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The Influence of Subjective Value, Importance, and Interest on Memory and Metacognition in Older and Younger Adults

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The Influence of Subjective Value, Importance, and Interest on Memory and Metacognition in Older and Younger Adults

A dissertation submitted in partial satisfaction of the

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in Psychology

by

Shannon Elizabeth McGillivray

2013

ABSTRACT OF THE DISSERTATION

The Influence of Subjective Value, Importance, and Interest on

Memory and Metacognition in Older and Younger Adults

by

Shannon Elizabeth McGillivray

Doctor of Philosophy in Psychology

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Professor Alan Castel, Chair

It is well documented that memory abilities decline in older adulthood. However, age-related memory deficits may be reduced for information that is more interesting or valuable. Using a variety of unique approaches, the current studies examined whether subjective value and interest impacted memory and metacognitive judgments (i.e., predictions about what one will remember) in older and younger adults in order to better understand mechanisms that enhance memory and metacognitive accuracy.

Experiments 1, 2, and 3 utilized a paradigm in which older and younger adults were presented with lists of words, word pairs, or items within specific scenarios. For each item, participants assigned it a value (from 0-10) that was akin to a "bet" on the likelihood it would be remembered. The results indicated that older and younger adults were equally able to remember items assigned higher values, and that accuracy of predictions increased with task experience.

Furthermore, when participants were able to rely on semantic knowledge, age-related differences in memory performance were eliminated.

Experiments 4 and 5 examined whether subjective interest and curiosity to learn influenced memory and metacognitive predictions in older and younger adults. In Experiments 4 and 5, participants were presented with trivia questions and asked to indicate how “curious” they were to learn the answer, after which they were shown the correct answer. In Experiment 5 participants also provided post-answer interest ratings and predictions of the likelihood the fact would be remembered. After a week delay, older and younger adults were more likely to recall answers to questions initially assigned higher ratings of curiosity and interest. Furthermore, predictions regarding what information would be recalled were highly accurate for both younger and older adults, and were influenced by interest in the material.

The results of all of the studies suggest that the ability to recall what one subjectively indicates is more valuable or interesting does not decline during the aging process. Furthermore, both younger and older adults displayed highly accurate insight regarding what information was likely to be remembered or forgotten, and they were able to use this knowledge to strategically maximize goal-related memory outcomes and performance.

The dissertation of Shannon Elizabeth McGillivray is approved.

Elizabeth Bjork

Aimee Drolet Rossi

Barbara Knowlton

Alan Castel, Committee Chair

University of California, Los Angeles

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For Terry McGillivray, my father.

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Selected Conference Presentations

McGillivray, S., & Castel A. D. (April 2012). *The impact of task experience and prior knowledge on memory and metacognitive performance.* Poster to be presented at the Cognitive Aging Conference, Atlanta, GA.

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McGillivray, S., & Castel, A. D. (November 2011). *The role of motivation in enhancing metacognitive accuracy.* Poster presented at the 52nd annual meeting of the Psychonomic Society, Seattle, WA.

McGillivray, S. & Castel, A. D. (April 2010). *Metacognitive improvement by younger and older adults in a value-directed remembering task*. Poster presented at the Cognitive Aging Conference, Atlanta, GA.

McGillivray, S., Castel, A., & Rhodes, M. (March 2008). *Memory for age information: The role of generation and schematic support.* Poster presented at the Cognitive Aging Conference, Atlanta, GA.

McGillivray S. & Fein G. (February 2007). *Cognitive performance in long-term abstinent alcoholics*. Poster presented at the 35th International Neuropsychological Society Conference, Portland, OR.

Chapter 1 – Background and Significance

It is well documented that aging is associated with a number of decremental cognitive changes, particularly within the area of explicit memory abilities (Craik & Salthouse, 2008; Kausler, 1994). Specifically, older adults often display difficulty in forming new episodic memories compared with younger adults (e.g., Nilsson, 2003). Although, in general, the ability to remember new information declines in older adulthood, the question of whether the ability to recall information that is more important, interesting, or valuable to the individual remains relatively under-investigated. This issue of whether value, importance or interest has an influence on memory is a necessary and vital question to examine (Hess, 2005; Zacks & Hasher, 2006), as it speaks to older adults' ability to maintain a high quality of cognitive and everyday functioning.

In many standard laboratory memory tasks all of the to-be-learned information is equally as important to remember, and it is typically found that older adult generally recall less information compared with younger adults (e.g., Craik & Salthouse, 2008). However, in the real world information varies greatly on how important it is to remember. For example, it is more important to remember your spouse's birthday than it is to remember the birthday of a casual acquaintance. Simple everyday task such as going to the grocery store often have some sort of prioritization, in that it is likely that some items on your list are more important to remember to purchase than others. Furthermore, information may be deemed more or less important or valuable depending on one's interests or current goals. Importantly, information can vary on its objective and subjective value. Individuals can be explicitly told by others what is important (objective value), but quite often value is subjectively determined, and what is deemed valuable by one person may not be considered important by another.

The following sections describe some of the major theories of cognitive aging as they pertain to older adults' memory and the ability to recall subjectively more valuable or important information. Next, I explore how both objective and more subjective measures of value, importance, or interest influence memory performance in younger and older adults. Lastly, I discuss how metacognition (insight into one's memory and memory processes) is affected during aging, as well as the potential role that metacognitive processes can play in the ability to remember valuable information.

Cognitive Aging Theories

A number of theories have been proposed to help explain why memory functioning is negatively impacted during the aging process. These theories focus on possible causes and mechanisms driving age-related cognitive changes, and also highlight situations in which older adults are more or less likely to experience memory impairments compared with younger adults. Importantly, many of the major theories of cognitive aging seem to run counter to the notion that older adults maintain the ability to recall what is more important.

The general slowing theory posits that a reduction in the speed with which cognitive processes operate occurs during aging, and this reduction in processing speed accounts for the majority of age-related variance on a variety of cognitive tasks (Henninger, Madden, & Huettel, 2010; Salthouse, 1996, 2000). In fact, there is evidence that measures of processing speed share upwards of 50-75% of the age-related variance on numerous cognitive tasks, including memory tasks (Salthouse, 1996). If slower processing speed negatively impacts older adults' memory abilities, then it is likely to have a more global impact on performance, regardless of whether the information is more or less valuable or interesting.

Similarly, the reduced resources theory suggests that it is a general reduction in the availability or allocation of necessary attentional resources both at encoding and retrieval that is the significant contributor to poorer memory performance among older adults (Anderson, Craik, & Naveh-Benjamin, 1998; Craik & Byrd, 1982; Park, Smith, Dudley, & Lafronza, 1989; Rabinowitz, Craik, & Ackerman, 1982). For example, when older adults are placed under divided attention, which reduces the amount of attention available for other tasks, there is a larger detrimental impact on performance compared with younger adults also under divided attention (Anderson et al., 1998; Park et al., 1989). The reduction in available attentional resources can make it difficult for older adults to engage in more cognitively demanding operations such as elaborative encoding, which is considered necessary for effective consolidation and retrieval of to-be-remembered information (Craik & Salthouse, 2008). This general reduction in the capacity and efficiency with which older adults' allocate attention could impact their ability to actively shift sufficient resources to more important information one is trying to remember. However, it could also be the case that interest and importance serve to naturally elicit and capture attention (McDaniel, Waddill, Finstad, & Bourg, 1990), which could lead to an amelioration of some memory deficits, although this is likely to be at the expense of less important information.

While there is evidence for age-related general cognitive slowing and a reduction in resources such as attention which can limit the amount of information one is able to process, other theories have proposed that older adults' memory troubles stem from the processing of too much (irrelevant) information. Hasher and colleagues (Darowski, Helder, Zacks, Hasher, & Hambrick, 2008; Hasher & Zacks, 1988; Lustig, Hasher, & Zacks, 2007) have suggested that older adults may suffer disproportionately from deficits in inhibitory processes (inhibition deficit theory), and this, in turn, can lead to poorer performance on cognitive tasks. An efficient system requires control and inhibition of irrelevant information in order to function properly, and thus requires working memory and attention. Older adults in particular may have difficulty suppressing inappropriate or irrelevant responses, controlling the focus of attention, and keeping irrelevant information out of working memory (e.g., Hasher and Zack, 1988). Furthermore, decreased inhibitory functions can reduce one's ability to switch attention from one target to another, and can lead to misinterpretation of information, inappropriate responses, and also forgetting. In regard to situations where there are varying degrees of value or interest, this theory might suggest that older adults may experience difficulty inhibiting some of the less relevant (e.g., low value, low interest) information which could, in turn, detract from the ability to focus on and recall more important information. However, if interest or value serve to enhance attentional focus, this could reduce the degree to which unwanted intrusions and irrelevant details negatively impact older adults' memory performance.

In addition to theories that focus on the possible mechanisms driving declines in cognitive function during aging, there are also theories that explore contributing factors of successful cognitive aging, and suggest that older adults are able to recall more important information. Selective optimization with compensation (SOC; Baltes & Baltes, 1990) asserts that successful aging is related to a focused and goal-directed investment of limited resources into areas that yield optimal returns. In fact, it has been suggested that perhaps due to limited cognitive resources, older adults may often be more selective compared with younger adults in how they choose to engage their cognitive resources (Hess, 2006). Thus, older adults should be able to selectively control cognitive operations based on their goals, motivation, and the meaningfulness of information, and compensate for impairments by optimizing performance in these specific, goal-related domains (see also Riediger, Li, & Lindenberger, 2006, for the adaptive nature of SOC).

Support for the SOC theory has come from findings that healthy older adults are able to successfully allocate limited resources when appropriate motivation (e.g., personal relevance and accountability) is present, enhancing performance (Germain & Hess, 2007; Hess, Rosenberg, & Waters, 2001), or when the structure of the learning environment promotes selectivity (e.g., Castel, 2008). Furthermore, Heckhausen (1999; Heckhausen & Schulz, 1995) suggests that older individuals have to take on the regulation of age-related losses in resources in order to function efficiently, and if successful, such regulation can aid efficient cognitive functioning. That is, older adults often need to be strategic in terms of how they utilize their memory resources, and insight into one's memory capabilities and limitations is essential.

Objective Value and Memory

The ability to recall information that is more important or valuable is essential to healthy memory functioning, and functioning in everyday life. On a daily basis individuals encounter much more information than it is possible to remember. Furthermore, as one ages and memory functioning becomes somewhat compromised, it is even more crucial to understand the impact that higher value or important information has on memory performance. For example, if older adults are not able to recall as much information as younger adults, but are able to recall the most important information, then perhaps quality of memory functioning remains intact despite deficits in memory quantity.

Previous studies have investigated potential age-related differences in the ability to recall objectively more important information. Castel and colleagues (Castel, Benjamin, Craik, & Watkins, 2002) examined both older and younger adults' ability to remember words paired with varying point values. In this “value-directed remembering” paradigm, words were paired with point values that ranged from 1 to 12, participants studied these word-value pairs one at a time, and were told the goal was to maximize their score on the word lists (participants were given multiple lists). Scores were determined by adding the number of points that were associated with each of the words successfully recalled. Thus, there was an incentive and goal within the task to recall the words paired with higher point values. Although younger adults recalled more words than older adults, recall for the words associated with the highest point values showed no age-related differences. These results suggest that older adults are able to remember high-value information to the same extent as younger adults, although it may be at the expense of lower-value information. This finding is intriguing due to the fact that theories proposing general cognitive slowing or reduced attentional resources would likely predict that older adults’ recall would be lower at every point value compared with younger adults. Instead, older adults seem to be able to shift attention and recall the high-value information at the expense of lower value information, maximizing memory efficiency (Castel, 2008; Castel et al., 2002; Friedman & Castel, in press), although this pattern only emerges with task experience (Castel, Balota, & McCabe, 2009). Thus, it is clear that value in form of points is a salient cue that older and younger adults can use to strategically guide attention and encoding operations.

Increasing the importance of information can also serve to mitigate age-related deficits commonly observed in source memory (i.e., memory for information about the contextual details accompanying an event). Using materials that were not tied to specific salient point values, Rahhal and colleagues (Rahhal, May, & Hasher, 2002) found no age-related differences when older adults were asked to recognize if the statement was true, false, or new (truth source), whereas large age-related differences were present when asked to identify the voice source (John or Mary said it). Presumably, most people would agree that remembering whether a previously heard statement was true or false is more important than remembering who said it. Similarly, older adults' memory performance equaled younger adults' on source memory tasks when the to-be-remembered information had an more important component (i.e., safety) compared with a less important feature (i.e., color) (May, Rahhal, Berry, & Leighton, 2005). The findings indicate that increasing the value or importance of information often mitigates age-related memory impairments, although typical age-related impairments exist for less valuable or important information. Consistent with the SOC theory (Baltes & Baltes, 1990), healthy older adults might be more selective in how they engage their cognitive resources, and value can serve as cue to guide and direct encoding operations that lead to successful recall of more important information.

Subjective Value and Memory

While there is evidence suggesting that older adults are able to recall more objectively high value information, it is often one's own interest or goals that determines the overall worth or "value" of information. Older adults, in particular, might place an even greater emphasis on remembering information they think is more important or valuable compared with information they are told is important. Some studies have examined the influence of this more subjective measure of importance on memory in older and younger adults by manipulating personal relevance of the to-be-remembered information. For example, Hess et al. (2001) found that older adults were more accurate in their recollection of information related to a narrative describing an older target person (increased relevance) compared with one describing a younger target person; younger adults showed the opposite effect. Furthermore, older adults benefitted to a greater extent from increasing relevance than did younger adults.

Extending the findings from Hess et al. (2001), Germain and Hess (2007) found this pattern of better memory for more personally relevant information held true under conditions that manipulated the age of the target person in the narrative (i.e., older versus younger) as well as the topic of the narrative (e.g., rising health care costs versus university budget cuts). It was also demonstrated that increased relevance was strongly associated not only with memory performance, but with more efficient processing. That is, when the passages were higher in personal relevance, older and younger adults displayed a greater ability in inhibiting distracting, irrelevant information interspersed within the passage. Interestingly, these effects were also stronger within the older adult sample (Germain & Hess, 2007), suggesting that interest or relevance of information can have an even larger positive effect on memory functioning among older adults compared with younger adults.

A recent study of younger adults conducted by Kang et al. (2009) examined whether initial curiosity to learn answers to novel trivia questions impacted memory performance. In addition, the study investigated the neurological underpinnings associated with curiosity to learn. Participants were shown a series of trivia questions, and had to indicate how curious they were to learn to answer, after which they were shown the answer. Neuroimaging results indicated that increased curiosity was associated with higher activity in a number of regions involved in reward learning and reward anticipation including the caudate, prefrontal cortex, and other areas linked with memory such as the parahippocampal areas. Furthermore, younger individuals also later remembered more answers to the questions they had indicated they were more curious about compared to those that evoked less curiosity.

The finding that curiosity could act as a form of reward anticipation, thus enhancing memory (Kang et al., 2009), has received further support in a similar study with younger adults utilizing monetary rewards (Murayama & Kuhbandner, 2011). Murayama and Kuhbander (2011) found that monetary rewards enhanced memory performance for "uninteresting" material, but did not enhance memory performance when the to-be-learned material was more interesting. The evidence that interest or curiosity may indeed induce similar processes as do monetary rewards may be particularly useful to examine in older adults, as some evidence suggests that older individuals may be more sensitive to potential rewards and gains relative to losses compared with younger adults (Denburg et al., 2007; Denburg, Tranel, & Bechara, 2005; Fein, McGillivray, & Finn, 2007; Samanez-Larkin et al., 2007).

While it has been demonstrated that younger and older adults are able to recall more interesting or more relevant information in certain contexts or tasks, what is currently lacking in the existent literature is the investigation of whether older adults can recall what they explicitly and subjectively indicate is more valuable or interesting. Previous studies have demonstrated that older adults' memory performance significantly benefits from information that is likely to be viewed as generally more relevant (Germain & Hess, 2007; Hess, Germain, Swaim, & Osowski, 2009; Hess et al., 2001). However, there has yet to be an investigation using paradigms that require older and younger adults to, on an item by item basis, provide ratings and judgments of what may be more or less valuable, important or interesting in order to understand the extent that these subjective ratings are predictive of one's later memory.

Metacognition and Aging

Asking participants to provide an explicit rating of value or interest is not completely dissimilar to paradigms designed to assess aspects of metacognition. Metacognition, or metamemory, simply refers to one's awareness and insight about one's own memory and how it works. Metamemory includes, but is not limited to, beliefs about one's memory skills and task demands, insight into memory changes, feelings and emotions about one's memory, and knowledge of memory functioning (Dunlosky & Metcalfe, 2009). Specific metamemory measures are typically categorized as involving either monitoring or control (Nelson & Narens, 1990). Metacognitive monitoring involves the assessment of ongoing memory encoding and retrieval processes, such as a beliefs regarding what information is more memorable, or feelings of confidence that what one remembered was accurate. Metacognitive control, which can be influenced by monitoring (Hertzog & Dunlosky, 2011), includes behaviors and actions implemented to achieve desired memory-related goals such as restudying information one feels is less well learned, or utilizing mnemonic strategies to enhance later recall. Beliefs that older and younger adults have about their memory abilities (e.g., belief that one will be able to remember important, interesting information) can influence expectations for memory performance (e.g., this information will be remembered), effort exerted during a memory task (e.g., engagement of more elaborative processing or strategy usage), and thus can influence one's actual performance.

One of the most common methodologies used to examine metamemory monitoring is to ask participants to make judgments of learning (JOLs) about what, or how much, they will later remember. These judgments can then be compared to actual recall performance in order to assess accuracy of the memory predictions. Previous research examining potential age-related differences in the accuracy of metamemory predictions (JOLs) have largely found that older adults' accuracy is comparable with younger adults (Connor, Dunlosky, & Hertzog, 1997; Hertzog, Sinclair, & Dunlosky, 2010; Hines, Touron, & Hertzog, 2009; Lovelace & Marsh, 1985; Murphy, Sanders, Gabriesheski, & Schmitt, 1981; for an exception see Bruce, Coyne, & Botwinick, 1982; Bunnell, Baken, & Richards-Ward, 1999). The findings suggest that monitoring of learning remains relatively intact throughout the lifespan, and older adults do maintain awareness of what they are more or less likely to remember.

In regard to age-related differences in metacognitive control, Dunlosky and Connor (1997) observed that when older and younger adults were allowed to restudy words at their own pace, all participants spent more time studying items that they had assigned lower JOLs (i.e., words they judged as more difficult to recall) compared with those words that had been given higher JOLs. However, younger adults exhibited this effect to a greater extent, indicating that some age-related differences were present in the degree to which monitoring was used to effectively allocate study time. However, Dunlosky and Hertzog (1997) found that younger and older adults used a "functionally identical algorithm" in their selection of items for restudy, and both younger and older individuals strategically selected to restudy the items they believed were not as well learned (Dunlosky & Hertzog, 1997; Hines et al., 2009).

Further evidence of age-related sparing of strategic metacognitive control operations was found by Castel and colleagues (Castel, Murayama, Friedman, McGillivray, & Link, 2013) in a task in which the objective value of the to-be-learned information was varied. In this study, participants were given two minutes to study a list of thirty words, and each word was associated with a different point value. Participants were allowed to study as few or as many of the items as they wanted, they were allowed to study items multiple times, and could control how long they studied each item. Importantly, in this task the goal was not necessarily to recall as many items as one could, but to obtain a high point score. Scores were the sum of the point values associated with words recalled, and thus some items were more valuable and important to remember. It was found that both older and younger adults were strategic in terms of studying higher point value words more often, and for longer periods of time, suggesting value can be used as a cue to guide strategic and selective behaviors during the learning process.

Importantly, metacognitive monitoring and control are thought to have a reciprocal relationship (e.g., Nelson & Narens, 1990). Specifically, if one is able to effectively monitor what information is more or less likely to be recalled, then that knowledge can be used to engage strategies to enhance memory for information deemed less well learned, and in turn one can then monitor the effectiveness of those strategies. The ability to utilize one's metacognitive monitoring and control processes is particularly important for older adults. While older adults often remember less information compared with younger adults, findings of intact monitoring and control suggests that older adults may be able to use metacognitive strategies or awareness to help overcome or compensate for age-related declines in memory performance (Hertzog & Dunlosky, 2011).

Current Studies and Goals of the Dissertation

Within the following chapters I describe two different lines of experiments that, in their own distinct way, assess older and younger adults' ability to recall what is, on an individual basis, judged as either more or less valuable or interesting. Experiment 1, 2 and 3, examine older and younger adults' ability to utilize strategic metacognitive monitoring and control to recall information assigned various values by the participants. Experiments 4 and 5 examine the extent to which subjective interest and curiosity to learn impact older and younger adults' memory performance, as well as metacognitive judgments.

Experiments 1, 2, and 3 utilized a novel paradigm in which participants provided value-driven judgments of learning. Standard judgments of learning regarding what a participant thinks he or she will be able to recall are, at least in a superficial way, similar to asking participants to rate (or are potentially influenced by) what they think is more important. However, the manner in which JOLs are typically assessed (e.g., "how likely is it you will remember this?") does not quite capture the construct of value. In the current studies, participants assigned each item within a list a specific point value. This value was how many points one received if the item was later recalled, but also how many points were lost if the item was not remembered. Essentially, participants were asked to bet on the likelihood they would recall an item. Thus, within this task, the value assignments were important, and one needed to actively and strategically monitor one's memory in order to be successful (i.e., obtain a high point score). The primary aim of these studies was to examine factors that influence older and younger adults' ability to use and assign value to information in a strategic manner, and investigate the extent to which individuals are able to recall this higher value information.

The primary goals of Experiment 4 and 5 were to examine whether initial curiosity in learning an answer to a novel trivia question, as well as interest level once the answer was learned, was associated with later memory performance in younger and older adults. These studies also investigated whether individuals' metacognitive ratings (i.e., JOLs) were accurate in predicting later memory, and whether JOLs were associated with ratings of interest. Although it is likely that many individuals hold the belief that interesting information is more likely to be remembered than uninteresting information, the magnitude of the effect that interest and curiosity have on older and younger adults' memory is relatively unknown. Furthermore, the extent that one's interest level is used as cue to inform JOLs has not been examined in previous studies of metacognitive monitoring.

The results from these studies have important implications, particularly for older adults. Information that is deemed as more valuable or interesting may help initiate additional elaborative processing and attention compared to less valuable information, which could serve to minimize some of the memory deficits often observed among older adults. It may even be the case that older adults' subjective judgments and ratings are more sensitive to the level of interest evoked by the information compared with younger adults, as it has been suggested that aging is associated with an increase in the selectivity in which cognitive resources are engaged (e.g., Baltes & Baltes 1990; Hess, 2006). Importantly, the results speak to older adults' ability to capitalize on intact cognitive functions, such as metacognitive processes, to increase memory performance for important and valuable information.

