showered and dressed.	Imagine the person getting ready for the day
60. You can polish your shoes with a banana peel.	Imagine the person polishing his or her shoes with a banana peel

APPENDIX E
Exit Questionnaire

For descriptive purposes, please answer the following questions:

1. What is your age? ________

2. What is your gender?
   a. Male
   b. Female
   c. Transgender
   d. Not specified

3. What is your race/ethnicity?
   a. Black
   b. White
   c. Asian
   d. Hispanic
   e. Multiracial/multi-ethnic
   f. Other: _______________
   g. Not specified

4. How many years of education have you completed? ____________ years
   (typical high school education = 12 years)

5. Is English your native language (i.e., was it the language you first learned as a child)?
   a. Yes
   b. No
      If no, how long have you been speaking English fluently: ______________

6. Do you wear glasses, contact lenses, or other optical devices so that you can see more clearly?
   a. Glasses, including bifocal and progressive glasses
   b. Contact lenses
   c. Other (explain): ____
   d. No I do not

7. Did you have any difficulty seeing the information that was presented on the computer?
   a. No
   b. Yes
      If yes, please explain: ____

8. Did you have any difficulty understanding the instructions?
   a. No
   b. Yes
      If yes, please explain: ____

APPENDIX F
Computer Administration Instructions

Study Phase – General Task Focus Condition

In this experiment you will be telling facts to faces.

A fact will be displayed for you to read. Once you read the fact silently, press the spacebar to display a face. Speaking out loud, tell the fact that you just read to the face.

Press the spacebar for another fact and repeat the process until you have finished telling all 50 facts to 50 faces.

Are there any questions?

Study Phase – Self Task Focus Condition

In this experiment you will be telling facts to faces.

The beginning of a fact will be displayed for you to read. Read the beginning of the fact and silently complete the fact with your answer. After you have completed the fact, press the spacebar to display a face. Speaking out loud, tell the person the completed fact.

Press the spacebar for another fact and repeat the process until you have finished telling all 50 facts to 50 faces. Are there any questions?

Study Phase – Refocus Task Focus Condition

In this experiment you will be telling facts to faces.

A fact will be displayed for you to read. Once you read the fact silently, press the spacebar to display a person's name and face. Speaking out loud, you will say the person's name and then tell the person the fact that you just read.

Press the spacebar for another fact and repeat the process until you have finished telling all 50 facts to 50 faces.

Are there any questions?

Study Phase – Imagery Task Focus Condition

In this experiment you will be telling facts to faces.

A way to create a mental image of each fact will be displayed for you to read, followed by the fact.

Read the mental image silently, the fact silently, and then press the spacebar to display a face. Speaking out loud, tell the fact that you just read to the face, while using the provided mental image.

When you are ready, press the spacebar for another fact and repeat the process until you have finished telling all 50 facts to 50 faces using the provided mental images. Are there any questions?

Test Phase – Destination Memory Recognition

In this part of the experiment you will indicate whether you told the face the fact on the screen by pressing the number on the keyboard that corresponds to your level of certainty.

1. Definitely No
2. Unsure No
3. Unsure Yes
4. Definitely Yes

Are there any questions?

Test Phase – Item Memory (Faces, Facts) Recognition

In this part of the experiment you will indicate whether you previously saw the face or said the fact by pressing the number on the keyboard that corresponds to your level of certainty.

1. Definitely No
2. Unsure No
3. Unsure Yes
4. Definitely Yes

Are there any questions?