Chapter 2 - Experiments 1, 2 and 3

Introduction

Age-related changes in memory functioning are well documented. However, there is growing evidence that suggests the effects of aging on metacognitive functioning are minimal, and that both older and younger adults might be able to utilize their metacognitive abilities in a strategic manner (Hertzog & Dunlosky, 2011; McGillivray & Castel, 2011). Metacognition (or more specifically, metamemory) refers to one's awareness of and insight into his or her own memory, and how it works. Metamemory includes, but is not limited to, beliefs about one's memory abilities and task demands, insight into memory changes, and knowledge of memory functioning (Dunlosky & Metcalfe, 2009). The ability to accurately monitor one's memory is vital to healthy and efficient cognitive functioning, particularly as one ages. If one is aware of what information might be remembered or forgotten, then actions can be taken to increase the odds of remembering, such as studying the information again or for longer periods of time, or simply writing it down. As explicit memory abilities decline during aging, the role that metamemory can assume during the learning process becomes even more relevant. Older adults are often very aware of deficits in memory performance (Hertzog & Hultsch, 2000; Levy & Leifheit-Limson, 2009), making the study of metamemory very pertinent to the questions surrounding potential age-related changes in the ability to strategically and accurately predict and remember information.

Experimental studies of metamemory focusing on one's ability to monitor and assess memory often involve asking participants to make judgments of learning (JOLs) about what or how much they will later remember, and absolute and/or relative accuracy of JOLs can be assessed. Absolute accuracy of JOLs is typically measured by calculating the average JOL rating (e.g., 40% if the scale was from 0-100%), and comparing it with the average percentage of information recalled (e.g., 30%). Absolute accuracy allows for insight into whether individuals display a general pattern of over-or-under confidence in memory abilities (in the above example it would be considered over-confidence). Relative accuracy, on the other hand, examines whether the JOLs assigned by an individual can distinguish between what information is later remember versus forgotten, and is typically assessed using gamma correlations (Nelson, 1984, 1996). Simply put, higher relative accuracy (i.e., a positive correlation) occurs when higher JOLs are given to information later recalled, and lower JOLs are given to information forgotten at test.

Investigations into the effects of aging on the accuracy of JOLs has been somewhat mixed. While some studies have found that older adults exhibit a larger pattern of overconfidence (i.e., poorer absolute accuracy) in their memory abilities compared with younger adults (i.e., there is a larger discrepancy between JOLs and actual memory performance; Bruce et al., 1982; Bunnell et al., 1999; Connor et al., 1997), other studies have found little to no age differences (Connor et al., 1997; Hertzog et al., 2010; Hines et al., 2009; Lovelace & Marsh, 1985; McGillivray & Castel, 2011; Murphy et al., 1981; see Hertzog & Dunlosky, 2011 for a recent review), or even slightly more accurate performance by older adults (Hertzog, Dunlosky, Powell-Moman, & Kidder, 2002; Rast & Zimprich, 2009). Importantly, studies examining relative metamemory accuracy compared with absolute accuracy (e.g., Connor et al., 1997; Hertzog et al., 2009), typically find no age-related differences in monitoring abilities between younger and older adults.

While the results surrounding metacognition and aging are somewhat varied, it is encouraging that, at least under some conditions, monitoring of learning remains relatively intact throughout the lifespan, and older adults do maintain awareness of what they are more or less likely to remember. Even studies that have found sizable metacognitive deficits in older adults (e.g., Bunnell et al., 1999) have also usually found that these deficits are less than those associated with actual memory ability. That is, metamemory abilities are likely better preserved in older adults than are explicit memory abilities. This sparing suggests that older adults may be able to use metacognitive strategies or awareness to help overcome or compensate for age-related declines in memory performance. The ability to use metacognitive insight in a strategic manner is consistent with the selective optimization with compensation theory of cognitive aging (Baltes & Baltes, 1990), which suggests that successful aging is linked to older adults' ability to selectively invest limited cognitive resources into areas that yield optimal returns. Furthermore, it has been suggested that accurate metacognitive insight might have a more direct impact on memory performance in its ability to modify attention and goal-directed processing (Castel, McGillivray, & Friedman, 2012; Hertzog & Dunlosky, 2011).

The investigation of strategy usage in metacognition is usually examined as a topic of metacognitive control (e.g., study time allocation, study choices, etc.). Studies investigating metacognitive control in younger and older adults typically find few age-related differences, with younger and older adults relying on similar strategies in choosing to spend more time or restudy items deemed less well learned (e.g., Dunlosky & Hertzog, 1997; Hines et al., 2009; for an exception see Dunlosky & Connor, 1997), or more important items (i.e., items worth more points; Castel et al., 2013; Price, Hertzog, & Dunlosky, 2010). These results suggest that not only are older adults able to effectively monitor their memory as well as younger adults, but can effectively exert control over strategic study behaviors.

Strategy usage observed in these studies of metacognitive control is often a product of goal-directed behavior, an element that is typically absent when one forms a JOL. In a standard JOL task, participants passively assign a numerical judgment of how likely they will remember an item, with no actual consequence or outcome tied to these predictions. However, the current experiments bridge the gap between studies of metacognitive monitoring and control through the introduction of consequences tied to metacognitive predictions. That is, in the current studies participants were asked to "bet" on the likelihood they would recall an item, and there were consequences associated with the accuracy of those bets. This use of bets as opposed to more passive JOLs allows for the examination of strategic elements of control within one's metacognitive monitoring behavior in both younger and older adults.

The current studies modified a novel paradigm by McGillivray and Castel (2011), in which participants were presented with lists of words paired with varying point values (1-20), and were told the point value indicated how much the word was worth. As participants were shown each item, they had to "bet" (yes or no) which items they would be able to remember. For any given item, if a participant bet on it, they would receive whatever points were associated with that item if they were later able to recall it, but would lose those points if they failed to recall it. Participants were told the goal was to maximize their score, and score was the sum of all of the words bet on and recalled, minus the sum of the words bet on and not recalled. Thus, there were rewards associated with accurately monitoring and predicting which items would be recalled, and penalties if one failed to do so. Furthermore, individuals were told their overall point score after each list, and engaged in six study-test trials, with different words on each list.

McGillivray and Castel (2011) found that both younger and older adults' bets and recall performance were significantly driven by the objective point value associated with the items.

That is, both younger and older adults strategically bet on and recalled more of the high value relative to the low value items, and there were no age differences for the higher valued items (although younger adults bet on and recalled more items overall), a finding that is consistent with previous literature (Castel et al., 2002; Castel, Farb, & Craik, 2007). In regard to metacognitive calibration, both younger and older adults were highly overconfident on initial lists (i.e., they bet on more items than they were actually able to recall), but this was significantly reduced with task experience. Furthermore, overall point scores on each list improved with task experience, and in fact older and younger adults' scores were comparable on later lists, despite the fact that older adults recalled less information overall. The ability of older adults to achieve comparable point scores compared to those of younger adults suggests that older adults were implementing strategies that actually led to the marginally better calibration on the later lists, in order to achieve goal-relevant outcomes (i.e., high point totals).

The introduction of consequences tied to metacognitive monitoring judgments utilized by McGillivray and Castel (2011) is a rather large departure from standard metacognition paradigms. It is, however, highly appropriate given that there are often consequences tied to our metacognitive predictions in daily life. For example, a student may choose to stop studying if she believes she has mastered the material, or an older adult may fail to write down important information given to him by a doctor if he thinks he will be able to remember it later. It is clear that consequences are present in the real world, thus the implementation of consequences into metacognitive paradigms offers an exciting and highly practical avenue of research.

The use of consequences does, however, introduce an aspect of risk and could potentially create a more stressful situation which one might assume would impact performance. However, the incorporation of incentives, while potentially increasing anxiety, likely also enhances participants' vigilance and awareness (Persaud, McLeod, & Cowey, 2007), resulting in increased motivation to accurately calibrate their predictions to their actual performance abilities. Motivation, incentives and accountability have been shown to increase performance on various cognitive tasks (e.g., Germain & Hess, 2007; Hess et al., 2009; Touron, Swaim, & Hertzog, 2007), and older adults in particular may benefit from these added incentives (Adams, Smith, Pasupathi, & Vitolo, 2002; Hess et al., 2001).

In addition, the use of multiple trials in the investigation of strategic metacognitive monitoring is necessary, and there is evidence that selectivity may only emerge with task experience (Castel et al., 2009; McGillivray & Castel, 2011). Prior studies have usually assessed the impact of task experience on metacognitive accuracy by presenting participants with the same set of information twice, and examining the degree of improvement in predictions and strategy usage (but see McGillivray & Castel, 2011; Rast & Zimprich, 2009). Dunlosky and Herzog (2000) found that the absolute accuracy of global predictions was not greatly improved for either younger or older adults across two study-test trials; however, relative accuracy of predictions did increase with task experience for both age groups. When the benefits of task experience on knowledge updating are more substantial, it has been found that older adults' ability to accurately update metacognitive predictions are impaired relative to younger adults (Matvey, Dunlosky, Shaw, Parks, & Hertzog, 2002; Price, Hertzog, & Dunlosky, 2008), although more recent studies have found comparable benefits of task experience by both younger and older adults (Hertzog & Dunlosky, 2011; McGillivray & Castel, 2011; Tullis & Benjamin, 2012). From a more general standpoint, these studies have all found that older and younger adults do tend to lower their predictions and correct initial overconfidence with task experience.

The role of task experience and feedback may be particularly important for older adults (e.g., Jacoby, Wahlheim, Rhodes, Daniels, & Rogers, 2010) in order to learn to calibrate predictions with actual performance. On-line monitoring needed for accurate predictions may tax attentional and working memory systems that can become compromised in old age (Bieman-Copland & Charness, 1994; Craik, 2002; Craik & Byrd, 1982; Hasher & Zacks, 1988), and older individuals may require more time and experience to adopt appropriate strategies and reach levels of performance on par with younger adults (McGillivray & Castel, 2011; Rogers, Hertzog, & Fisk, 2000; Touron, Hoyer, & Cerella, 2004).

Experiment 1

The findings from McGillivray and Castel (2011) indicate that the introduction of negative consequences may have served to enhance motivation to accurately monitor and update performance expectations with task experience, perhaps even to a larger extent for older adults relative to younger adults. However, the question remains whether a similar pattern of results would be found if value was not objectively defined as it was in McGillivray and Castel, and rather it was left up to the participant to decide what would be more or less "valuable". It is clear that point values associated with items are a salient cue younger and older adults use to guide metacognitive predictions (McGillivray & Castel, 2011; Price et al., 2010). It is unclear, when under the control of participants, whether older and younger adults will be able to strategically allocate value (i.e., points) relative to their own memory abilities. In the current set of studies, participant viewed items one at a time for a fixed duration, and as they saw each item they had to assign it a value from 0-10. The value assigned was how many points participants received if they later recalled the item, but also how many points they lost if the item was not recalled.

Across all three experiments participants engaged in six study-test cycles, and were given feedback regarding their overall point score at the end of each list.

Requiring participants to assign value is more similar to standard JOL paradigms, and allows for more direct comparisons with prior metacognitive monitoring and aging research. The "bet" (i.e., point value) assigned in the current studies is similar to a judgment of how likely a participant believes an item will be recalled. That is, if one thinks an item will be recalled later, a higher value should be given. However, the bets also need to be strategic, and require the use of metacognitive control processes in that individuals have to learn to only assign high values to items that they actually are able to later recall in order to be successful in the task. It is expected that if metacognitive monitoring and control are relatively intact across adulthood, then older adults, while potentially recalling fewer items, should achieve comparable levels of metacognitive resolution as younger adults. However, the use of some cognitive resources might be necessary in order to determine and assign point values, particularly in a paradigm where the incentive and need for accuracy is quite salient (i.e., loss of point when incorrect). If cognitive resources are utilized in the process of attempting to strategically assigning values, this might create a situation that is potentially detrimental to some measures of performance, particularly for older adults.

Method

Participants

The participants consisted of 28 older adults (16 females, *M* age = 76.1, *SD* = 6.8) and 24 younger adults (19 females, *M* age = 20.8, *SD* = 3.1). Older adults were all living in the Los Angeles area, and recruited through community flyer postings as well as through the UCLA Cognition and Aging Laboratory Participant Pool. Older adults had good self-reported health ratings (*M* = 8.4 on a scale of 1-10, with 1 indicating extremely poor health and 10 indicating excellent health), and had an average of 17.4 years of education. Older adults were paid $10 an hour for their time and reimbursed for parking expenses. Younger adults were all University of California, Los Angeles undergraduates and received course credit for their participation.

Materials

The materials utilized in Experiment 1 were identical to those used in McGillivray and Castel (2011). The items consisted of seventy-two common nouns. The log mean hyperspace analog to language average frequency of the words was 8.8 (range = 7.2-10.1), as obtained from the elexicon.wustl.edu Web site (Balota et al., 2007), and all of the words were four or five letters in length (e.g., lion, radio, train). The words were randomly assigned without replacement into one of 6 different lists and each list contained 12 words.

Procedure

Participants were told that they would be presented with six different lists of words, and that each list contained 12 words. They were told that for each word they would need to assign it a point value from 0-10. If they were later able to remember that word on an immediate free recall test, they would receive the points they has indicated they wanted it to be worth. However, if they failed to recall the word they would lose those points. Participants were informed to think of it like they were betting on their memory. Participants were told they could use the values as many times as they wanted (e.g., assign numerous words '8'), and they were told that a value assignment of '0' was like passing on an item and should be given if they did not think they would be able to recall an item. It should be noted that participants saw each word for the same amount of time, regardless of the point value assigned. Participants were also told the goal was to try to get as many points as possible, and were encouraged to try to maximize gains and to minimize any losses.

Participants were shown the words one at a time, each for 5 seconds. As each word was presented they had to indicate how many points they wanted that word to be worth. Participants made all responses verbally, which were recorded by an experimenter. After all 12 words were presented they were given a 30s free recall test in which they had to verbally recall as many words as they could from the list (they did not need to recall the point values). Immediately following the recall period, participants were informed of their score for the list, but were not given feedback about specific items. Scores were calculated by summing the points associated with the words successfully recalled, and then subtracting the number of points associated with the words that were not recalled. The next list began immediately after the scores were calculated and the feedback was provided (approximately 20-30s later). This procedure was repeated until all six lists had been completed.

Results and Discussion

A number of dependent variables were analyzed. The measures included the number of items "bet" on (i.e., items given a point value greater than 0), the number of items correctly recalled, overall point scores, metacognitive accuracy (i.e., gamma correlations between bets and recall), the frequency that each value was assigned, and the number of 0's recalled. All data analyses conducted on task experience (i.e., list) were done collapsing across lists 1-2, 3-4, 5-6, creating the variables "initial lists," "middle lists," and "later lists."

Bets and Recall

In order to assess general metacognitive strategy and memory performance, the average number of words bet on and recalled was examined as a function of list. The results of bets and recall by list for both younger and older adults are presented in Figure 1.1. A 2 (Age Group: older and younger) x 3 (List: initial, middle, later) mixed ANOVA revealed that overall the number of items bet on decreased on later lists, $F(2, 100) = 24.96$, $MSE = 2.10$, $p < .001$, $\eta_p^2 = .33$, and older and younger adults bet on a similar number of items, $F(1, 50) = 2.16$, $p = .15$. Age Group and List did not interact ($p = .48$). A 2 (Age Group) x 3 (List) ANOVA on the number of items recalled showed that older adults recalled fewer items than younger adults, $F(1, 50) = 19.64$, $MSE = 3.87$, $p < .001$, $\eta_p^2 = .28$. There was also an effect of list, $F(2, 100) = 14.19$, $MSE = .79$, $p < .001$, $\eta_p^2 = .22$, but no significant age group by list interaction ($p = .53$).

Point Score

Within this paradigm, participants were told to maximize their score and were given feedback regarding their score at the end of every list. The average scores (a measure of overall performance) for both younger and older adults are displayed in Figure 1.2. A 2 (Age Group) x 3 (List) ANOVA revealed that, overall, older adults had lower scores compared with younger adults, $F(1, 50) = 4.09$, $MSE = 861.21$, $p < .05$, $\eta_p^2 = .08$. Importantly, scores for both younger and older adults increased with task experience, $F(2, 100) = 26.04$, $MSE = 192.36$, $p < .001$, $\eta_p^2 = .34$. No significant interaction was observed ($p = .21$).

Metacognitive Accuracy

Metacognitive accuracy was assessed through gamma correlations, a measure of resolution between point value bets and recall that ranges between -1 to +1, and the results are displayed in Figure 1.3. A 2 (Age Group) x 3 (List) ANOVA revealed that the overall gamma correlations between bets and recall were similar for older ($\gamma = .58$) and younger adults ($\gamma = .53$), $p = .65$, and that metacognitive resolution increased on the later trials, $F(2, 96) = 12.85$, $MSE = .08$, $p < .001$, $\eta_p^2 = .21$. Furthermore, there was a significant age group by list interaction, *F*(2,

96) = 3.73, *MSE* = .08, $p < .05$, $\eta_p^2 = .07$. Post-hoc t-tests revealed that older adults actually had better resolution compared with younger adults on initial lists, $t(50) = 2.13$, $p < .05$, but no age-differences were observed on middle or later lists (all *p's* > .45).

Point Value Strategy

Potential differences in the assignment of value by older and younger adults across lists were examined. Figure 1.4A shows the average proportion that each point value was assigned (0-10), collapsed across all lists, for both older and younger adults. Looking at the results displayed in Figure 1.4A, the distribution of scores between older and younger adults is quite similar, and it appears that many of the values were rarely utilized. In fact, only three values were assigned, on average, at least once per list (more than 8.3% of the time). These higher frequency values were the 0, 5, and 10 point value. Due to the limited use of values other than 0, 5, and 10, a 2 (Age Group) by 3 (List), by 3 (Value: 0, 5, 10) ANOVA was conducted in order to examine potential differences in value assignment behaviors between age groups, as well as any potential strategic changes with task experience. Figure 1.4B displays the average proportion that each of the 3 key point values (0, 5, and 10) was assigned, collapsing across List 1-2, List 3-4, and 5-6 for older adults, and Figure 1.4C displays these data for younger adults. There was a significant effect of Age Group, $F(1, 50) = 15.14$, *MSE* = .06, $p < .001$, $\eta_p^2 = .23$; and effect of List, $F(2, 100) = 19.71$, *MSE* = .01, $p < .001$, $\eta_p^2 = .28$; Value, $F(2, 100) = 3.51$, *MSE* = .13, $p < .05$, $\eta_p^2 = .07$; as well a marginally significant Age Group by List by Value interaction, $F(4, 200) = 2.31$, *MSE* = .02, $p = .06$, $\eta_p^2 = .04$.

Post-hoc t-tests were conducted comparing the frequency that older and younger adults assigned each of the three values (0, 5, and 10) within each of the three blocks of lists. The only significant difference between the age groups occurred on Lists 1-2, in which older adults utilized the 10 point value more often than younger adults $t(50) = 3.87$, $p < .001$, all other *p's* > .12. Additional t-tests were conducted in order to examine any potential changes in the proportional use of the values with task experience within the older and younger adult sample. Both older and younger adults increased the number of 0 values assigned after the initial lists $t(27) = 4.56$, $p < .001$, and $t(23) = 3.82$, $p < .001$, respectively for older and younger adults, but after this initial increase the overall proportion of 0's assigned remained fairly constant for both age groups (all *p's* > .22). In regard to the 5 point value, older adults utilized this value fewer times on later list compared to middle lists, $t(27) = 2.30$, $p < .05$, whereas younger adults assigned fewer 5 values on later lists compared to initial lists $t(23) = 2.57$, $p < .05$. Examining the usage frequency of the 10 point value, older adults assigned fewer 10 values on the middle lists compared with the initial, $t(27) = 3.67$, $p = .001$, and later lists, $t(27) = 2.97$, $p < .01$. A slightly different pattern was found with younger adults, who displayed an increase in the number of 10 values assigned only on the later list compared with both the initial, $t(23) = 3.10$, $p < .01$, and middle lists, $t(27) = 4.19$, $p < .001$.

Lastly, given the high proportion of 0 values assigned, the number of words recalled that were assigned a 0 value was examined. Although there were no penalties (or gains) associated with recalling an item given a 0, this could be a potential indicator of the ability to effectively inhibit irrelevant information. Although the overall frequency of 0 point values recalled was quite low, a 2 (Age Group) x 3 (List) ANOVA revealed that, overall, older adults actually recalled fewer of the items they had assigned a 0 ($M = .34$, $SD = .35$) compared with younger adults ($M = .61$, $SD = .54$), $F(1, 29) = 7.73$, $MSE = .52$, $p < .01$, $\eta_p^2 = .21$, and task experience reduce this effect, $F(2, 58) = 7.08$, $MSE = .24$, $p < .01$, $\eta_p^2 = .20$. The interaction, $F(2, 58)$ =

6.22, *MSE* = .24, p <.01, η_p^2 = .19, indicated that initially younger adults recalled more 0s than older adults, $t(34)$ = 4.27, p < .001, but this difference disappeared on later lists (all *p*'s, > .73).

It was found that both younger and older adults were able to successfully recall words they had assigned higher subjective values, and were able to improve metacognitive accuracy and reduced initial overconfidence with task experience. In fact, by the last list, gamma correlations were exceeding high and identical for both younger and older adults (γ's = .70). Despite achieving comparable levels of metacognitive accuracy, older adults did have significantly lower scores compared with younger adults. However, this finding is not unexpected given the fact that older adults recalled fewer items than younger adults, and the number of items recalled was highly related to overall point score (r = .42, p < .01).

In regard to the strategic use of value, in order to maximize performance (score) in this particular paradigm, the most effective strategy would be to assign 0 to words that one could not recall, and 10 to words recalled. Both younger and older adults did display large initial overconfidence (betting on more items they could recall), but increased the number of 0 values assigned with task experience, demonstrating sensitivity to potential losses. The use of the value 5 could be considered less strategic given the goals of the task, and both age-groups did show a significant decrease in the number of 5 values assigned, although this did not occur until the later lists. Concerning the use of the 10 point values, older adults decreased the use of the 10 point value on middle lists, a slightly less strategic move which may have resulted in the observed dip in overall point score (see Figure 1.2), but with task experience did show a return to a more frequent use of the 10 value on the later lists. Demonstrating a slightly different pattern, younger adults appeared to quickly learn to increase and maintain a relatively high level use of the 10 point value after the initial lists. Thus, it appears that older adults may have taken longer than younger adults to adopt more appropriate value assignment strategies, but with enough task experience displayed an extremely similar pattern compared with younger individuals. Importantly, it was also found that older adults were somewhat less likely to recall items they had assigned a 0, indicating that older individuals were able to inhibit and effectively monitor less relevant information.

Experiment 2

Within Experiment 1, assignment of the subjective values may have posed somewhat of a challenge to participants. The stimuli (all simple, unrelated nouns) did not lend themselves to aiding in the assignment of value given that, presumably, the words were all equally salient and memorable. Despite this inherent challenge of the task, it may have led participants to base the assignment of value less on intrinsic cues of the items (i.e., features of the words themselves) and instead rely more on extrinsic or mnemonic cues such as the task demands and how many words they learned they were able to recall (Koriat, 1997). In this respect, the paradigm succeeded in promoting successful strategy use. Nevertheless, it is less naturalistic to ask individuals to assign subjective consequential values to items that inherently do not elicit this type of comparative judgment.

Experiment 2 was conducted in order to investigate the impact of utilizing stimuli that do provide stronger intrinsic cues, and also lend themselves to the development of appropriate strategy use with task experience. It has previously been shown that associative or semantic relatedness between word pairs is an extremely salient intrinsic cue that is used by individuals in the assignment of JOLs, and it is also strongly related to recall performance (e.g., Connor et al., 1997; Dunlosky & Matvey, 2001; Hertzog et al., 2002; Hertzog et al., 2010). For example, Hertzog and colleagues have examined JOL accuracy and monitoring abilities among younger and older adults (Hertzog et al., 2002). Participants were presented with either related or unrelated word pairs and asked to provide JOLs. Both age groups exhibited better overall recall performance for related pairs compared to unrelated pairs, although older adults recalled fewer words overall. However, older adults' average JOLs were closer (and nearly accurate) to their actual memory performance, whereas younger adults were slightly less accurate in the direction of under-confidence. Both groups gave higher JOLs for related compared to unrelated pairs, indicating they were sensitive to cues of associative relatedness, although older adults were slightly more responsive to this type of information than were younger adults.

Judgments of learning have been shown to be sensitive to cues of associative strength, and both younger and older adults can use those cues to increase metacognitive accuracy. Experiment 2 adapted the paradigm described in Experiment 1, and utilized semantically related and unrelated word pairs. It was hypothesized that the use of word pairs could aid in both the subjective assignment of point values as well as in the adoption of more effective strategies (e.g., assigning high values to related word pairs, and low or 0 point values to the unrelated word pairs). Previous research indicates that older and younger adults are aware that they are more likely to recall semantically related compared to unrelated items (Connor et al, 1997; Hertzog et al., 2002; Hertzog et al., 2010; Hertzog & Dunlosky, 2011), and thus individuals could learn to capitalize on this knowledge about what is more or less likely to be recalled to inform decisions surround value assignments, maximize goal-related outcomes (i.e., achieve high scores) and enhance metacognitive accuracy.

Methods

Participants

Participants consisted of 24 older adults (10 females, *M* age = 68.0, *SD* = 6.7) and 24 younger adults (12 females, *M* age = 20.4, *SD* = 1.1). Older adults had good self-reported health ratings (*M* = 8.5 on a scale of 1-10, with 1 indicating extremely poor health and 10 indicating excellent health), and had an average of 17.4 years of education. The recruitment and compensation procedures were identical to those described in Experiment 1.

Materials

The stimuli consisted of 144 word pairs. Half of the word pairs were unrelated and had no associative strength (e.g., handle-blanket, roof-beach), and the other half were related word pairs with moderate levels of associative strength (e.g., dish-bowl, lemon-sour). The unrelated word pairs were adapted from Connor et al. (1997). The related word pairs were created using the University of South Florida Free Association Norms database (Nelson, McEvoy, & Schreiber, 1998). The related word pairs were selected such that the target word never had the highest associative strength with the cue word, and on average had an associative strength of .14 (range: .11-.18). This was done to specifically lower the probability that an individual would simply be able to guess the correct target word when given the cue at test.

The related and unrelated word pairs were each randomly assigned, without replacement, to one of the six lists. Each list contained 12 related word pairs, and 12 unrelated word pairs, presented in a fixed random order. Order of the lists was counterbalanced between participants.

Procedure

The procedure was very similar to that described in Experiment 1. Participants were told they would see six lists of word pairs, with 24 word pairs in each lists. There were told that for each word pair, they would need to assign it a point value from 0-10. This value was like a "bet," and if they later recalled the target word when given the cue word they would receive whatever points they had given the word pair, but would lose those points if they failed to recall the second word when given the first word. Participants were told the goal in the task was to maximize their score, and that it was up to them to decide how to assign the point values. They were told they could use each value as many times as they liked, and were encouraged to assign "0" if they did not think they would be able to recall an item. Participants were informed that during the test they would always be shown the first word of the pair, and would need to try to recall the second word.

During the study phase, participants were shown the word pairs one at a time, each for 5 seconds. As each word was presented they had to say out loud how many points they wanted that pair to be worth. After all 24 word pairs were presented they were given a cued recall test. During the test, they were shown each of the cue words one at a time, and had to recall, out loud, the word that went with it. They were told if they could not remember the word, they could "pass" and move onto the next item. The cued recall test was self-paced. Immediately following the recall period, participants were informed of their score for the list. Scores were calculated in the same manner as described in Experiment 1. The next list began immediately after the scores were calculated and the feedback was provided, and this procedure was repeated until all six lists had been completed. All participant responses were recorded by an experimenter.

Results and Discussion

Bets

Figure 2.1 displays the average number of items bet on (assigned values greater than 0) by younger and older adults as a function of relatedness (related versus unrelated word pairs). For all analyses of task experience Lists 1-2, 3-4, and 5-6 were averaged. A 2 (Age Group) by 2 (Relatedness) by 3 (List) was conducted and revealed that older adults bet on fewer items than younger adults, $F(1, 46) = 6.32$, $MSE = 22.99$, $p < .05$, $\eta_p^2 = .12$. The number of items bet on showed an overall decrease on later lists, $F(2, 92) = 9.61$, $MSE = 1.84$, $p < .001$, $\eta_p^2 = .17$, and related word pairs were bet on more frequently than unrelated word pairs, $F(1, 46) = 93.14$, $MSE = 18.19$, $p < .001$, $\eta_p^2 = .67$. Furthermore, a significant Age Group by List by Relatedness interaction was observed, $F(2, 92) = 8.39$, $MSE = 1.50$, $p < .001$, $\eta_p^2 = .15$.

Post-hoc t-tests examining age-related differences in the number of items bet on across lists as a function of relatedness revealed that on initial lists, older and younger adults bet on a similar number of unrelated word pairs ($p = .15$), but older adults actually bet on a higher number of related word pairs than did younger adults, $t(46) = 2.42$, $p < .05$. On the middle lists, older adults bet on fewer unrelated items compared with younger adults, $t(46) = 3.22$, $p = .002$, and both age groups bet on a similar number of related word pairs ($p = .14$). The later lists showed a similar pattern as the middle lists, with older individuals betting on fewer of the unrelated word pairs, $t(46) = 3.78$, $p < .001$, and only marginally more of the related word pairs than did younger adults, $t(46) = 1.87$, $p = .07$. Within the older adult group, the number of unrelated items bet on decreased on the middle list compared with initial lists, $t(23) = 4.17$, $p < .001$, and again very slightly on the later lists compared with middle lists $t(23) = 1.73$, $p < .10$. There was no change in the number of related word pairs bet on with task experience for the older adults (all *p's* > .38). Younger adults, conversely, did not show any change in the number of unrelated word pairs bet on across lists (all *p's* > .25), or the number of related word pairs bet on across lists (all *p's* > .65).

Recall

Recall performance was examined in a 2 (Age Group) by 2 (Relatedness) by 3 (Lists) ANOVA, and the results are displayed in Figure 2.2. Not surprisingly, older adults recalled fewer target words compared with younger adults, $F(1, 46) = 27.36$, $MSE = 9.43$, $p < .001$, $\eta_p^2 = .37$, and related word pairs were remembered much better than unrelated word pairs, $F(1, 46) = 561.22$, $MSE = 5.63$, $p < .001$, $\eta_p^2 = .92$. There was a very marginal impact of List, with a slight trend toward higher recall on later lists $F(2, 92) = 2.61$, $MSE = 1.03$, $p = .08$, $\eta_p^2 = .05$. A significant Age Group by Relatedness by List interaction was also obtained, $F(2, 92) = 10.55$, $MSE = .94$, $p < .001$, $\eta_p^2 = .19$.

Post-hoc t-tests revealed that younger adults recalled more of the unrelated items compared with older adults across all lists (all *p's* < .001), but younger and older adults recalled a similar number of the related word pairs on all lists (all *p's* > .29). Furthermore, older adults recalled more unrelated items on the initial lists compared with the middle lists, $t(23) = 2.45$, $p < .05$ and later lists, $t(23) = 3.03$, $p < .01$. Older individuals also recalled more related items on the later lists compared with both the initial lists, $t(23) = 3.77$, $p = .001$, and the middle lists, $t(23) = 2.78$, $p = .01$. Younger adults displayed a different pattern compared with older adults. Younger adults recalled fewer unrelated items on the initial lists compared with the middle list $t(23) = 3.41$, $p < .01$, and later lists, $t(23) = 2.85$, $p < .01$. The number of related items recalled by younger adults remained constant across all lists (all *p's* > .28).

Point Score

Overall score, a measure of performance, was analyzed in a 2 (Age Group) by 2 (Relatedness) by 3 (List) ANOVA, and the results are displayed in Figure 2.3. Older adults obtained lower overall point scores compared with younger adults $F(1, 46) = 5.71$, $MSE = 1533.71$, $p < .05$, $\eta_p^2 = .11$; scores improved with task experience $F(2, 92) = 19.48$, $MSE = 188.88$, $p < .001$, $\eta_p^2 = .30$; and scores were much higher for related compared to unrelated word pairs, $F(1, 46) = 718.27$, $MSE = 570.50$, $p < .001$, $\eta_p^2 = .94$. While a significant Age Group by

Relatedness by List interaction was not obtained, $F(2, 92) = 2.31$, $p = .11$, both an Age Group by List interaction, $F(2, 92) = 3.88$, $MSE = 188.88$, $p < .05$, $\eta_p^2 = .08$, and an Age Group by Relatedness interaction, $F(1, 46) = 9.02$, $MSE = 570.50$, $p < .01$, $\eta_p^2 = .16$, were observed.

Post hoc t-tests on the Age Group by List interaction revealed that on initial lists, younger and older adults had similar point scores ($p = .17$), but that older adults had lower overall scores on the middle lists $t(46) = 3.09$, $p < .01$, and only marginally lower scores on the later lists, $t(46) = 1.79$, $p = .08$. Furthermore, older adults scores remained relatively constant on the initial and middle lists, but then improved on the later lists $t(23) = 3.33$, $p < .01$. On the other hand, younger adults showed improvement earlier, and scores increased on middle lists compared with initial lists, $t(23) = 4.81$, $p < .001$, but then remained stable between the middle and later lists ($p = .41$). Post-hoc t-tests examining the Age Group by Relatedness interaction revealed that older adults had significantly lower point scores for the unrelated items, $t(46) = 4.34$, $p < .001$. However, both younger and older adults obtained similar scores for the related items ($p = .68$).

Metacognitive Accuracy

Metacognitive accuracy was assessed through gamma (γ) correlations. Given the magnitude of the effect relatedness had on betting and recall, gamma correlations were not examined as a function of relatedness. Furthermore, within the data set it was apparent that numerous individuals would, for example, assign all related items the same point value (e.g., 10), particularly on later lists, thus making it impossible to compute gammas as a function of relatedness for many of the individuals. The effect of task experience on the average gamma correlations for younger and older individuals was assessed in a 2 (Age Group) by 3 (List) ANOVA, and the results are displayed in Figure 2.4. Older adults had significantly higher gamma correlations than younger adults, $F(1, 45) = 11.49$, $MSE = 0.05$, $p = .001$, $\eta_p^2 = .20$, although both older and younger adults' gammas were exceeding high ($\gamma = .88$ and .75, respectively). Furthermore, metacognitive accuracy increased on later lists, $F(2, 90) = 3.86$, $MSE = 0.01$, $p < .05$, $\eta_p^2 = .08$. A very marginal interaction was also obtained, $F(2, 90) = 2.46$, $MSE = 0.01$, $p < .10$, $\eta_p^2 = .05$. Looking at the pattern of results in Figure 2.4, it appears that younger adults' gamma correlations did not change as a function of list, whereas older adults' accuracy increased slightly on later trials. Post-hoc t-tests confirmed these observations, in that younger adults' average gamma correlation remained relatively constant (all *p's* > .17), whereas older adults' gamma correlations increased on the later trials, $t(23) = 3.26$, $p < .01$.

Point Value Strategy

Potential differences in the assignment of value by older and younger adults across lists were examined. The average value assigned by younger and older adults for related as well as unrelated items, as a function of list is presented in Table 1. A 2 (Age Group) by 2 (Relatedness) by 3 (List) ANOVA revealed that significantly higher values were assigned to related compared to unrelated word pairs, $F(1, 46) = 650.13$, $MSE = 3.77$, $p < .001$, $\eta_p^2 = .93$; the average bet value changed as a function of list, $F(2, 92) = 5.32$, $MSE = .86$, $p < .01$, $\eta_p^2 = .10$; and there was no effect of age group, $F(1, 46) = .90$, $p = .35$. However, a significant Age Group by Relatedness by List interaction was observed, $F(2, 92) = 3.96$, $MSE = .50$, $p < .05$, $\eta_p^2 = .08$.

Post-hoc t-test revealed that on initial lists, older adults assigned significantly higher points to related items than did younger adults, $t(46) = 2.32$, $p < .05$, but this difference disappeared on middle and later lists, (all *p's* > .10). For the unrelated items, average point values were comparable between young and older adults on initial lists ($p = .12$), but younger adults assigned higher point values to unrelated word pairs on middle and later lists compared with older adults, $t(46) = 2.90$, $p < .01$ and $t(46) = 3.61$, $p = .001$, respectively. The older adults also assigned significantly lower values to the unrelated pairs on later lists compared with initial lists, $t(23) = 2.33$, $p < .05$, and higher values to the related pairs on later lists compared with initial lists, $t(23) = 2.14$, $p < .05$. While older adults assigned lower values with task experience to the unrelated word pairs, younger adults assigned higher values to these items on middle $t(23) = 2.20$, $p < .05$ and later lists $t(23) = 2.64$, $p < .05$, compared to initial lists. Younger adults also assigned higher values to related word pairs on the middle $t(23) = 2.74$, $p < .05$ and later lists $t(23) = 3.08$, $p < .01$, compared to initial lists.

Figure 2.5A displays the average proportion that each point value was assigned (0-10), collapsed across lists and levels of relatedness, for both older and younger adults. Looking at the results displayed in Figure 2.5A, the distribution of scores between older and younger adults is quite similar, and as in Experiment 1, it appears that many of the values were rarely utilized. In fact, only two values were used, on average, at least two out of the 24 times per list (more than 8.3% of the time). These higher frequency values were the 0 and 10 point value. Due to the limited use of values other than 0 and 10, a 2 (Age Group) by 3 (List), by 2 (Value: 0 and 10) ANOVA was conducted in order to examine potential differences in value assignment behaviors between age groups, as well as any potential strategic changes with task experiment. Figure 2.5B displays the average proportion that each of the two key point values (0 and 10) was assigned, collapsing across List 1-2, List 3-4, and 5-6 for older and younger adults. The results revealed no effect of Age Group, $F(1, 46) = 1.3$, $p = .26$. However, there was a significant effect of List, $F(2, 92) = 53.36$, $MSE = .01$, $p < .001$, $\eta_p^2 = .54$; an effect of Value, $F(1, 46) = 6.72$, $MSE = .14$, $p < .05$, $\eta_p^2 = .13$; as well a significant Age Group by List by Value interaction, $F(2, 92) = 7.71$, $MSE = .01$, $p = .001$, $\eta_p^2 = .14$.

Post-hoc t-tests revealed that while older adults utilized the 0 value equally as often as younger adults on initial lists (p = .35), older adults assigned 0 more frequently than younger adults on middle lists, $t(46) = 2.71$, $p < .01$, and later lists, $t(46) = 3.21$, $p < .01$. Younger and older adults utilized the 10 point value equally as often on all lists (all *p's* > .15). Older adults increased the number of 0 point values assigned after the initial lists, $t(23) = 3.87$, $p = .001$, and used the 10 point value more frequently after the initial lists as well $t(23) = 3.41$, $p < .01$. Younger adults did not show a difference in the frequency of 0 point values assigned across lists (all *p's* > .47), but did assign the 10 point value more frequently on the middle compared with initial lists, $t(23) = 4.54$, $p < .001$, and on the later lists compared with middle lists, $t(23) = 2.63$, $p < .05$.

Lastly, given the high proportion of 0 values assigned, the number of words recalled that were assigned a 0 value was examined in order to assess participants' ability to effectively inhibit extraneous information. Over 70% of the participants did not assign zero values to related word pairs, thus item relatedness was not included as part of the analysis. A 2 (Age Group) x 3 (List) ANOVA revealed that, overall, older adults actually recalled slightly fewer items they had assigned a 0 compared with younger adults, despite the fact that older individuals utilized the 0 value more often, $F(1, 30) = 3.13$, $MSE = 1.43$, $p = .09$, $\eta_p^2 = .10$. However, the number of word pairs assigned a 0 and later recalled was quite low for both older ($M = .90$, $SD = .69$) and younger adults ($M = 1.33$, $SD = .69$). Furthermore, there was no effect of task experience (list), $F(2, 60) = .84$, $p = 44$, nor was there an interaction, $F(2, 60) = .13$, $p = .88$.

The introduction of stimuli that contained cues to accurately guide value judgments produced quite striking effects. While older adults bet on fewer items, recalled fewer items, and achieved lower point scores compared with younger adults, age-related differences were eliminated for the related word pairs. The finding that age-related differences were prominent for the unrelated word pairs is consistent with older adults' deficits in associative learning (Naveh-Benjamin, 2000; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003; Old & Naveh-Benjamin, 2008). However, age-related associative deficits for the related word pairs were not present, although the related words pairs likely allowed older individuals to rely more on verbal or semantic knowledge, which is less susceptible to age-related declines (McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010; Naveh-Benjamin et al., 2003). Both younger and older adults also demonstrated a strategic use of point values with task experience. Both younger and older adults assigned more 10 point values with task experience, particularly for related pairs, suggesting effective strategies that helped maximize score. Furthermore, older adults, who had larger initial overconfidence, utilized the 0 point value more frequently on later lists, and assigned lower values to the unrelated word pairs.

Importantly, older adults displayed better metacognitive accuracy than younger adults, although both age groups were highly accurate. This finding that older adults have better relative accuracy than younger adults is somewhat inconsistent with previous research (Connor et al., 1997; Hertzog & Dunlosky, 2011; Hertzog et al., 2002; Hertzog et al., 2010). However, Herzog and colleagues (2002) have reported that older individuals were more likely to utilize semantic relatedness as a cue when making JOLs. In the current study, it is clear that younger adults bet on unrelated pairs more often than older adults, and gave higher values to these unrelated word pairs. That being said, younger adults were able to recall more of the unrelated word pairs compared with older adults. Thus, for younger adults who presumably have fairly intact associative memory abilities, perhaps associative strength is not as good of a cue as it is for older adults to utilize when making metamemory judgments.

Nevertheless, metacognitive accuracy was extremely high for both age groups, particularly on later lists. A recent meta-analysis examining the accuracy of immediate and delayed JOLs found that gamma correlations were, on average, .42 for immediate JOLs, and .77 for delayed JOLs (Rhodes & Tauber, 2011). In the current study, in which judgments were immediate, gamma correlations were .88 for older adults, and .75 for younger adults. Accuracy this high for immediate judgments could be due to the use of consequences (gaining or losing points) that were linked with these judgments, which created the need for strategic control during the learning process. Importantly, it suggests that one's ability to accurately predict what information will be remembered has been vastly underestimated in prior studies that have examined JOL accuracy.

Experiment 3

Experiment 3 was conducted in order to further explore the influence semantic knowledge has on memory, measures of performance, and metacognitive accuracy in younger and older adults using more naturalistic materials. Experiment 3 introduced context to the various lists, and each list centered around a different, specific scenario. For example, one list focused on going on a picnic, and all of the items on the list were items that could be taken on a picnic (see Appendix A for a complete list of materials). In addition, the lists were created such that it was likely that most people would judge some items as more vital to taking on the picnic (e.g., basket, plates, chicken, etc.), while other items might be seen as less relevant (e.g., frisbee, radio, candles, etc.).

The introduction of context to this paradigm could increase the amount of schematic or semantic support available to participants. Schematic support refers to the idea that schemas or prior knowledge within a domain can serve to enhance memory by supporting encoding and retrieval operations within that domain. It has been proposed that the presence of schematic support can reduce the reliance on effortful, self-initiated processes (which may be detrimentally affected in aging), and that this in turn can improve memory performance (Castel, 2008; Craik & Bosman, 1992; Soederberg-Miller, 2003). This hypothesis is supported by a study conducted by Castel (2005) that examined memory for prices of everyday grocery items. When grocery items were realistically priced there were no age-related associative memory impairments for prices of the grocery items, whereas large age-related decrements were present when older adults were asked to remember unrealistic prices of grocery items. This may, in part, be due to an increase in evaluative processing, in which individuals evaluated whether the prices or information were consistent or inconsistent with prior knowledge, and then remembered the information in relation to their expectations (e.g., Castel, 2005; Soederberg-Miller, 2003).

Besken and Gulgoz (2009) have also examined the impact of schema reliance in a source memory task among younger and older adults. Participants were shown a series of schema-consistent and schema-inconsistent statements said by one of two targets that varied in their profession (doctor versus bank-teller). In addition to this, some participants had profession-appropriate schemas activated before or after being shown the statements. Both older and younger adults were better able to accurately identify the source of the statement when the statement was typical given the profession, and schemas activated prior to encoding led to higher source monitoring abilities. These findings further indicate the schemas (especially those that are active during encoding) can aid in appropriate contextualization of information which serves to enhance later memory recall, although it is unclear whether improvement will be seen on metacognitive measures. It was hypothesized that the utilization of scenarios could reduce age-related discrepancies in memory performance, as could also assist participants in the decisions surrounding the assignment of point values.

Methods

Participants

Participants consisted of 24 older adults (18 females, *M* age = 77.3, *SD* = 7.1) and 24 younger adults (17 females, *M* age = 20.4, *SD* = 1.0). Older adults had good self-reported health ratings (*M* = 8.4 on a scale of 1-10, with 1 indicating extremely poor health and 10 indicating excellent health), and had an average of 16.7 years of education. The recruitment and compensation procedures were identical to those described in Experiment 1.

Materials

The materials consisted of six lists, each with 20 items each. There were six scenarios: going camping, going on a vacation, going on a picnic, planning a child's birthday party, going to a class, and cooking lasagna. Items within each list were chosen to realistically reflect what could be used or needed within each of these contexts, but likely varied on how vital or central they were to the scenario. For example, the "camping" list contained the following items: bug spray, ax, soap, marshmallows, cups, whistle, tarp, hot dogs, tent, clock, wood, sleeping bag, tablecloth, shovel, chair, matches, cards, trash bags, boots, and lantern. Thus, for the camping scenario there were centrally important items such as tent and sleeping bag, as well as items that were likely deemed to be less important such as a clock or a tablecloth. For a complete list of items within each scenario see Appendix A.

Procedure

Each list contained 20 items related to a different scenario, the items were presented in fixed random order, and the order of the lists was counterbalanced between participants. The instructions given to participants were largely similar to those used in Experiment 1. Participants were told that they would be given six list of 20 items each. As they saw each item, they were informed they should assign it a point value from 0-10, and this value would be how many points they would receive if they later successfully recalled the item, but also how many points they would lose if they failed to recall the item. As in the previous experiments, participants were told the goal was to maximize their score, and were encouraged to assign an item a 0 if they did not think they would be able to recall it. Participants were told that each of the lists centered around a specific scenario, and that the items would likely vary on how vital or important they were for the given context. In addition, participants were informed of the scenario immediately prior to the start of each list. Participants were shown the items one at a time for 5 seconds each, and during that 5 seconds had to assign the item a point value. After the immediate free recall test which lasted approximately 1 minute, participants were given their score and the next list began. Scores were determined in the manner described in Experiment 1, and all responses were made verbally by the participants and recorded by an experimenter.

Results and Discussion

Bets and Recall

As was done in Experiment 1 and 2, in order to assess how general metacognitive strategy and memory changed with task experience, the number of items bet on (assigned values greater than 0) and recalled were examined as a function of list and the results are displayed in Figure 3.1. A 2 (Age) by 3 (List) ANOVA revealed that overall the number of items bet on remained constant over lists, $F(2, 92) = .61$, $p = .54$, older and younger adults bet on a similar number of items $F(1, 46) = .22$, $p = .64$; and Age and List did not interact, $F(2, 92) = .12$, $p = .89$. Interestingly, older adults correctly recalled a similar number of items compared with younger adults, $F(1, 46) = .00$, $p = .99$. There was no effect of List on recall, $F(2, 92) = .91$, $p = .41$, nor was there an interaction, $F(2, 92) = .31$, $p = .74$.

Point Score

The average point scores for both younger and older adults are displayed in Figure 3.2. A 2 (Age Group) x 3 (List) ANOVA revealed that older and younger adults obtained comparable scores, $F(1, 46) = .37$, $p = .55$, and that scores increased on the later trials, $F(2, 92) = 7.32$, $MSE = 326.10$, $p = .001$, $\eta_p^2 = .14$. No interaction was observed ($p = .33$).

Metacognitive Accuracy

The effect of task experience on the average gamma correlations for younger and older individuals was assessed in a 2 (Age Group) by 3 (List) ANOVA, and the results are displayed in Figure 3.3. The average gamma correlations were similar for younger and older adults, $F(1, 46) = .09$, $p = .77$, and both older and younger adults' gammas were relatively high ($\gamma = .57$ and .54, respectively). There was no effect of list, $F(2, 92) = 1.58$, $p = .21$, nor was there an interaction, $F(2, 92) = .06$, $p = .94$.

Point Value Strategy

Although gamma correlations remained constant across lists, as did recall, the fact that overall point scores increased on later lists suggests potential differences in the strategic assignment of value with task experience. Figure 3.4A shows the average proportion that each point value was assigned (0-10) for both older and younger adults across all lists. Similar to what was observed in Experiment 1, only three values (0, 5, and 10 point value) were assigned more than 10% of the time (i.e., more than 2 out of the 20 items per list). Due to the limited use of values other than 0, 5, and 10, a 2 (Age Group) by 3 (List), by 3 (Value: 0, 5, 10) ANOVA was conducted in order to examine potential differences in value assignment behaviors between age groups, as well as any potential strategic changes with task experience. Figure 3.4B displays the average proportion that each of the 3 key point values (0, 5, and 10) was assigned, collapsing across List 1-2, List 3-4, and 5-6 for older adults, and Figure 3.4C displays these data for younger adults. There was an effect of Age Group, $F(1, 46) = 4.07$, $MSE = .08$, $p = .05$, $\eta_p^2 = .08$, indicating that older adults utilized the three values more often than younger adults. There was also an effect of List, such that the 0, 5 and 10 point values were assigned more often on later lists, $F(2, 92) = 6.02$, $MSE = .00$, $p = .003$, $\eta_p^2 = .12$. Although the linear effect of value was not significant, $F(2, 92) = 2.04$, $p = .14$, given the pattern of results displayed in Figure 3.4A, it appears that the 5 point value was utilized less often than either the 0 and 10 point value. Confirming this, there was a significant quadratic effect of Value, $F(1, 46) = 4.09$, $MSE = .13$, $p < .05$, $\eta_p^2 = .08$. However, no interactions were significant (all *p's* > .17).

The number of items assign a '0' and recalled was also examined. A 2 (Age Group) x 3 (List) ANOVA revealed no effect of Age, $F(1, 31) = 2.54$, $p = .12$, with both younger and older adults recalling very few items they had assigned a 0 point value ($M = .89$, $SD = .92$ and $M = 1.4$ $SD = .92$, respectively). Both younger and older adults recalled marginally fewer items assigned a 0 point value with task experience, $F(2, 62) = 3.00$, $MSE = .59$, $p = .06$, $\eta_p^2 = .09$. No interaction was observed, $F(2, 62) = .62$, $p =.54$.

Scenarios

Given the fact that each list centered around a different scenario, the effect of the specific scenarios on the primary measures (i.e., bets, recall, point scores, and gamma correlations) was examined in order to determine if one or more of the scenarios disproportionately favored either younger or older adults. Four separate 2 (Age Group) by 5 (Scenario) ANOVAs were conducted on each of the four measures. The list position of each scenario had been counterbalanced, thus list was not included in the analyses. The number of items bet on was not affected by an interaction between Age and Scenario, $F(5, 230) = .74$, $p = .59$. However, the analysis on the number of items recalled did produce a significant Age and Scenario interaction, $F(5, 230) = 2.83$, $MSE = 3.33$, $p < .05$, $\eta_p^2 = .06$. Interestingly, post-hoc t-tests revealed no significant differences in the number of items recalled between younger and older adults on any of the scenarios (all *p's* >.17). An interaction between Age and Scenario was also observed for point scores, $F(5, 230) = 2.99$, $MSE = 530.97$, $p < .05$, $\eta_p^2 = .06$. Post-hoc t-tests showed that older adults obtained higher point scores on the "cooking a lasagna" list compared with younger adults $t(46) = 2.35$, $p < .05$. No age-related differences in point score occurred for any of the other five scenarios (all *p's* > .20). Lastly, the magnitude of gamma correlations were not affected by an interaction between Age and Scenario, $F(5, 225) = 1.58$, $p = .17$.

The use of specific scenarios within each list produced some surprising results. Specifically, no significant age-related differences were observed on any of the measures, including overall recall. Increasing contextual and schematic support seemed to aid in older adults' ability to effectively recall the items. Qualitative observations made during the testing phase suggest that older adults were utilizing their schematic knowledge of the scenarios to monitor and facilitate recall. For example, a number of older participants mentioned items they were fully aware were not presented on a list, but these participants would comment that the items should have been on the list. In this manner, older adults were able to effectively monitor their memory during encoding, and were also able to effectively monitor their output and did not produce significantly more domain-specific intrusion errors than did younger adults.

Unlike what was found in Experiment 1 and Experiment 2, task experience led to only minor improvements in performance in overall score, whereas improvements in metacognitive accuracy did not occur. Task experience may be slightly less necessary for older and younger adults to learn to identify and predict what information is likely to be later remembered when all of the information is presented within the frame of a familiar context.

General Discussion

The current studies were designed to examine the degree to which older and younger adults could utilize strategic control when making value-based metacognitive monitoring judgments, and also the extent to which semantic knowledge impacted metacognitive accuracy and memory performance. In general, no age-related differences in metamemory accuracy were observed, metamemory accuracy was exceedingly high, and metamemory accuracy tended to improve with task experience in both Experiment 1 and 2. In fact, older adults, at times, had better metamemory accuracy compared with younger adults (Experiment 2). Furthermore, when the stimuli allowed the participants to utilize schematic or semantic knowledge (Experiment 3; the related word pairs in Experiment 2), no age-related differences were observed in recall performance or overall point score. This lack of age differences in memory performance, while rare, is consistent with evidence that schemas and prior knowledge can serve to mitigate typically observed age-related memory deficits (Castel, 2005).

However, when schematic support was absent (Experiment 1; the unrelated word pairs in Experiment 2), older adults recalled fewer items and obtained somewhat lower point scores, consistent with findings of typical age-related memory deficits (e.g., Kausler, 1994; Naveh-Benjamin & Ohta, 2012) and associative-memory deficits (e.g., Naveh-Benjamin, 2000; Old & Naveh-Benjamin, 2008). That being said, both younger and older adults were able to use their metacognitive knowledge of what was more or less likely to be recalled, and assigned value in a strategic manner that resulted in extremely high metacognitive accuracy.

Although schematic support and semantic knowledge aided overall memory performance, there seemed to be a trade-off in regard to the large benefits of task experience observed in Experiment 1. When semantic support was available, there was less of an effect of task experience on measures of performance and accuracy. However, point scores, a central measure of performance within this paradigm, continued to show a benefit of task experience for both younger and older adults across all three experiments, despite sometimes negligible changes in overall recall and metacognitive accuracy (Experiment 3). This suggests task experience, was helpful to both younger and older adults in terms of the adopting better strategies in assigning value to the items.

Within these experiments, it was more strategic in terms of the overall goal (high point scores) to assign 0 points to items that were not recalled, and 10 points to items later recalled, and both younger and older adults were largely successful in adopting this strategy. Many studies utilizing standard JOLs to assess memory monitoring find that individuals frequently assign JOLs that center around the mean of the scale (e.g., 50 on a scale from 0-100). In the current "betting" paradigm, where overall point score was emphasized and there were penalties and rewards tied to the judgments, extreme values (0 and 10) were more commonly assigned by participants, and tendency to use these values increased with task experience. Furthermore, despite an increasingly high number of 0 point values assigned to items with task experience, an extremely few number of those items were later recalled by either younger or older adults, particularly on the later lists.

While the lack of age-related differences in relative metamemory accuracy is consistent with prior studies (Connor et al., 1997; Hertzog et al., 2002; Hertzog et al., 2010; Tullis & Benjamin, 2012), what is a surprising departure from prior literature is the extremely high level of accuracy that both age groups were able to achieve (gammas often close to or well over .70). In the current set of studies participants did not assign typical JOLs to items, but instead "bet" on the likelihood an item would be recalled. Thus, instead of a JOL, participants were assigning meaningful values. These values were meaningful such that in the task there was a consequence linked to the value assignments, and strategy was central to achieving task-related goals (i.e., obtaining higher point scores). Furthermore, the utilization of consequences made individuals more accountable for their judgments, which likely increased motivation for accuracy and strategy use. The findings suggest that when judgments are formed utilizing both one's metacognitive monitoring and metacognitive control abilities, younger and older adults display a remarkably high degree of accuracy and strategic use of memory and metacognitive abilities.

In Experiment 1, and to lesser extent Experiment 2, metamemory accuracy continued to increase with task experience. However, task experience had no effect on younger and older adults' accuracy in Experiment 3, or on younger adults' accuracy in Experiment 2. What could be occurring during Experiment 2 and 3 that did not occur in Experiment 1 is a differential utilization of cues in the process of assigning point values. Research examining JOLs has suggested that there are a number of cues that an individual may utilize when forming a JOL (Koriat, 1997), and these include intrinsic and extrinsic cues. Intrinsic cues refer to cues directly related to the items, such as the degree of semantic association between a cue and a target. Extrinsic cues include cues related to the task demands, such as the length of the delay between study and test, and also strategies utilized by the learner while forming judgments. In Experiment 1, the items themselves may have had less of an impact on the assignment of values (i.e., provided less of an intrinsic cue). Thus, with task experience participants may have developed and then relied more on extrinsic cues such as an understanding of the conditions of the task, and employing appropriate strategies needed to improve performance such as betting on fewer items. However, in Experiments 2 and 3 participant's judgments (i.e., assignment of point values) may have been more influenced by the intrinsic cues of the items (i.e., semantic relatedness in Experiment 2, or relationship to the scenario in Experiment 3). This could suggest that when intrinsic cues are somewhat lacking, task experience might be more necessary for younger, and especially older, adults to learn to adopt appropriate utilization of extrinsic cues to aid in value judgments.

In Experiment 2 some improvements with task experience were apparent, particularly for older adults (although much less so than in Experiment 1). However, no increases or decreases in metacognitive accuracy occurred in Experiment 3, and overall metacognitive accuracy was lower in Experiment 3 compared to Experiments 1 and 2. It may have been the case that all or most of the items in Experiment 3 seemed relatively important or memorable within the given context, and in a sense were more analogous to the related word-pairs in Experiment 2. Some research has suggested that over-reliance on schemas or prior knowledge can have a negative impact on monitoring accuracy (Toth, Daniels, & Solinger, 2011). In Experiment 2, there was both a presence and lack of a semantic relationship between the cue and target word, which may have been a more salient distinction to help guide point value assignments, and this distinction between items was somewhat lacking in Experiment 3. In Experiment 2, participants were likely aware that the unrelated word pairs were more difficult to recall than the related word pairs (Berry, Williams, Usubalieva, & Kilb, in press; Connor et al., 1997; Hertzog & Dunlosky, 2011; Hertzog et al., 2002; Hertzog et al., 2010). This increase in intrinsic cue utilization (i.e., relatedness) could have resulted in a decrease in the reliance on the extrinsic and mnemonic cues, which can play an important role in adopting more efficient strategies with task experience, such as in Experiment 1.

Although previous research has shown that explicit, experimenter-defined point values influence both memory (Castel et al., 2002; Friedman & Castel, in press) as well as metacognitive judgments (McGillivray & Castel, 2011; Soderstrom & McCabe, 2011), in the current set of experiments, the value that each item was "worth," was left up to the participant. The consistently high accuracy in remembering the items assigned higher values by both younger and older adults indicates that the ability to recall what one assigns higher values remains intact in older adulthood. It is precisely the change in the way in which monitoring judgments were approached that likely contributed to this higher overall accuracy. Typical JOLs are somewhat passive, and there is no actual reward or penalty for accuracy or lack thereof. By implementing consequences tied to metamemory judgments, these judgments became more meaningful and important, and thus enhanced the need to accurately monitor one's memory. The results from these studies offer evidence that the ability to utilize one's metacognitive monitoring and control abilities is intact during older adulthood, and that proper motivation and accountability of one's memory predictions can lead to substantial improvements in the ability to accurately and strategically select and predict what is later remembered.

Table 2.1.

Mean point value (and standard deviation) assigned to related and unrelated word pairs by younger and older adults across lists in Experiment 2

	Relatedness	List 1	List 2	List 3	List 4	List 5	List 6	Average
Older Adults	Unrelated	2.4(1.6)	1.8(1.8)	1.8(2.0)	1.6(1.6)	1.6(1.7)	1.3(1.5)	1.8(1.5)
	Related	8.4(1.6)	8.7(1.4)	8.8(1.2)	8.9(1.3)	8.9(1.3)	9.1(1.3)	8.8(1.2)
Younger Adults	Unrelated	2.4(1.4)	3.3(2.4)	3.3(2.3)	3.8(2.8)	3.9(2.8)	3.6(2.8)	3.4(2.2)
	Related	7.1(2.0)	7.9(1.8)	8.2(1.9)	8.1(1.8)	8.2(1.9)	8.5(1.6)	8.0(1.6)

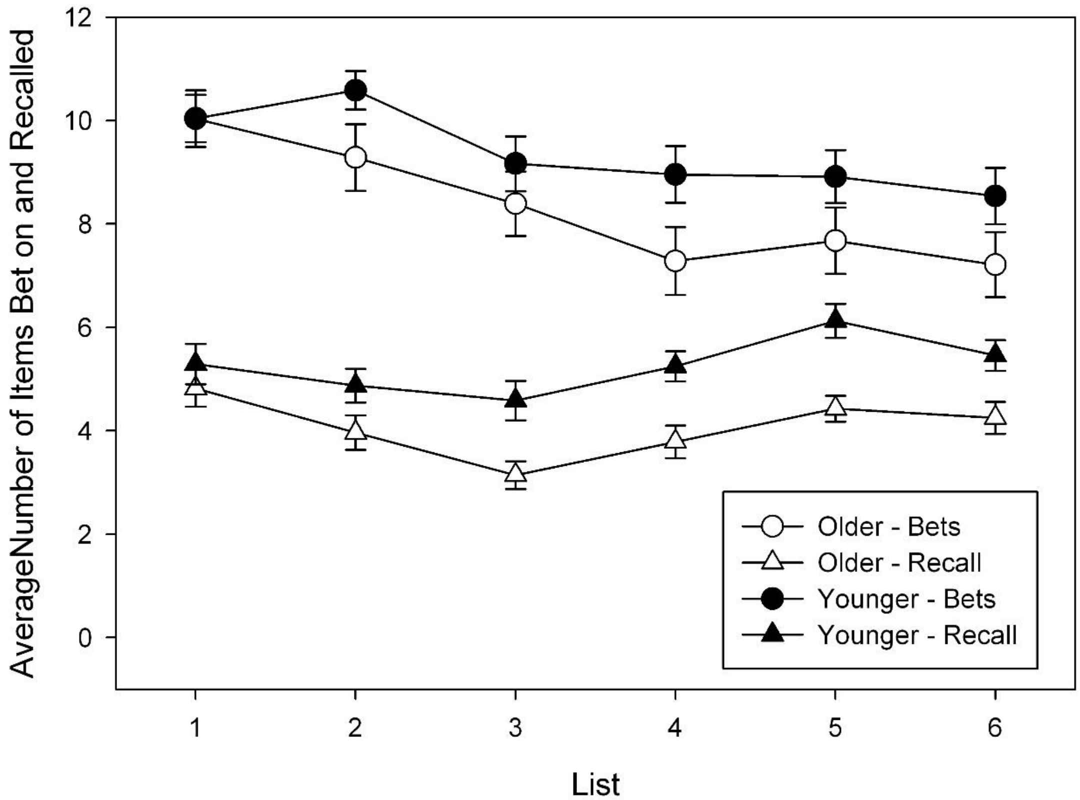

Figure 1.1. Figure 1.1 displays the average number of items bet on (assigned a value greater than 0) and recalled by both older and younger adults across the six study-test lists in Experiment 1. Error bars represent standard error of the mean.

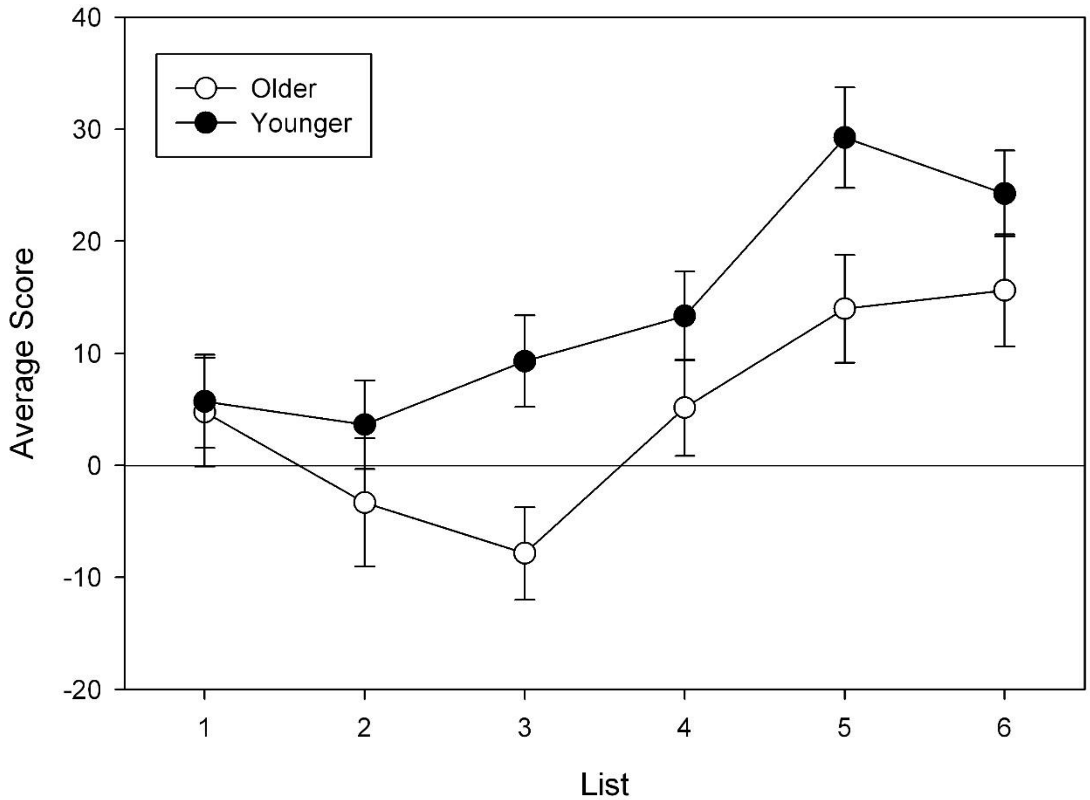

Figure 1.2. Figure 1.2 displays the average overall point score achieved on each list by both older and younger adults in Experiment 1. Error bars represent standard error of the mean.

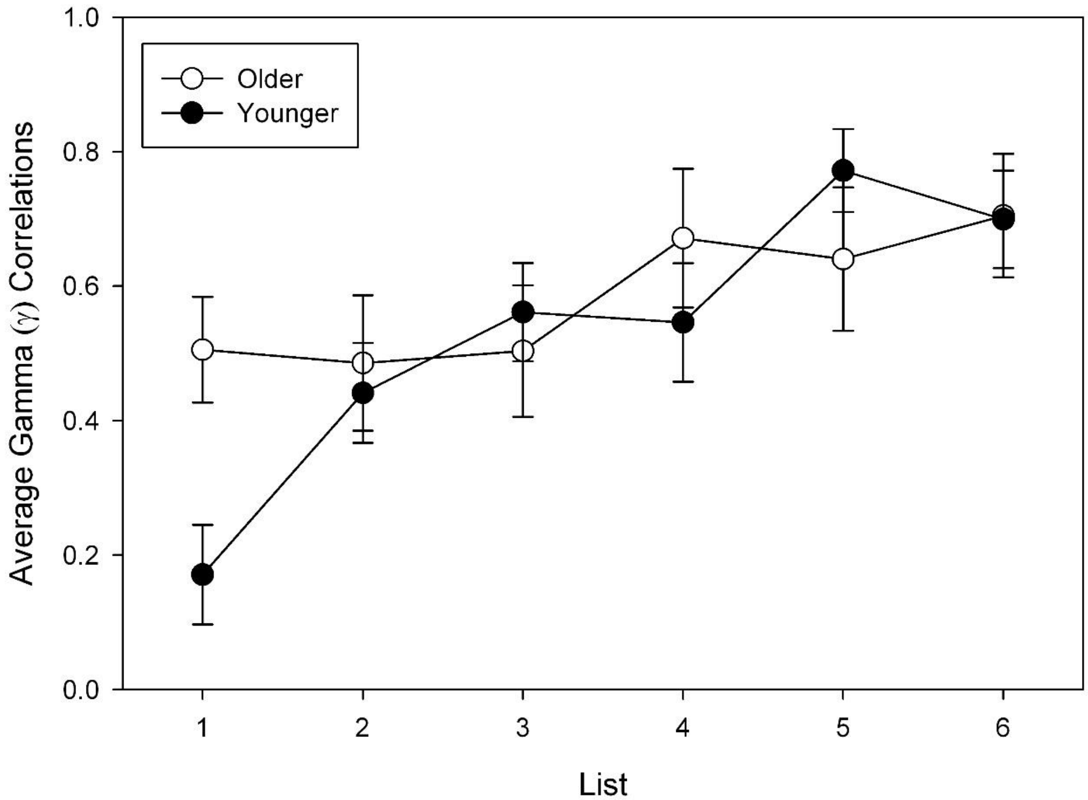

Figure 1.3. Figure 1.3 displays the average gamma (γ) correlations for both younger and older adults on each of the six study-test trials in Experiment 1. Error bars represent standard error of the mean.

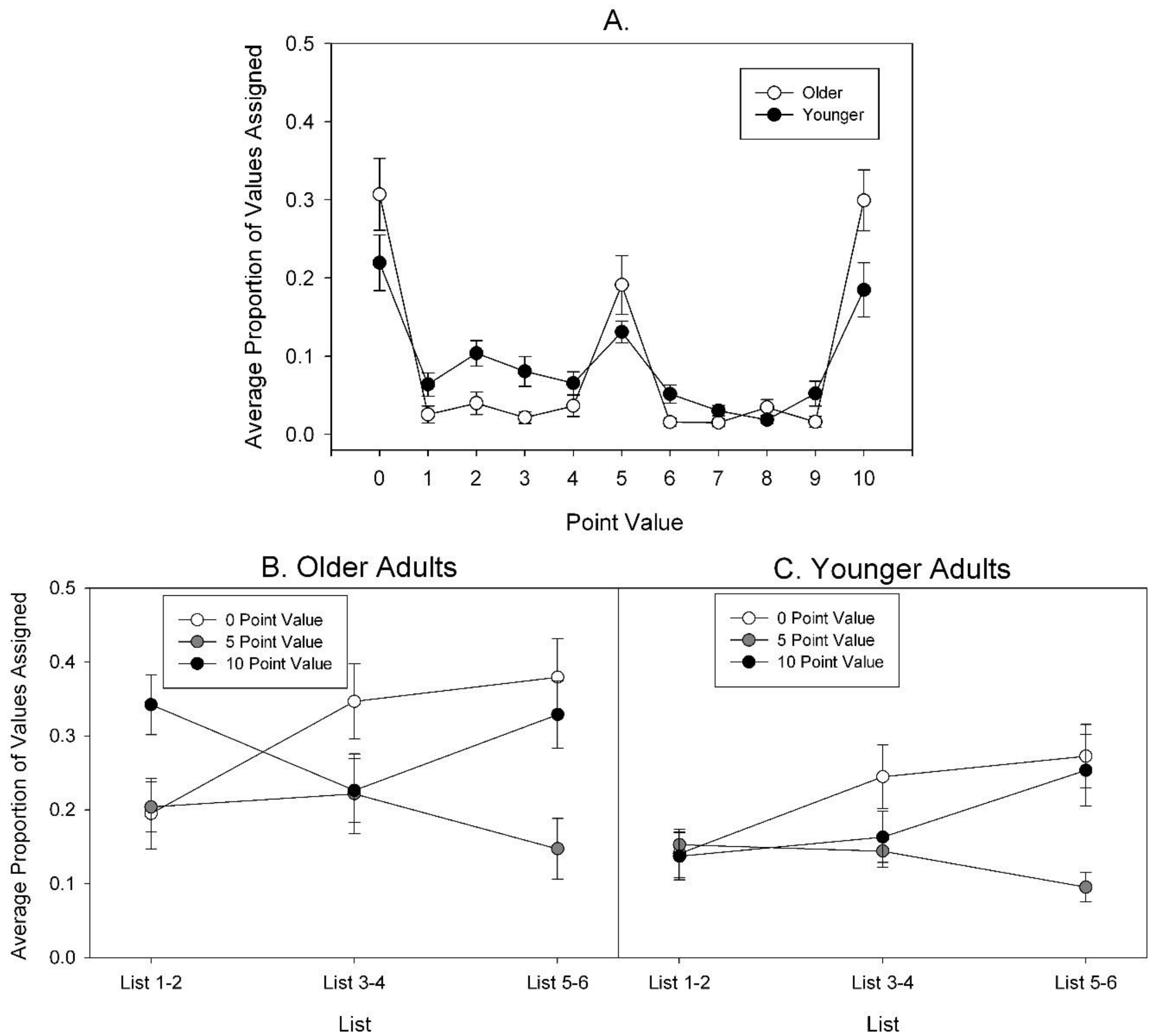

Figure 1.4. Figure 1.4A displays the average proportion each value was assigned by both younger and older adults collapsing across all lists in Experiment 1. Figure 1.4B displays the average proportion each of the three high-frequency values (0, 5, and 10) was used by older adults across List 1-2, List 3-4, and Lists 5-6 by younger adults, and Figure 1.4C displays these data for younger adults. Error bars represent standard error of the mean.

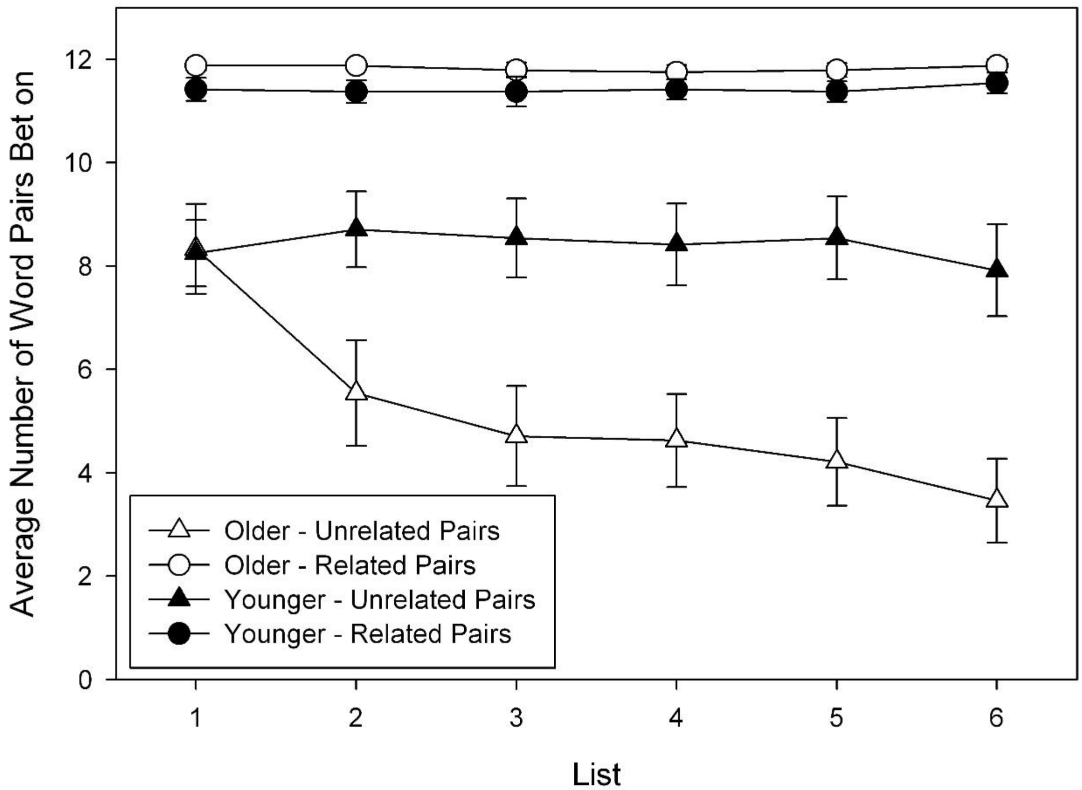

Figure 2.1. Figure 2.1 displays the average number of related and unrelated word pairs bet on (assigned a value greater than 0) by younger and older adults for each of the six study-test lists in Experiment 2. Error bars represent standard error of the mean.

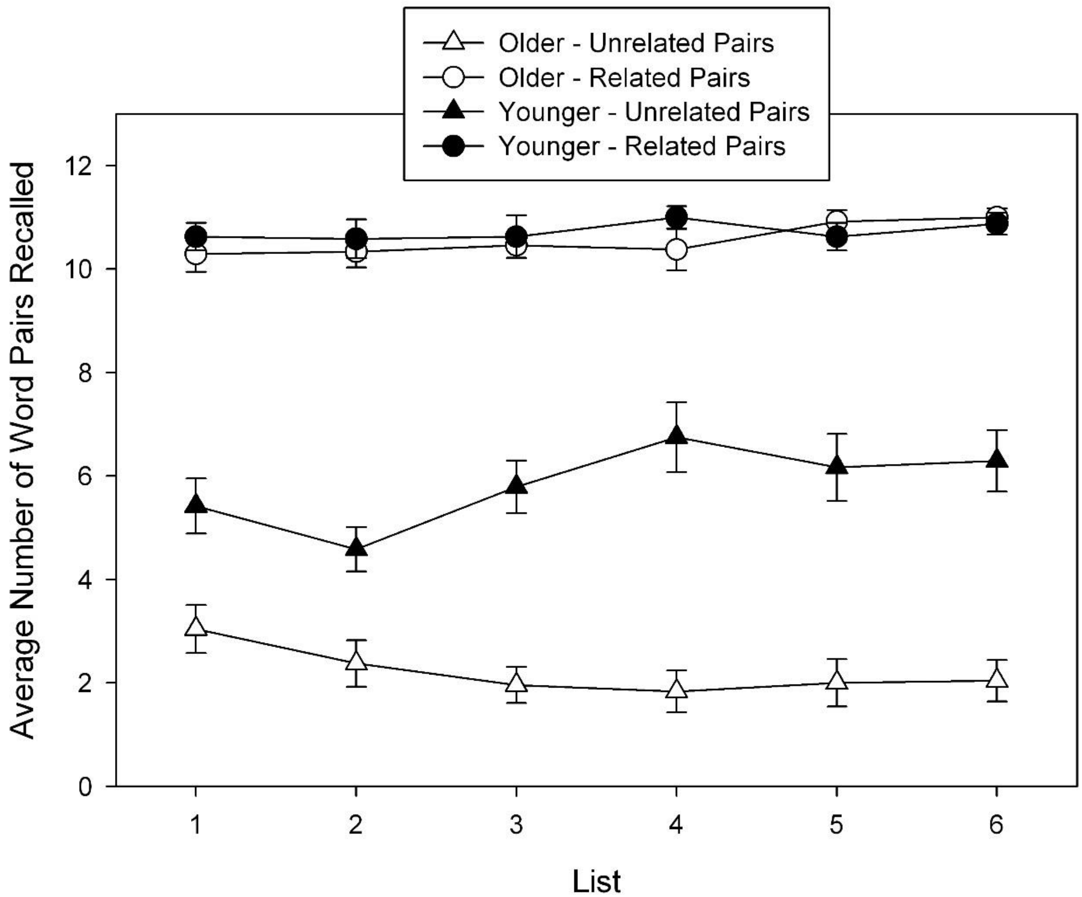

Figure 2.2. Figure 2.2 displays the average number of related and unrelated word pairs recalled by younger and older adults for each of the six study-test lists in Experiment 2. Error bars represent standard error of the mean.

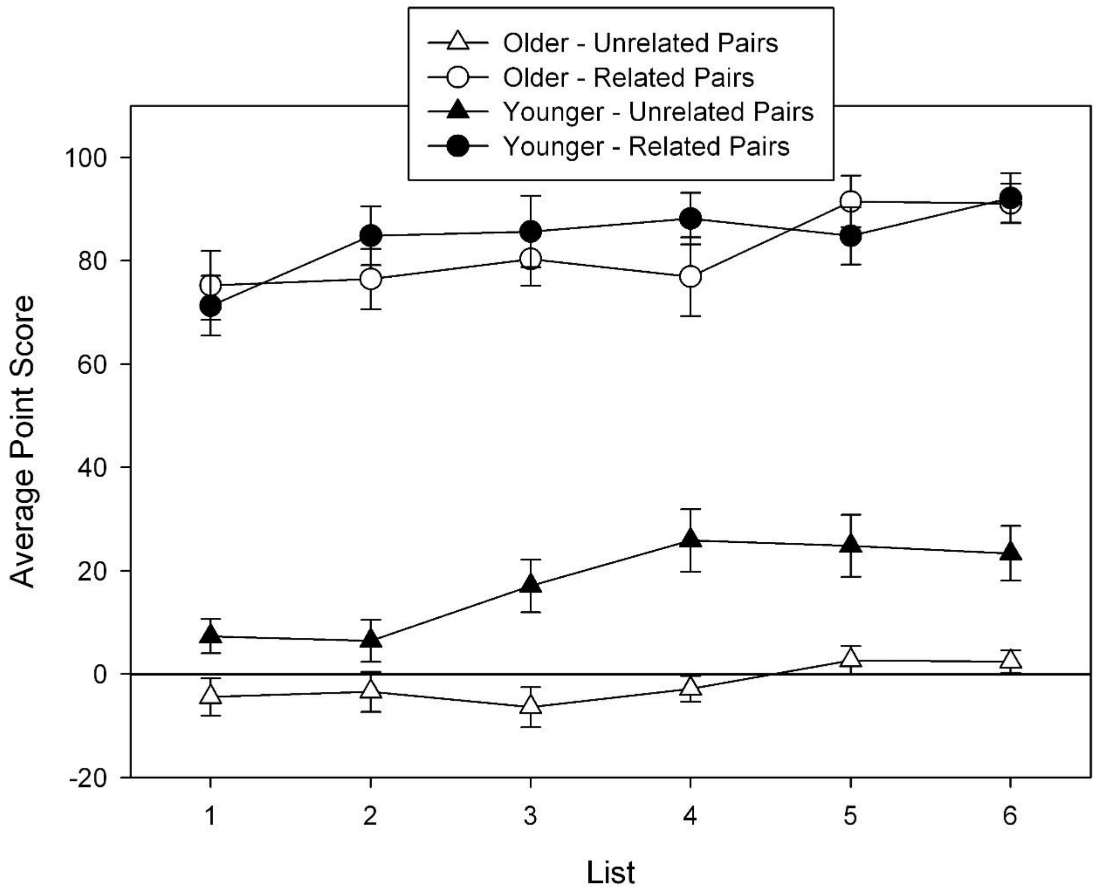

Figure 2.3. Figure 2.3 displays the average overall point score achieved for related and unrelated word pairs by both older and younger adults, in each of the study-test lists in Experiment 2. Error bars represent standard error of the mean.

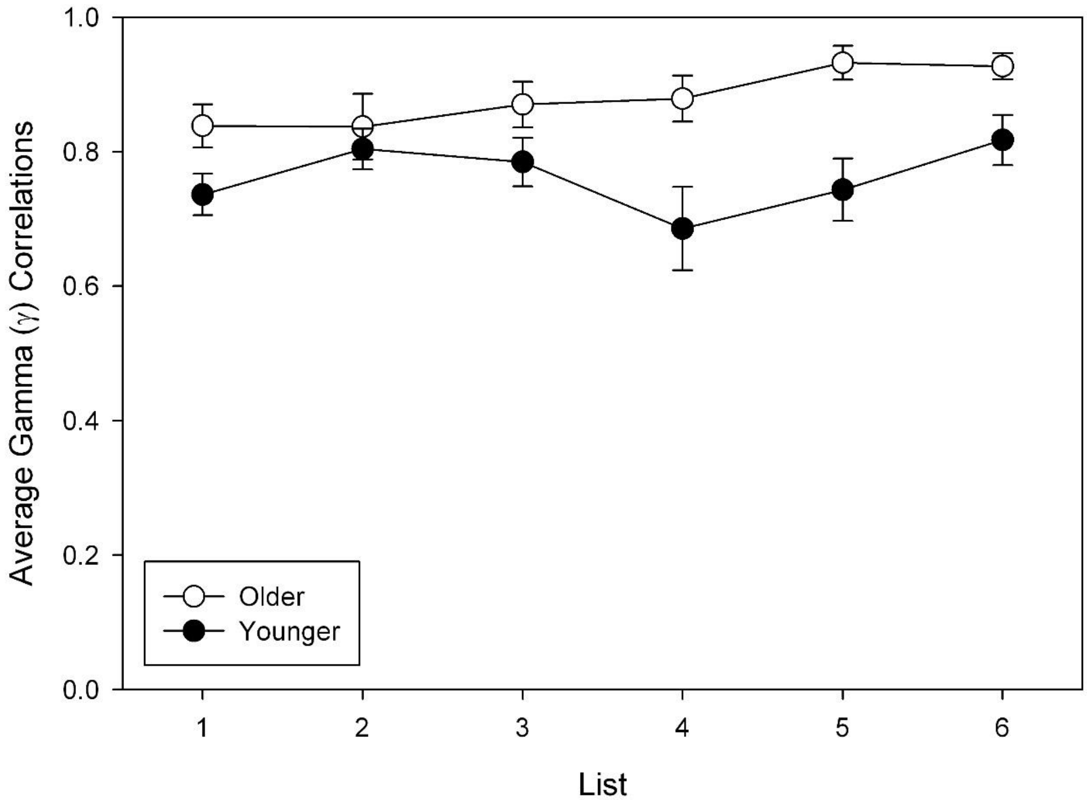

Figure 2.4. Figure 2.4 displays the average gamma (γ) correlations for both younger and older adults on each of the six study-test trials in Experiment 2. Error bars represent standard error of the mean.

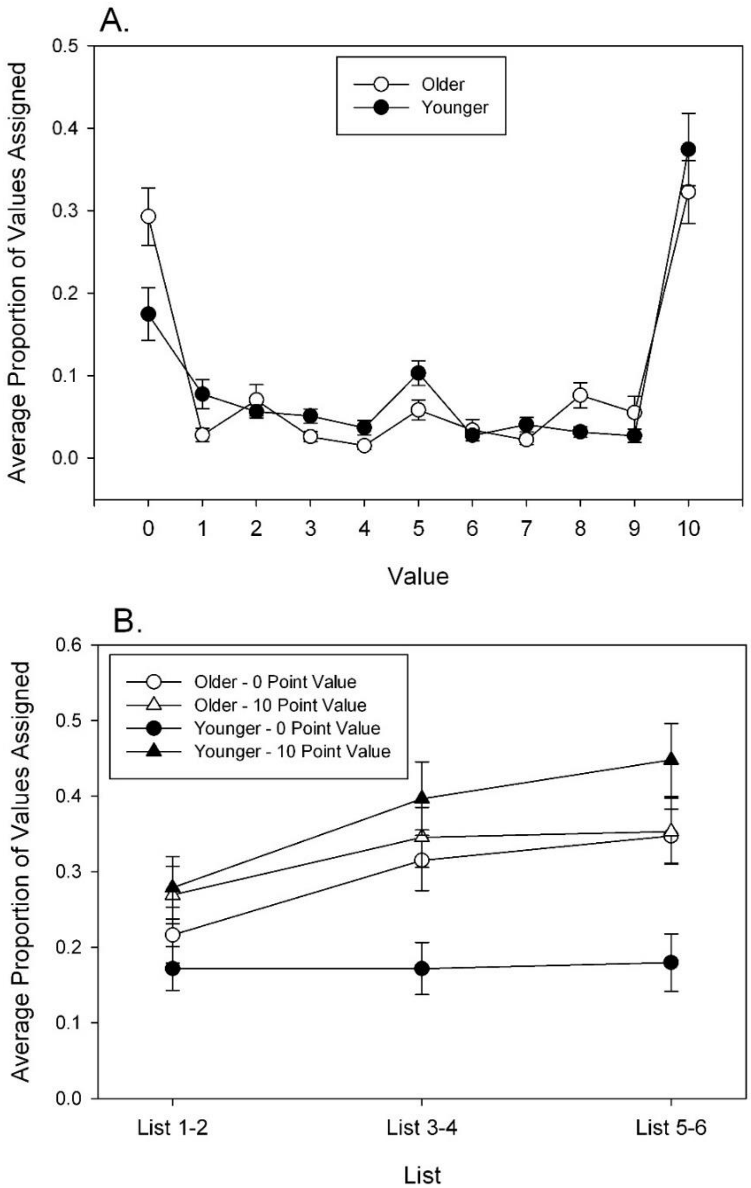

Figure 2.5. Figure 2.5A displays the average proportion each value was assigned by both younger and older adults collapsing across all lists in Experiment 2. Figure 2.5B displays the average proportion each of the two high-frequency values (0 and 10) was used by older and younger adults adults across List 1-2, List 3-4, and Lists 5-6. Error bars represent standard error of the mean.

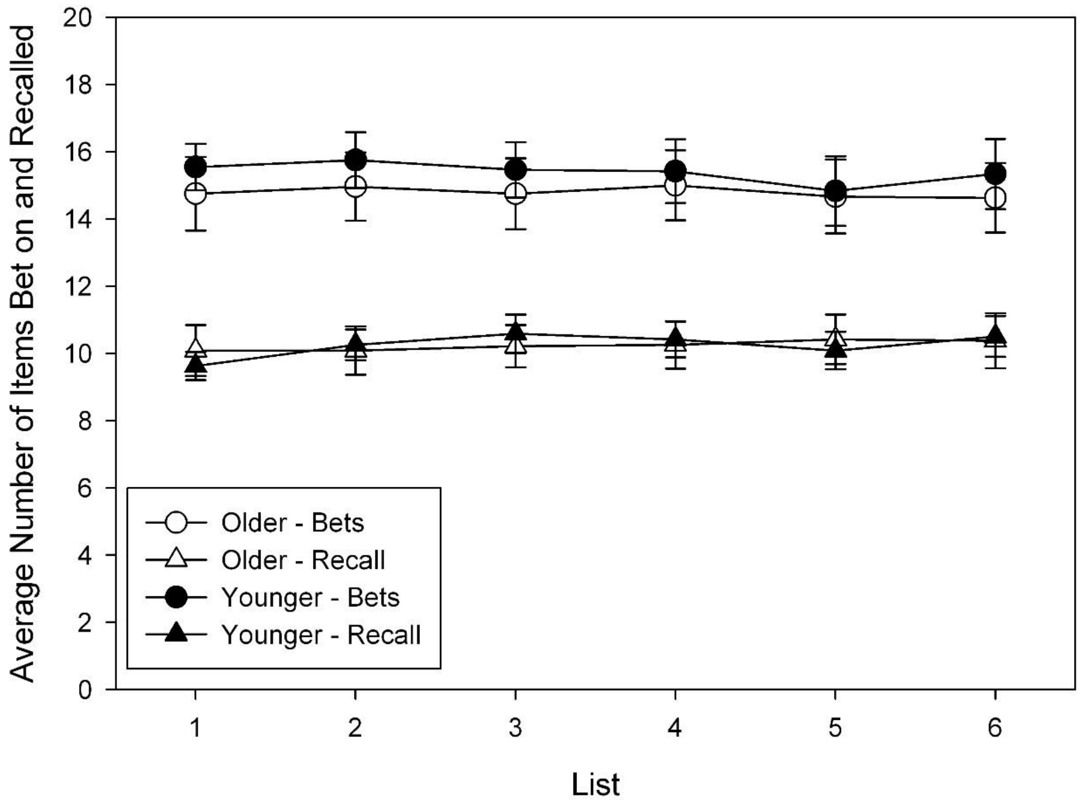

Figure 3.1. Figure 3.1 displays the average number of items bet on (assigned a value greater than 0) and recalled by both older and younger adults across the six study-test lists in Experiment 3. Error bars represent standard error of the mean.

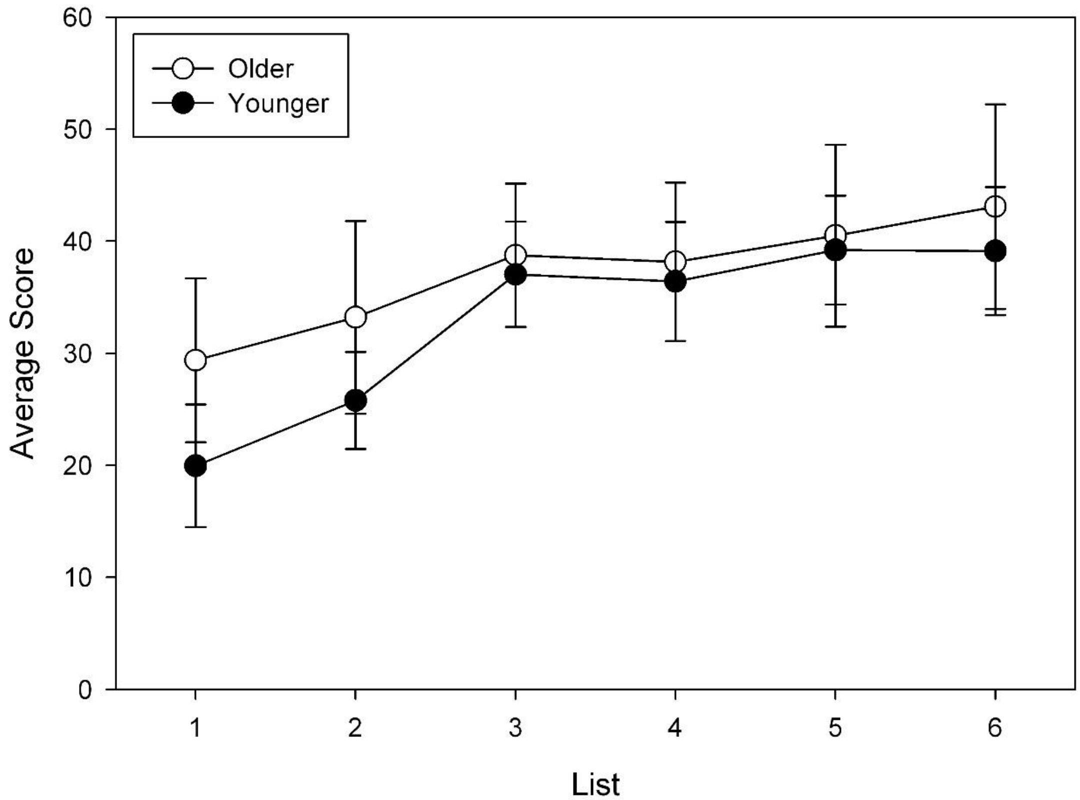

Figure 3.2. Figure 11 displays the average overall point score obtained on each list by both older and younger adults in Experiment 2. Error bars represent standard error of the mean.

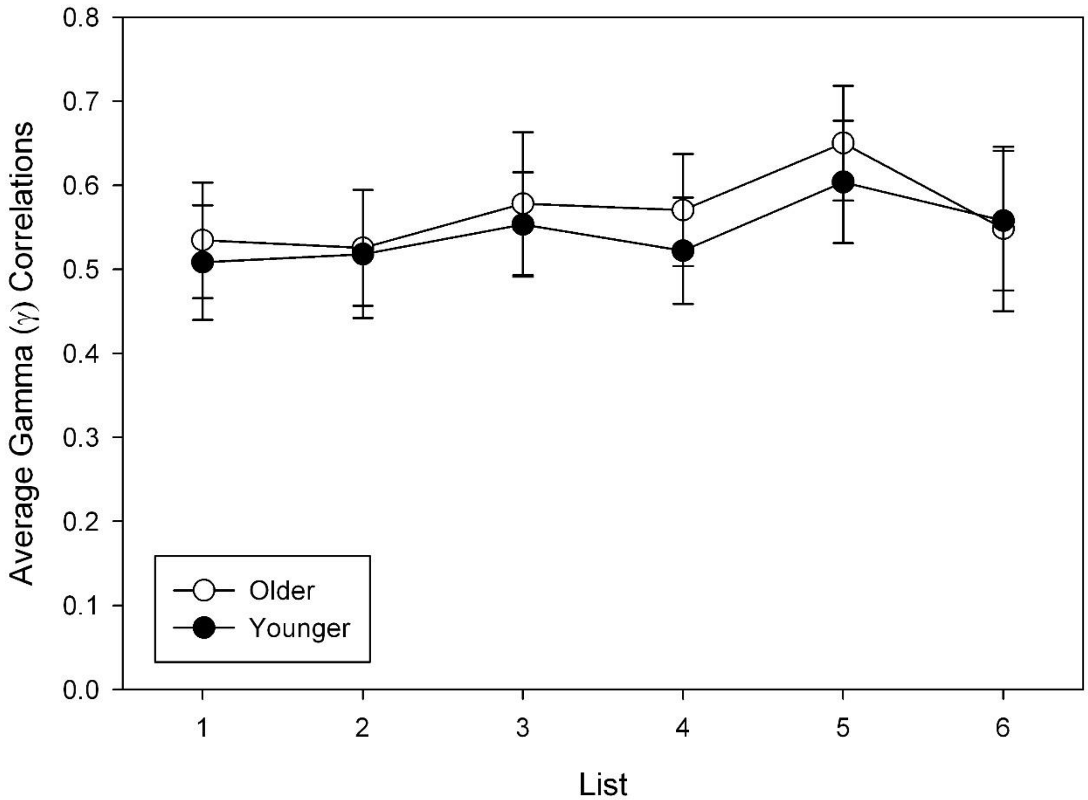

Figure 3.3. Figure 3.3 displays the average gamma (γ) correlations for both younger and older adults on each of the six study-test trials in Experiment 3. Error bars represent standard error of the mean.

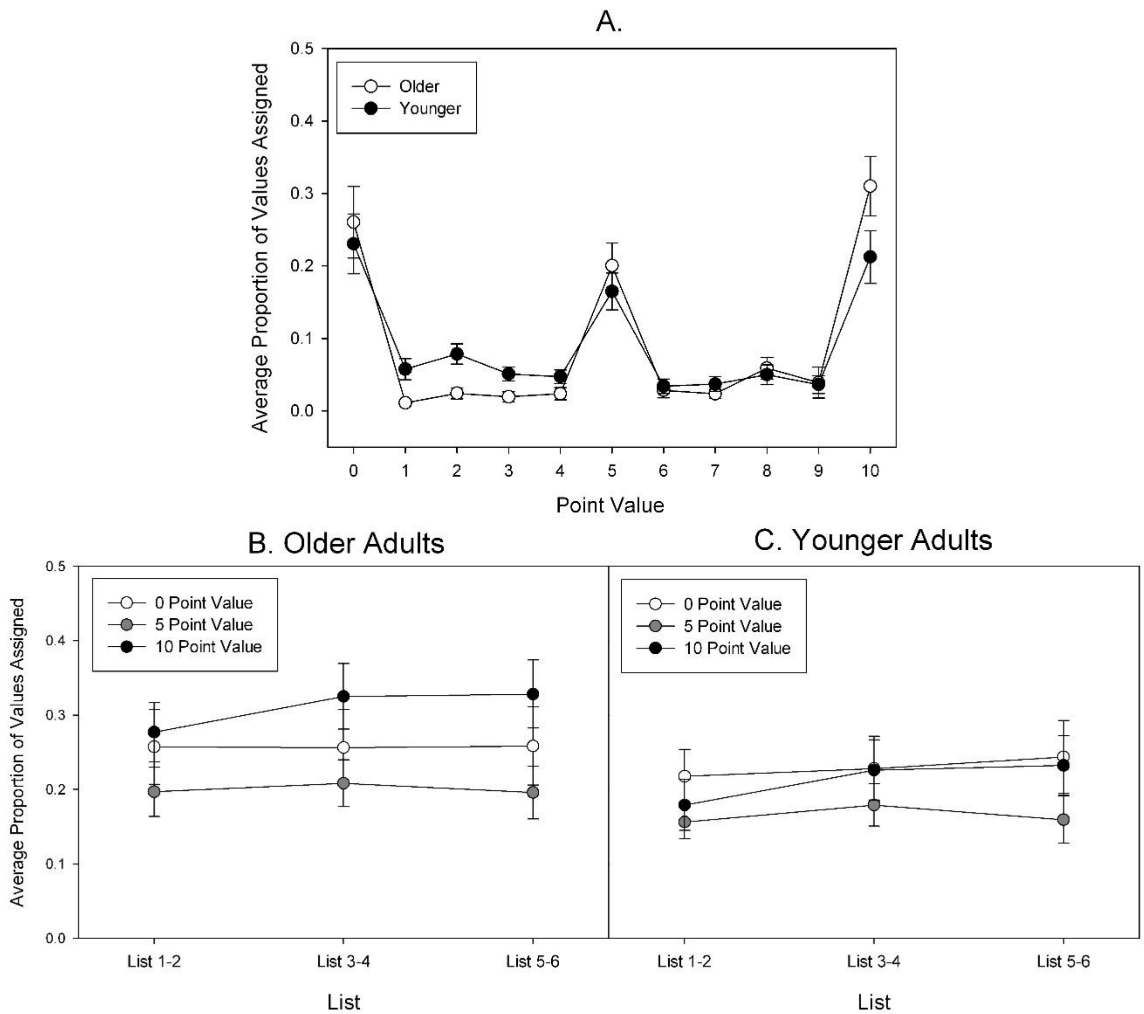

Figure 3.4. Figure 3.4A displays the average proportion each value was assigned by both younger and older adults collapsing across all lists in Experiment 3. Figure 3.4B displays the average proportion each of the three high-frequency values (0, 5, and 10) was used by older adults across List 1-2, List 3-4, and Lists 5-6 by younger adults, and Figure 3.4C displays these data for younger adults. Error bars represent standard error of the mean.

Chapter 3 - Experiments 4 and 5

The previous set of experiments all utilized a novel value-based metacognitive monitoring task that required participants to provide explicit, subjective point value assessments to words, word-pairs, and items. Motivation to remember information assigned higher values was introduced through the use of consequences associated with value judgments, such that forgetting an item assigned a high value resulted in lower point value totals. However, when consequences are not present, motivation to remember may occur as a result of the material itself, given the overall goals and interests of the learner. The following section explores the effects of subjective interest and curiosity on memory performance as well as metacognitive accuracy in younger and older adults.

Introduction

On a daily basis we are presented with a vast amount of information, only a small fraction of which we can later recall. What then, causes us to remember some things, and forget others? When asked, many of us reply that if the information is important or interesting to us we will remember it. Although this is an assumption that is likely held by many individuals, only recently has it begun to receive attention in memory research (e.g., Kang et al., 2009; Murayama & Kuhbandner, 2011). The question of whether individuals do, in fact, remember information that is more personally interesting or engaging is an even more critical issue within the topic of aging and memory. It is well documented that aging is associated with decrements in memory abilities (Craik & Salthouse, 2008), and older adults typically experience more difficulties in recalling information than do younger individuals. As it is often more challenging for older individuals to remember information, it is extremely important to consider and investigate the extent that factors such as personal interest affect the memory of older as well as younger adults, and whether there are any age-related difference in the degree to which level of interest impacts memory and metacognitive predictions.

Central to the topic of interest or importance and the relationship with memory is the distinction between objective and subjective importance. When information is objectively presented as more important (i.e., worth more points compared to information worth fewer points), studies have found negligible age-related differences for the most important pieces of information (e.g., Castel et al., 2002; Castel et al., 2013; McGillivray & Castel, 2011). However, in the real world, importance of information is often subjectively determined, and what is considered important or more interesting by one person may be considered less so by another.

Subjective interest has previously been examined in younger adults (Kang et al., 2009). Within Kang et al.'s study, interest was defined as curiosity to learn unknown information. Curiosity is akin to interest, and is thought to reflect a gap between desired knowledge and the current level of understanding (Loewenstein, 1994), although other definitions of curiosity may exist. In an fMRI study (Kang et al., 2009, Experiment 1), younger adults were presented a series of obscure trivia questions, and participants had to indicate how curious they were to learn the answer as well as their confidence that they might know the answer. After participants provided these ratings they were shown the answer to the trivia question. The results indicated that "higher" curiosity items were associated with an increase in activation in a number of regions involved in reward learning and reward anticipation including the caudate, prefrontal cortex, and other areas linked to memory such as the parahippocampal areas. The potential relationship between curiosity and explicit memory was also examined (Kang et al., 2009, Experiment 2). Younger adults engaged in the behavioral portion of the task, and were then given a surprise recall test (11-16 days later) during which they were presented with the trivia questions and asked to recall the answers. The results revealed that curiosity strongly predicted later memory accuracy, with participants recalling a larger percentage of questions given higher curiosity ratings relative to medium or lower curiosity ratings.

The finding that increased curiosity may act as a form of reward anticipation, thus enhancing memory (Kang et al., 2009) has received further support in a similar study utilizing monetary rewards (Murayama & Kuhbandner, 2011). As in the study by Kang et al., Murayama and Kuhbander (2011) presented younger participants with trivia questions chosen to illicit either high or low levels of interest. Additionally, half of the participants were told they would receive monetary compensation for each question answered correctly. After a week delay, participants recalled more interesting compared with uninteresting questions, and participants in the monetary reward condition recalled more than in the non-monetary condition. Importantly, monetary reward only enhanced memory performance for the "uninteresting" questions, and did not result in higher performance between groups for the more interesting questions. The evidence that interest or curiosity may indeed induce similar processes as do monetary rewards may be particularly useful to examine in older adults, as some evidence suggests that older individuals may be more sensitive to gains relative to losses compared with younger adults (Denburg et al., 2007; Denburg et al., 2005; Fein et al., 2007; Samanez-Larkin et al., 2007).

The effect of interest on memory in older adults has been examined to some degree, by assessing personal relevance of material. Hess et al. (2001) found that older adults were more accurate in their recollection of information related to a narrative describing an older target person (increased relevance) compared with one describing a younger target person. Furthermore, older adults benefitted to a greater extent from increasing relevance than did younger adults, although both age groups displayed a benefit. Extending these findings, Germain and Hess (2007) found the pattern of increased memory for more personally relevant information held true under conditions that manipulated the age of the target person described in a narrative (i.e., older versus younger) as well as the topic of the narrative (e.g., anti-aging medications versus proposed tuition increases). It was also demonstrated that increased relevance was strongly associated not only with memory performance, but with more efficient processing (i.e., the inhibition of distracting, irrelevant information), and that these effects were also stronger for older adults compared with younger adults (Germain & Hess, 2007).

Although the studies by Hess and colleagues (Germain & Hess, 2007; Hess et al., 2001) indicate that older individuals are more likely to recall information that is more relevant to older adults as a whole, the materials were specifically designed to be either younger or older adult-relevant. In the current experiments, which were largely modeled after Kang et al. (2009), materials consisted of 60 trivia questions covering a wide range of topics that presumably were no more or less interesting to either younger or older adults. In both Experiment 4 and 5, younger and older adults were presented with obscure trivia questions. After being shown the question, participants indicated their curiosity to learn the answer, and also their confidence they knew what the answer was. Following these rating they were shown the actual answer. In Experiment 5, a second rating of interest was assessed after the answer was revealed, as well as a judgment of the likelihood that they would be able to later remember that answer. Approximately one hour later, participants were given a cued-recall test on half of the questions, and approximately 6 days later they were tested on the other half of the questions.

It was hypothesized that subjective interest and curiosity may have an even larger impact on later memory for older adults compared with younger adults. Some theoretical accounts of why memory is negatively impacted in aging cite deficiencies in directing attention and inhibiting irrelevant information (Darowski et al., 2008; Hasher & Zacks, 1988; Levy & Leifheit-Limson, 2009), as well as a general reduction in the availability of necessary attentional resources (Anderson et al., 1998; Craik & Byrd, 1982; Rabinowitz et al., 1982). However, interest can help direct and sustain attention (Germain & Hess, 2007; Renninger & Hidi, 2011), and less attentional resources may be needed to process interesting material (McDaniel et al., 1990), which may be particularly important and beneficial for older individuals.

In addition to the effect of curiosity on memory, it was also hypothesized that memory performance would be better for questions that elicited higher confidence errors compared to questions in which participants indicated they were not confident in their initial guess. High confidence errors, if immediately corrected, can lead to the hypercorrection effect, a finding that individuals are more likely to correctly recall information following a higher confidence compared with lower confidence error (Butterfield & Metcalfe, 2001). It has been suggested that high confidence errors capture one's attention, and engage cognitive resources in order to correct the wrongly held belief (Butterfield & Metcalfe, 2001, 2006; Fazio & Marsh, 2009). Older and younger adults both display the hypercorrection effect to the same degree (Cyr & Anderson, in press), indicating that age should have little impact on the degree that confidence judgment errors impact later memory performance.

Methods

Participants

The participants consisted of 24 older adults (14 females, *M* age = 78.8, *SD* = 5.7) and 24 younger adults (20 females, *M* age = 20.6, *SD* = 1.9). Older adults were all living in the Los Angeles area, and recruited through community flyer postings as well as through the UCLA Cognition and Aging Laboratory Participant Pool. Older adults had good self-reported health ratings (*M* = 8.3 on a scale of 1-10, with 1 indicating extremely poor health and 10 indicating excellent health), and had an average of 16.8 years of education. Older adults were paid $10 an hour for their time and reimbursed for parking expenses. Younger adults were all University of California, Los Angeles undergraduates and received course credit for their participation as well as $10 upon completion of the long-delay memory test.

Materials

The stimuli consisted of 60 trivia questions, mainly adopted from Kang et al. (2009), or taken from various trivia sites on the Internet. Some examples of the trivia questions are: "What was the first product to have a bar code?" (Wrigley's gum), "What was the first nation to give women the right to vote?" (New Zealand), "What is the biggest constellation in the sky?" (hydra). A complete list of the trivia questions and answers is presented in Appendix B.

Procedure

The trivia questions were randomized, and four separate fixed orders of encoding were created. Participants were told that they were going see 60 obscure trivia questions, and that it was very unlikely that they (or most people) would know the precise answer, although they were told that they could guess what the answer might be. Participants were not told that their memory would be tested. They were told that after each question they should indicate how curious they were to learn the answer on a scale from 1-10 (1 = not at all curious; 10 = extremely curious). They were also asked to indicate how confident they felt in their guess, or how confident they were that they actually knew what the correct answer was, on a scale from 0-100, with 100 indicating they are sure they know the answer. After they provided these ratings, participants were then shown the question again with the correct answer. Participants were given a sample question prior to the start of the experiment. Each of the 60 trivia questions was presented for 10 seconds, and after this the prompt for the curiosity rating appeared followed by the prompt for the confidence rating (both self-paced). After participants provided these ratings they were shown the question with the correct answer for 6 seconds. Participants' guesses and ratings were all made verbally, and were recorded by an experimenter. The experimenter also noted which question were guessed correctly.

Approximately 60 minutes later (*M* = 59.7 minutes, *SD* = 12.7) participants were given a surprise cued recall test on half of the questions (the long-delay test contained the other half). Thirty questions were randomly selected from the original sixty, and presented in a fixed random order. At test, participants were shown the questions one at a time, and asked to try and recall the correct answer. Participants were given as much time as they needed to provide their answer. If participants indicated they did not know the answer or if they guessed incorrectly, they were told what the correct answer was.

Participants completed the experiment in the laboratory and then were contacted again approximately six days later (*M* = 6.1, *SD* = 1.2) by phone, during which they were tested on the other half of the questions. Participants were not aware, nor were they told at any point they would be contacted after a delay, thus the long-delay memory test was a surprise. During the test, questions were read aloud to the participants over the phone, and participants were given as much time as need to indicate their response. The reading of the question was repeated if the participant requested. If participants indicated they did not know the answer or if they guessed incorrectly, they were told what the correct answer was. One of the reasons for conducting the long-delay test over the phone as opposed to having participants come back into the lab, was to reduce the likelihood that participants would suspect that their memory for the questions would be tested after a longer delay. In fact, participants indicated they were not expecting to have their memory tested when they were called with the surprise test request. The questions asked during the short-delay and long-delay were counterbalanced between participants.

Results and Discussion

All questions that participants indicated they knew prior to being shown the answers were excluded from analyses in order to only assess new learning and memory. Older adults knew significantly more answers compared with younger adults (M = 6.5, SD = 2.9 and M = 4.0, SD = 3.0, respectively), $t(46) = 3.01$, $p < .01$. In order to examine whether increased curiosity led to better memory performance, each participants' average curiosity rating was calculated. Questions that fell below the individuals' average curiosity rating were considered "lower curiosity" and questions falling above the mean were considered "higher curiosity" items, similar to what was done by Kang et al. (2009). In addition, the same mean-split procedure was done with the confidence ratings in order to assess whether higher confidence errors led to better memory performance. This mean-split also allowed for a roughly equal number of questions in the "higher" and "lower" categories.

Although higher and lower curiosity and confidence items were calculated on the level of the individual, t-tests were conducted to examine whether older or younger adults gave higher or lower average ratings of curiosity or confidence. Older and younger adults had comparable average curiosity ratings (M = 6.2, SD = 1.7 and M = 6.4, SD = 1.2, respectively), $t(46) = .31$, $p = .76$, as well as confidence ratings (M = 17.3, SD = 15.1 and M = 12.9, SD = 9.5, respectively), $t(46) = 1.19$, $p = .24$.

Curiosity and Memory – Short Delay

The proportion of answers recalled for questions given higher versus lower curiosity ratings was examined in a 2 (Age Group) by 2 (Curiosity: Higher and Lower) ANOVA, and the results are displayed in Figure 4.1. After an hour delay, younger and older adults recalled a vast majority of the questions (M = 80.8%, SD = 14.2% and M = 84.4%, SD = 10.3%, respectively). There was no effect of Age Group, $F(1, 46) = 1.24$, $p = .27$ or Curiosity, $F(1, 46) = 1.47$, $p = .23$. There was, however, a very marginal interaction, $F(1, 46) = 3.01$, $MSE = .03$, $p = .09$, $\eta_p^2 = .06$. Post-hoc t-tests revealed that younger adults recalled significant more of the higher curiosity information compared with older adults, $t(46) = 2.10$, $p < .05$, although no age-related differences were observed for the lower curiosity questions ($p = .98$). Younger adults also remembered more of the answers for the higher compared with lower curiosity questions, $t(23) = 2.11$, $p < .05$. Older adults recalled an equal proportion of the higher and lower curiosity information ($p = .72$).

As was mentioned, overall recall performance was near ceiling after the hour delay. It could be that the effect of curiosity on memory performance was being masked to some extent by the fact that most of the participants remembered almost all of the answers to the questions. Examining the proportion of answers correctly recalled, there was a smaller set of participants (N =13, seven older adults and six younger adults) who did recall, on average, less than 75% of the information. A t-test comparing the proportion of higher versus lower curiosity information recalled for these 13 individuals did show a marginal impact of curiosity on memory performance, $t(12) = 1.92$, $p = .08$.

Confidence and Memory – Short Delay

The proportion of answers recalled for questions given higher versus lower confidence ratings is displayed in Figure 4.2. A 2 (Age Group) by 2 (Confidence: Higher and Lower) ANOVA revealed no effect of Age Group, $F(1, 46) = 1.10$, $p = .30$ or Confidence, $F(1, 46) = .69$, $p = .41$, and no interaction, $F(1, 46) = .09$, $p = .77$. As was mentioned, overall recall performance was near ceiling after the hour delay, and the effect of confidence on memory performance could have been masked by the fact that most of the participants recalled almost all of the information. A t-test comparing the proportion of higher versus lower confidence information recalled for the 13 individuals who remembered less than 75% on the short-delay test did not, however, show an effect of confidence on memory, $t(12) = 1.53$, $p = .15$.

Curiosity and Memory – Long Delay

A 2 (Age Group) by 2 (Curiosity) ANOVA was conducted to examine the effect of curiosity on memory performance after a longer delay, and the results are displayed in Figure 4.3. After six days, older adults recalled a lower percentage of questions ($M = 44.5\%$, $SD = 15.3\%$) compared with younger adults ($M = 53.0\%$, $SD = 12.7\%$), $F(1, 46) = 4.74$, $MSE = .04$, $p < .05$, $\eta_p^2 = .09$. Importantly, there was a substantial impact of curiosity on memory performance, $F(1, 46) = 25.01$, $MSE = .02$, $p < .001$, $\eta_p^2 = .35$. Age Group and Curiosity did not interact, $F(1, 46) = .00$, $p = .99$. Gamma correlations (γ) between curiosity ratings and memory were also computed for younger and older adults in order to examine the degree that the differences in subjective curiosity ratings predicted long-term memory. Gamma correlations for both older adults ($\gamma = .21$, $p = .001$) and younger adults ($\gamma = .25$, $p < .001$) were significant and comparable ($p = .62$).

Confidence and Memory – Long Delay

A 2 (Age Group) by 2 (Confidence) ANOVA was conducted to examine the effect of confidence on memory performance and the results are displayed in Figure 4.4. Older adults recalled a lower percentage of questions compared with younger adults, $F(1, 46) = 5.74$, $MSE = .04$, $p < .05$, $\eta_p^2 = .11$. There was also an effect of confidence on memory performance, $F(1, 46) = 5.68$, $MSE = .02$, $p < .05$, $\eta_p^2 = .11$, with a higher proportion of answers recalled for the questions that initially elicited higher compared with lower confidence errors. No interaction was observed between Age Group and Confidence level, $F(1, 46) = .20$, $p = .65$. Gamma correlations (γ) between confidence ratings and memory were also computed for younger and older adults in order to examine the degree that the differences in subjective confidence ratings predicted long-term memory. Although younger and older adults' average gamma correlations was comparable ($p = .85$), the relationship between confidence and memory was found to be somewhat stronger for younger adults ($\gamma = .16$, $p < .05$) than older adults ($\gamma = .14$, $p = .09$).

Initial higher curiosity in learning answers to unknown questions led to increased benefits in memory for both younger and older adults, particularly after a long delay. The findings in the current study replicate those of Kang et al (2009), and extend them to an older adult sample. Contrary to hypotheses, older adults' initial curiosity did not have a larger impact on memory compared with younger adults. There was some indication that the effect of curiosity on memory might be present after shorter delays, although the overall high degree of memory accuracy makes it difficult to ascertain the magnitude of the effect. Furthermore, higher confidence errors were also associated with increased memory performance by younger and older adults, consistent with findings of the hypercorrection effect (Butterfield & Metcalfe, 2001, 2006; Cyr & Anderson, in press). The results indicate that while aging may negatively impact memory, the processes the lead one to recall more versus less interesting information are not detrimentally affected during the aging process.

Experiment 5

Evidence from Kang et al. (2009) and Experiment 4 provide evidence as to the impact of initial curiosity on memory. However, in both of these tasks the measure used to assess interest (the curiosity rating), was collected prior to the answer being shown. It may be the case that interest levels are increased (possibly leading to additional elaborative processing) or decreased once the answer is known. Although it is highly probable that initial curiosity and continued interest levels after the answer is revealed will be similar, it is also likely that pre-interest (i.e., curiosity) and post-interest are differentially associated with recall. In Kang et al., (2009: Experiment 2), pupil dilation responses were recorded during encoding, and peak dilation responses occurred approximately 800ms after the correct answer was shown to the participants. Furthermore, pupil dilation responses have been linked with interest, arousal, cognitive effort, surprise and attention (Beatty, 1982; Hess & Polt, 1960; Preuschoff, t Hart, & Einhauser, 2011), suggesting that certain memory enhancing cognitive processes might heighten after something novel and interesting is learned. For example, it is likely that once the answer is shown, and if interest becomes or remains high, additional elaborative processing and attentional resources are engaged, leading post-answer interest to perhaps be a better predictor of long-term memory than initial curiosity.

In addition to this, there is the question of whether individuals will explicit indicate that they are more likely to recall questions that invoke higher levels of interest and curiosity. If participants hold the belief that interesting material is, in fact, more memorable, then interest and curiosity could have a large impact on metacognitive judgments. In order to examine this, participants were asked to provide judgments of learning (JOLs). JOLs have been shown to be influenced by a number of intrinsic factors and cues related to the target material (Koriat, 1997), although under or over-utilization of certain cues can decrease the degree that JOLs are predictive of later memory (e.g., Koriat & Bjork, 2005; Rhodes & Castel, 2008).

Despite the belief held by many that interesting information is more memorable, subjective interest has yet to be examined as a potentially powerful (and useful) cue utilized by individuals in judgments of what is more or less likely to be remembered. The evidence from Experiment 4, Kang et al. (2009), and Murayama and Kuhbandner (2011) suggest that curiosity or interest are associated with long-term memory, and thus interest would be a valid and perhaps salient cue for individuals to utilize when forming JOLs. In regard to aging, older and younger adults often show equivalent relative accuracy in the ability to predict what is more versus less likely to be remembered (Connor et al., 1997; Hertzog et al., 2002; Hertzog et al., 2010; McGillivray & Castel, 2011), suggesting metacognitive judgments would be equally accurate for younger and older adults.

The current experiment was conducted in order to replicate the main findings from Experiment 4, and also expand the investigation of the relationship between subjective interest and memory to include interest once something new is learned, as well as examine whether JOLs are influenced by interest and are predictive of later memory performance. As was done in Experiment 4, both a 1 hour delay test and a 1 week delay test were included in the procedures for the current study. The shorter delay test was essential due to that fact that it was likely that a majority of participants would expect that their memory would be tested given the incorporation of JOLs during study. Although no explicit mention of a memory test was made to participants in the instructions, one of the purposes of the short-term test was to decrease the likelihood that participants would anticipate the longer delay memory test.

Methods

Participants

The participants consisted of 24 older adults (13 females, *M* age = 72.9, *SD* = 6.1) and 24 younger adults (16 females, *M* age = 20.3, *SD* = 1.2). None of the participants who participated in Experiment 4 participated in the current experiment. Older adults had good self-reported health ratings (*M* = 8.2 on a scale of 1-10, with 1 indicating extremely poor health and 10 indicating excellent health), and had an average of 17.4 years of education. Recruitment and compensation procedures for younger and older adults were identical to those described in Experiment 4.

Materials

The stimuli consist of 60 trivia questions, most of which were used in Experiment 4. Sixteen of the 60 questions were changed in order create a wider range of topics that better represented categories such as science, literature, pop culture, and art. Some of the questions removed were those that were either guessed correctly a high percentage of the time by participants, or were those that were from over-represented categories such as geography. The sixteen new questions were taken from various Internet trivia sites. A complete list of the trivia questions and answers is presented in Appendix B, including the sixteen new questions and answers which are located at the bottom of Appendix B.

Procedure

The procedures were similar to those described in Experiment 4, but were modified in order to incorporate the post-answer interest ratings as well as JOLs. Participants were presented with a question for 10 seconds. Participants were told to provide a guess if they had one, but were not required to guess the answer. Following the question, participants provided curiosity ratings on a scale from 1-10, and confidence ratings on a scale from 1-10. Immediately after these ratings participants were shown the question with the correct answer for 6 seconds. Following the answer, participants were asked to indicate their interest level in the piece of information now that they knew the answer. Interest ratings were on a scale from 1-10, with 1 indicating “not interesting at all,” and 10 indicating “extremely interesting.” Lastly, participants were asked to indicate how likely it was that they would remember the fact, also on a scale from 1-10 with 1 indicating "definitely will not remember," and 10 indicating "definitely will remember. All of the ratings were based on a scale from 1-10 in order to reduce potential confusion, and the scales were displayed on the computer screen while participants made their judgments. Curiosity ratings, confidence ratings, interest ratings, and JOLs were all self-paced. This procedure was repeated for all 60 questions. The procedures surrounding both the short-delay and long-delay test were identical to those described in Experiment 4. The average shorter-delay length was approximately 60 minutes (M = 59.6, SD = 12.5), and the average delay before the final test was approximately 7 days (M = 6.8, SD = 1.0).

Results and Discussion

All questions that participants indicated they knew prior to being shown the answers were excluded from analyses. As in Experiment 4, older adults knew significantly more answers compared with younger adults (M = 6.5, SD = 3.6 and M = 3.6, SD = 2.6, respectively), $t(46) = 3.15$, $p < .01$. In order to assess whether increased curiosity, confidence, post-answer interest, and JOLs led to better memory performance, each participants' average rating for each of the four variables was calculated. Questions that fell below an individuals' average were considered, for example, "lower curiosity" and questions falling above the mean were considered, for example "higher curiosity" items.

Group Differences in Average Ratings

Although higher and lower curiosity, confidence, interest, and JOL items were calculated on the level of the individual, t-tests were conducted to examine whether older or younger adults gave higher or lower average ratings of curiosity, confidence, interest, or JOLs. Older adult had slightly higher average curiosity ratings compared with younger adults (M = 6.5, SD = 1.6 and M

= 5.6, *SD* = 1.4, respectively), *t*(46) = 2.28, $p < .05$, confidence ratings (*M* = 2.6, *SD* = 1.3 and *M* = 1.8, *SD* = .6, respectively), *t*(46) = 2.63, $p < .05$, and JOLs (*M* = 6.1, *SD* = 1.8 and *M* = 5.0, *SD* = 1.6, respectively), *t*(46) = 2.35, $p < .05$. Older adults also had marginally higher post-answer interest ratings compared with younger adults (*M* = 5.8, *SD* = 1.8 and *M* = 5.0, *SD* = 1.2, respectively), *t*(46) = 1.90, *p* = .06.

Relationship Among Ratings

It was expected that some of the subjective ratings could be correlated with one another. Pearson's correlations were conducted and the results are displayed in Table 5.1. For both younger and older adults, curiosity ratings and interest ratings were highly correlated (all *p's* < .01). Furthermore, both curiosity and interest ratings were correlated with JOLs for both younger and older adults (all *p's* < .01). Confidence ratings were slightly correlated only with initial curiosity, and only for younger adults.

Curiosity and Memory – Short Delay

The proportion of answers recalled for questions given higher versus lower curiosity ratings was examined in a 2 (Age Group) by 2 (Curiosity: Higher and Lower) ANOVA, and the results are displayed in Figure 5.1. After an hour delay, younger and older adults recalled a vast majority of answers to the questions (*M* = 86.6%, *SD* = 7.7% and *M* = 89.1%, *SD* = 11.9%, respectively). There was no effect of Age Group, *F*(1, 46) = .81, *p* = .37. Despite the high memory performance, the was an effect of initial Curiosity, *F*(1, 46) = 13.86 *MSE* = .01, *p* = .001, $\eta_p^2 = .23$. Age Group and Curiosity did not interact, *F*(1, 46) = .31, *p* = .58. In Experiment 4, analyses on a smaller set of participants who recalled less than 75% of the information was conducted. However, in the current experiment, only four participants (two younger and two older) recalled less than 75% after the hour delay.

Confidence and Memory – Short Delay

The proportion of answers recalled for questions given higher versus lower confidence ratings is displayed in Figure 5.2. A 2 (Age Group) by 2 (Confidence: Higher and Lower) ANOVA revealed no effect of Age Group, $F(1, 46) = .64$, $p = .43$, or Confidence, $F(1, 46) = .80$, $p = .38$, and no interaction, $F(1, 46) = .26$, $p = .61$.

Post-Answer Interest and Memory – Short Delay

The proportion of answers recalled for questions given higher versus lower interest ratings after the answer was shown was examined in a 2 (Age Group) by 2 (Interest: Higher and Lower) ANOVA, and the results are displayed in Figure 5.3. There was no effect of Age Group, $F(1, 46) = .44$, $p = .51$. There was a rather large effect of Interest, $F(1, 46) = 31.22$ $MSE = .01$, $p < .001$, $\eta_p^2 = .40$, with participants recalling more answers that elicited higher interest levels. Age Group and Interest did not interact, $F(1, 46) = .03$, $p = .85$.

Change in Interest Level – Short Delay

Initial curiosity and post-answer interest were highly correlated, and often curiosity ratings were identical to interest ratings. In fact, curiosity and interest ratings were identical 36.9% of the time (SD = 20.0%). However, interest ratings were lower than initial curiosity ratings 42.9% of the time (SD = 21.3%), and interest ratings were higher than initial curiosity ratings 20.3% of the time (SD = 16.4%). In order to examine how change in interest impacted memory, the proportion of lower interest (i.e., post-answer interest was lower than initial curiosity), same interest, and higher interest questions recalled were analyzed in a 2 (Age Group) by 3 (Change in Interest: Lower, Same, Higher) ANOVA, and the results are displayed in Figure 5.4. There was no effect of Age Group, $F(1, 46) = .01$, $p = .95$. There was, however, a small effect of Change in Interest, $F(2, 90) = 2.66$ $MSE = .03$, $p = .08$, $\eta_p^2 = .06$. Participants recalled significantly more answers to questions only when post-answer interest increased from initial curiosity compared to when it decreased, t(46) = 2.17, p < .05. Age Group and Change in Interest did not interact, $F(2, 90) = .03$, $p = .85$.

JOLs and Memory – Short Delay

Gamma (γ) correlations, a measure of relative metacognitive accuracy, were computed between JOLs and recall for both younger and older adults. The average gamma correlation was positive, but not significant, for older adults ($\gamma = .23$, $p = .13$), whereas the gamma correlations were significant for younger adults ($\gamma = .28$, $p < .01$). Similar to the analyses for the curiosity, confidence, and interest variables, the proportion of answers recalled for questions given higher versus lower JOLs was also examined in a 2 (Age Group) by 2 (JOL: Higher and Lower) ANOVA, and the results are displayed in Figure 5.5. There was no effect of Age Group, $F(1, 46) = .50$, $p = .48$. There was a rather large effect of JOL ratings, $F(1, 46) = 35.29$ $MSE = .01$, $p < .001$, $\eta_p^2 = .43$. There was also a marginal interaction between Age Group and JOLs, $F(1, 46) = 3.29$ $MSE = .01$, $p = .08$, $\eta_p^2 = .07$. Although older and younger adults recalled similar proportions of answers to questions given higher versus lower JOLs (all *p's* > .19), and younger and older adults both recalled significantly more of the answers to questions given higher compared to lower JOLs [$t(23) = 5.17$, $p < .001$ and $t(23) = 3.12$, $p < .01$, respectively], the effect appears to be somewhat large for younger adults.

Curiosity and Memory – Long Delay

After approximately one week, recall performance was still fairly high for both older adults (*M* = 50.1%, *SD* = 11.8%) and younger adults (*M* = 51.8%, *SD* = 12.8%). A 2 (Age Group) by 2 (Curiosity) ANOVA was conducted to examine the effect of curiosity on memory performance after a longer delay, and the results are displayed in Figure 5.6. Somewhat surprisingly, older and younger adults recalled a similar proportion of answers $F(1, 46) = .07$, $p = .79$. Importantly, there was a large impact of initial curiosity on memory performance, $F(1, 46) = 65.00$, $MSE = .02$, $p < .001$, $\eta_p^2 = .59$. Age Group and Curiosity did not interact, $F(1, 46) = .14$, $p = .71$. Gamma correlations (γ) between curiosity ratings and memory were computed for younger and older adults in order to examine the degree that the differences in subjective curiosity ratings were able to distinguish between what was remembered versus forgotten. Gamma correlations were significant for both older adults ($\gamma = .30$, $p < .001$) and younger adults ($\gamma = .33$, $p < .001$), and there was no difference between the age groups ($p = .73$).

Confidence and Memory – Long Delay

A 2 (Age Group) by 2 (Confidence) ANOVA was conducted to examine the effect of confidence on memory performance and the results are displayed in Figure 5.7. There was no effect of Age Group, $F(1, 46) = .86$, $p = .36$. There was an effect of confidence on memory performance, $F(1, 46) = 15.65$, $MSE = .03$, $p < .001$, $\eta_p^2 = .25$, with a higher proportion of answers recalled for the questions that initially elicited higher compared with lower confidence errors. Age Group and Confidence level did not interact, $F(1, 46) = .01$ $p = .91$. Gamma correlations (γ) between confidence ratings and memory were also computed for younger and older adults in order to examine the degree that the differences in subjective confidence ratings predicted long-term memory. Younger and older adults' average gamma correlations were comparable ($p = .94$), and significant for both younger adults ($\gamma = .28$, $p < .01$) and older adults ($\gamma = .29$, $p < .01$).

Post-Answer Interest and Memory – Long Delay

The proportion of answers recalled for questions given higher compared to lower interest ratings was examined in a 2 (Age Group) by 2 (Interest) ANOVA, and the results are displayed in Figure 5.8. There was no effect of Age Group, $F(1, 46) = .21$, $p = .65$. There was a large effect of Interest, $F(1, 46) = 59.46$ $MSE = .02$, $p < .001$, $\eta_p^2 = .56$. Age Group and Interest did not interact, $F(1, 46) = .04$, $p = .84$. Younger and older adults' average gamma correlations between post-answer interest ratings and memory were similar ($p = .46$), and were significant for both younger adults ($\gamma = .37$, $p < .001$) and older adults ($\gamma = .43$, $p < .001$).

Change in Interest Level – Long Delay

At the long-delay test, curiosity and interest ratings were identical to one another 36.0% of the time (*SD* = 20.8%). However, interest ratings lowered from initial curiosity ratings 45.3% of the time (*SD* = 22.1%), and interest ratings were higher than initial curiosity ratings 20.0% of the time (*SD* = 15.1%). In order to examine how change in interest impacted memory, the proportion of lower interest, same interest, and higher interest questions recalled was analyzed in a 2 (Age Group) by 3 (Change in Interest) ANOVA, and the results are displayed in Figure 5.9. There was no effect of Age Group, $F(1, 42) = .01$, $p = .91$. There was an effect of Change in Interest, $F(2, 84) = 5.70$ $MSE = .05$, $p < .01$, $\eta_p^2 = .12$. Age Group and Change in Interest did not interact, $F(2, 84) = 2.21$, $p = .12$. Participants recalled significantly more answers to questions when post-answer interest increased from initial curiosity compared to when it decreased, $t(43) = 3.06$, $p < .01$, and slightly more answers to questions when post-answer interest increased from initial curiosity compared to when it stayed the same, $t(43) = 1.96$, $p = .06$. There was no difference between the proportion of answers recalled when interest decreased compared to when it stayed the same ($p = .25$). Younger and older adults' average gamma correlations between the change in interest ratings and memory were similar ($p = .41$), but were not significant for either younger adults ($\gamma = .06$, $p = .28$) or older adults ($\gamma = .15$, $p = .09$).

JOLs and Memory – Long Delay

The proportion of answers recalled for questions given higher versus lower JOLs was also examined in a 2 (Age Group) by 2 (JOL) ANOVA, and the results are displayed in Figure 5.10. There was no effect of Age Group, $F(1, 46) = .78$, $p = .38$. There was a substantial effect of JOL ratings, $F(1, 46) = 139.02$ $MSE = .02$, $p < .001$, $\eta_p^2 = .75$. There was also a marginal interaction between Age Group and JOLs, $F(1, 46) = 3.31$ $MSE = .02$, $p = .08$, $\eta_p^2 = .07$. Although both older and younger adults recalled more answers to questions given higher JOLs compared with lower JOLs (all *p's* < .001), younger adults recalled a slightly higher proportion of answers given higher JOLs compared with older adults, $t(46) = 1.80$, $p = .06$. Both younger and older adults recalled a similar proportion of answers to questions given lower JOLs ($p = .74$). Younger and older adults' average gamma correlations between JOL ratings and memory were similar ($p = .32$), and were significant for both younger adults ($\gamma = .53$, $p < .001$) and older adults ($\gamma = .46$, $p < .001$).

Surprisingly, there were no age-related differences in overall memory performance at both the short-delay and long-delay memory test. After a one hour delay, both younger and older adults recalled more answers to questions given higher compared to lower initial curiosity ratings, post-answer interest ratings, JOLs, as well as well as for questions in which interest level increased from initial levels after the answer was displayed. However, at the time of the short delay test recall was quite high, and most of the participants recalled almost all of the trivia answers. Due to the fact that memory was at or close to ceiling, the results at the short delay test should be interpreted with some caution.

Memory performance was much lower after a week delay, and rather substantial effects of all of the measures were apparent. Older and younger adults recalled more answers to questions given higher compared with lower initial curiosity ratings, confidence ratings, post-answer interest ratings, JOLs, as well as well as for questions in which interest level increased from initial levels after the answer was displayed, replicating and extending the findings from Kang et al (2009) and Murayama and Kuhbandner (2011) . The magnitude of the gamma correlations (except change in interest) suggest that ratings of curiosity, magnitude of confidence in errors, post-answer interest, as well as JOLs are able to distinguish between what is more or less likely to be later recalled. Furthermore, the magnitude of the overall gamma correlations indicate that some of the measures might be better able to distinguish between what is forgotten compared with recalled after a delay. JOLs had the highest overall correlation with later memory performance ($\gamma = .50$), followed by interest ratings ($\gamma = .40$), curiosity ratings ($\gamma = .32$), and lastly confidence ratings ($\gamma = .28$).

Curiosity, post-answer interest, and JOLs were also highly correlated with one another; confidence ratings were only correlated with initial curiosity, and only for younger adults. Thus, it would seem that participants were using their curiosity and interest ratings to help inform their JOLs. Of course, JOLs were assessed immediately after interest ratings were given, so the relationship between interest and JOLs could partially be a result of the temporal proximity of the two ratings. If a participant had just given an answer an extremely high interest rating, then this rating was probably in one's mind when asked to provide a JOL. Despite this limitation, the results suggest that under some conditions older and younger adults utilize feelings of interest or curiosity to help accurately predict what information will be later remembered.

General Discussion

The goals of the current set of experiments (Experiment 4 and 5) were to evaluate the extent that aging impacts that ability to recall what is more compared to less subjectively interesting, and to investigate the extent to which initial curiosity to learn, or interest once something new is learned is predictive to later memory performance and is associated with metacognitive monitoring judgments.

The results of the two experiments largely replicated the findings from Kang et al. (2009) and Murayama and Kuhbandner (2011), and extend these finding to older adults, in that higher initial curiosity to learn an answer to a novel trivia question was associated with better long-term memory for that information. It was also found that higher confidence errors were more likely to be recalled than lower confidence errors after a delay, consistent with the hypercorrection effect (Butterfield & Metcalfe, 2001, 2006; Cyr & Anderson, in press). Expanding on the notion of initial curiosity to learn, the current studies examined subjective interest ratings once a fact was known, and this measure of interest was also highly associated with long-term memory performance. Furthermore, metacognitive monitoring judgments (JOLs) were quite accurate in discriminating between what was more or less likely to be later recalled. The results of the current studies also indicated that both younger and older adults are more likely to recall information given higher compared with lower curiosity ratings, interest ratings, and JOLs after a somewhat shorter (1 hour) delay. However, given the extremely high accuracy rate on the short-delay test, it is difficult to ascertain the degree to which curiosity and interest can, within a relatively short period of time, impact memory performance.

Interestingly, while older adults recalled an overall lower proportion of the answers compared with younger adults on the long-delay test in Experiment 4, no age-related differences in memory performance were observed in Experiment 5. This could be partially due to the fact that the older adults were significantly older in Experiment 4 relative to Experiment 5 ($p < .01$), and that among the older participants (collapsing across the two experiments), age was negatively correlated with long-term recall performance ($r = -.19$). This discrepancy could also be attributed to the methodological differences between the two experiments. Experiment 5 included ratings of interest and JOLs after the answer was displayed, and thus participants had slightly more time think about each item. Perhaps when older adults are given more time to reflect on newly learned information, age-related difference are diminished.

Although it was predicted that the level of curiosity and perhaps interest would have a larger impact on older compared with younger adults' memory (Germain & Hess, 2007; Hess et al., 2001), no age-related differences were observed. In the current studies, curiosity and interest ratings were equally associated with what was later recalled for both younger and older adults. In the studies by Hess and colleagues (Germain & Hess, 2007; Hess et al., 2001), personal relevance for younger and older adults was manipulated varying the age of a target individual in a narrative or through the content of the narrative. Although ratings of personal relevance for the passages were collected, participants were told the main goal was to learn the material. Thus, it could be that participants, and perhaps younger adults in particular, were less focused on how interesting the material was to them, and more focused on trying to remember the material. This could be one of the reasons why younger adults displayed less of an effect of personal relevance on memory in these prior studies. In the current studies, no explicit mention of a memory test was made, and more emphasis was placed on one's interest in the material. By asking for explicit ratings of curiosity and interest, it ensured that participants were thinking about these factors while processing the information, and thus it is less surprising that both younger and older adults' subsequent memory was equally affected by interest in the material. What the results of the current studies do suggest are that the mechanisms that support the ability to recall what one finds more interesting are intact in the aging process.

In Experiment 5, initial curiosity ratings as well as post-answer interest ratings were collected. It was found that both curiosity and interest were related to later memory performance, and were highly correlated with one another. Curiosity is thought to be more analogous to reward anticipation (Kang et al., 2009; Murayama & Kuhbandner, 2011), while interest is perhaps more akin to a measure of satisfaction with the actual reward. Although curiosity and interest ratings were closely related to one another, there was a slightly stronger impact between ratings of post-answer interest and memory compared with ratings of initial curiosity and memory for both younger and older adults. It is probable that while initial curiosity is sufficient to engage and activate processes that promote later memory performance, once an answer is learned that is interesting, additional or continued processing and cognitive resources are engaged. This notion is supported by evidence in Experiment 5, such that participants were more likely to recall the answer to question when interest ratings were higher than initial curiosity ratings, compared to when interest ratings were lower than curiosity ratings.

Many people hold the belief that interesting information is better remembered. However, despite this popular belief, the relationship between interest and JOLs had not previously been examined. In the current study, both initial curiosity and interest were highly correlated with JOLs. It should be noted that JOLs were assessed immediately after interest, and thus it is likely that participants were actively thinking about their interest in a topic when forming their JOLs, which could have contributed to the high degree of relatedness between the measures. Nevertheless, the results suggest that when older and younger adults are thinking about how interesting a piece of information is, they might use their subjective feelings of interest or curiosity in a topic to help monitor and judge whether information is likely to be remembered or forgotten. Given that curiosity and interest were found to be related to actual memory performance, this is a valid and useful cue to rely on. Furthermore, gamma correlations between JOLs and memory performance were stronger (γ =.50) than those of either interest (γ =.40) or curiosity (γ =.32) suggesting that younger and older adults were utilizing cues beyond just interest to help inform their judgments and increase accuracy in predicting one's later memory.

The ability to recall what one finds more interesting appears to remain intact as one ages. Interest might serve to rally and direct attentional resources or lead one to engage in more elaborative encoding, which in turn benefits long-term memory. This effect of subjective interest is particularly important for older adults given declines within certain cognitive domains. Importantly, a person's interests are often linked with satisfaction in life, and the results of the current study are encouraging to younger as well as aging individuals in that they demonstrate that the ability to remember what we care about does not fade.

Table 5.1

Correlations between curiosity, confidence, interest and JOL ratings in Experiment 5.

	Measure	Curiosity	Confidence	Interest	JOLs
Younger Adults	Curiosity	1	.42*	.74***	.69***
	Confidence	.	1	.32	.23
	Interest	.	.	1	.82***
	JOLs	.	.	.	1
Older Adults	Curiosity	1	.27	.83***	.60**
	Confidence	.	1	.21	.32
	Interest	.	.	1	.62**
	JOLs	.	.	.	1

Note. * indicates ($p < .05$); ** indicates ($p < .01$); and *** indicates ($p < .001$)

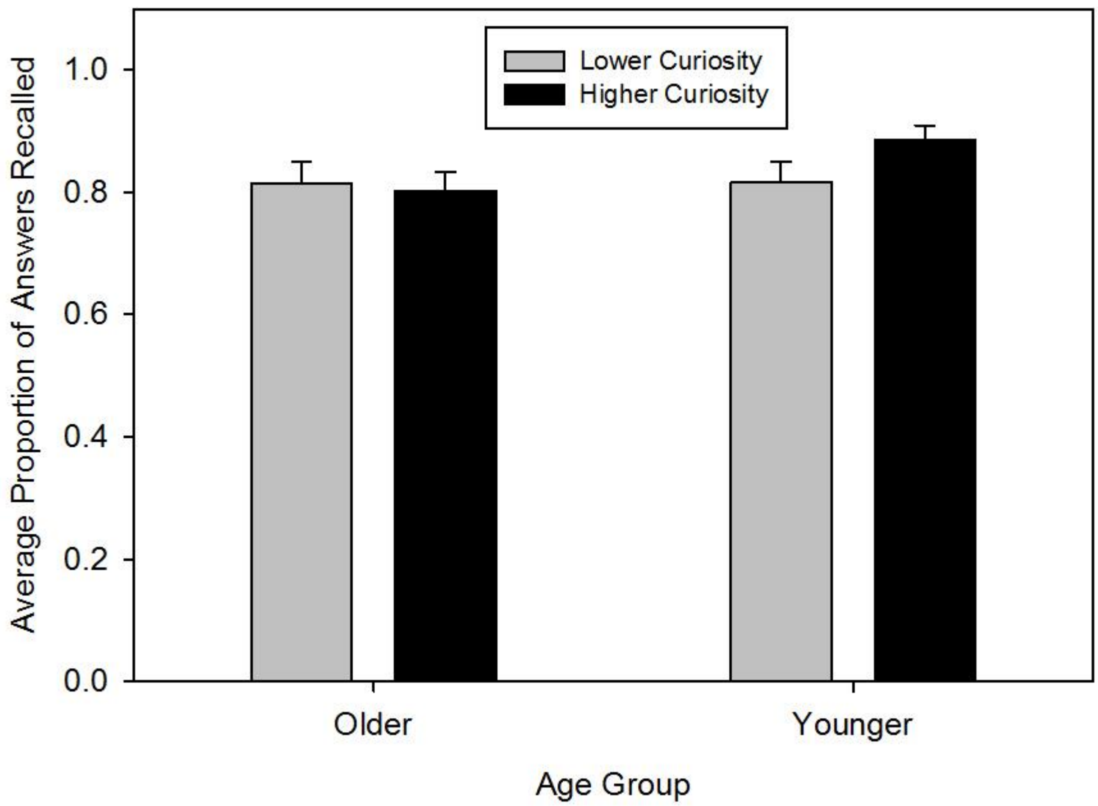

Figure 4.1. Figure 4.1 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions given higher versus lower ratings of initial curiosity in Experiment 4. Error bars represent standard error of the mean.

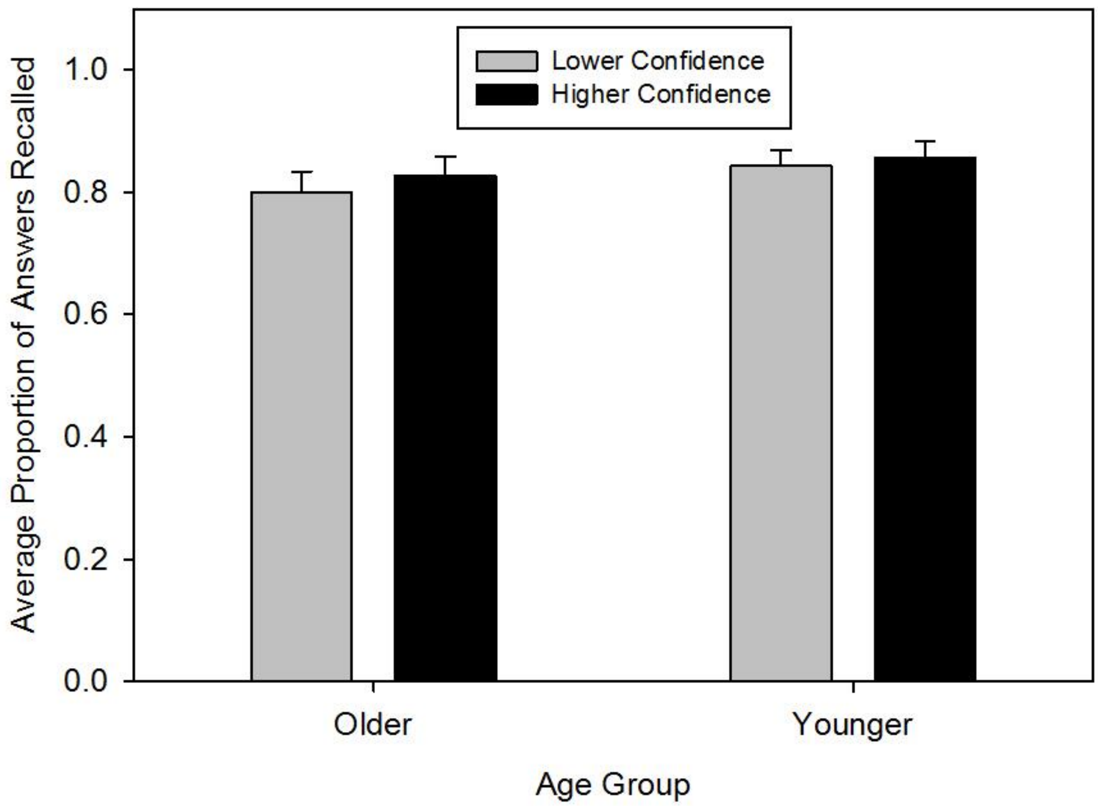

Figure 4.2. Figure 4.2 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions given higher versus lower confidence ratings in Experiment 4. Error bars represent standard error of the mean.

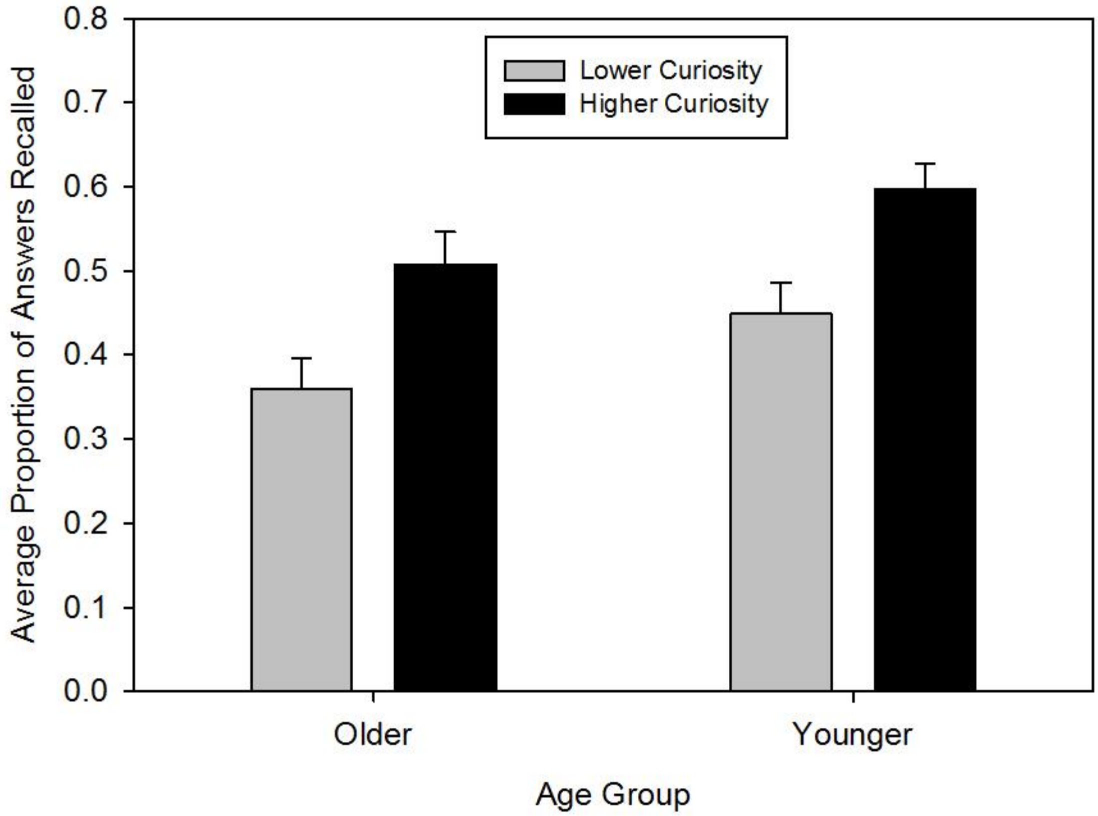

Figure 4.3. Figure 4.3 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 6 days) for questions given higher versus lower ratings of initial curiosity in Experiment 4. Error bars represent standard error of the mean.

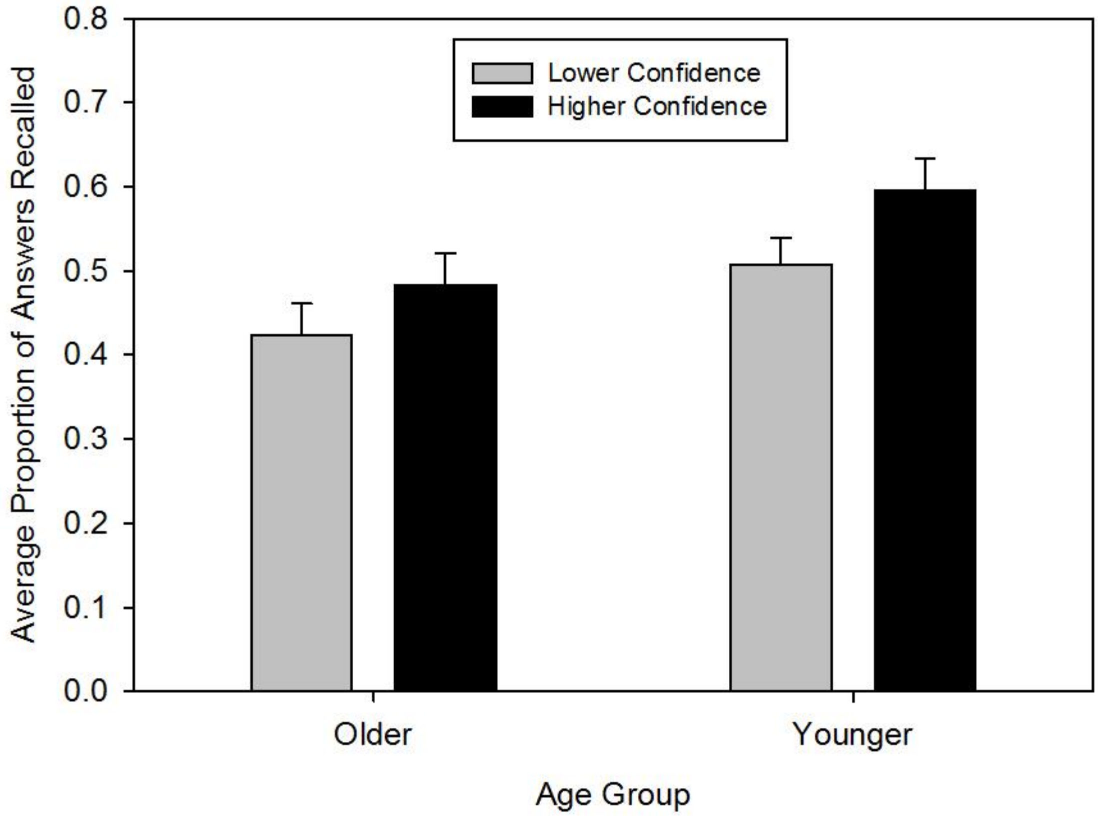

Figure 4.4 Figure 4.4 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 6 days) for questions given higher versus lower confidence ratings in Experiment 4. Error bars represent standard error of the mean.

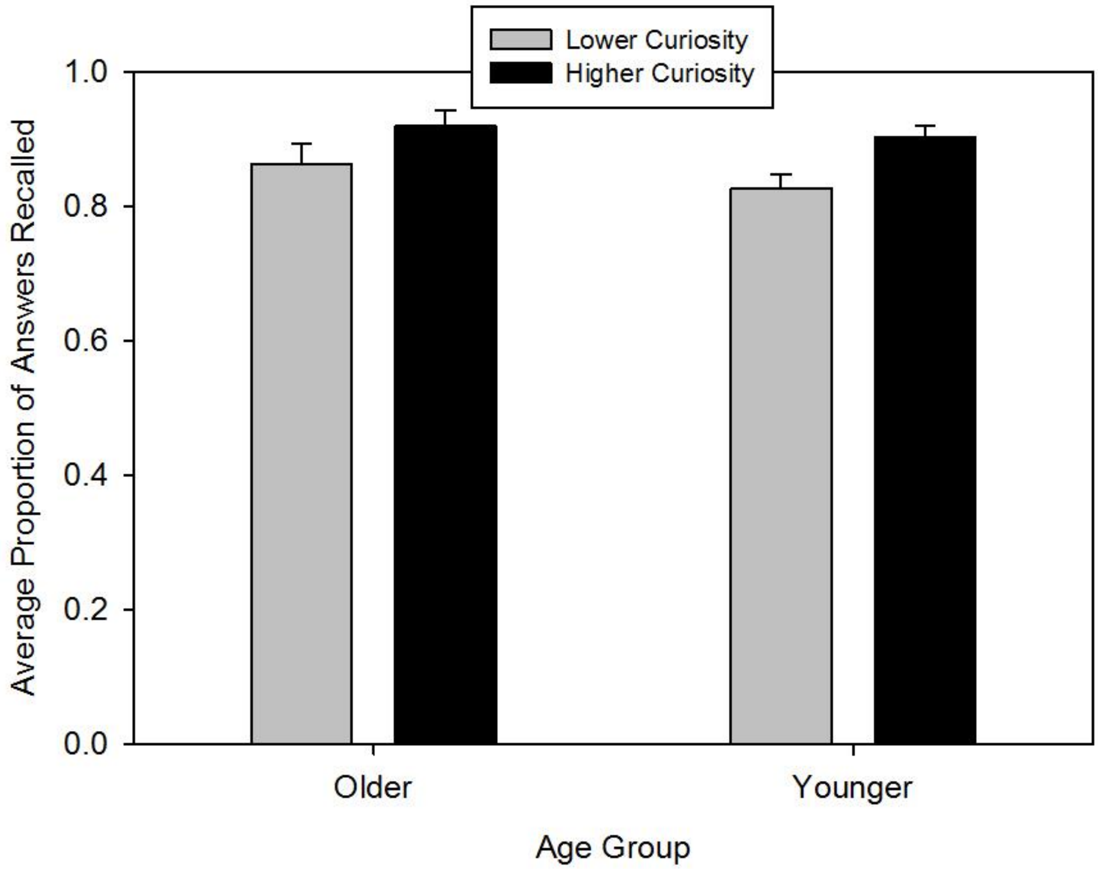

Figure 5.1. Figure 5.1 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions given higher versus lower ratings of initial curiosity in Experiment 5. Error bars represent standard error of the mean.

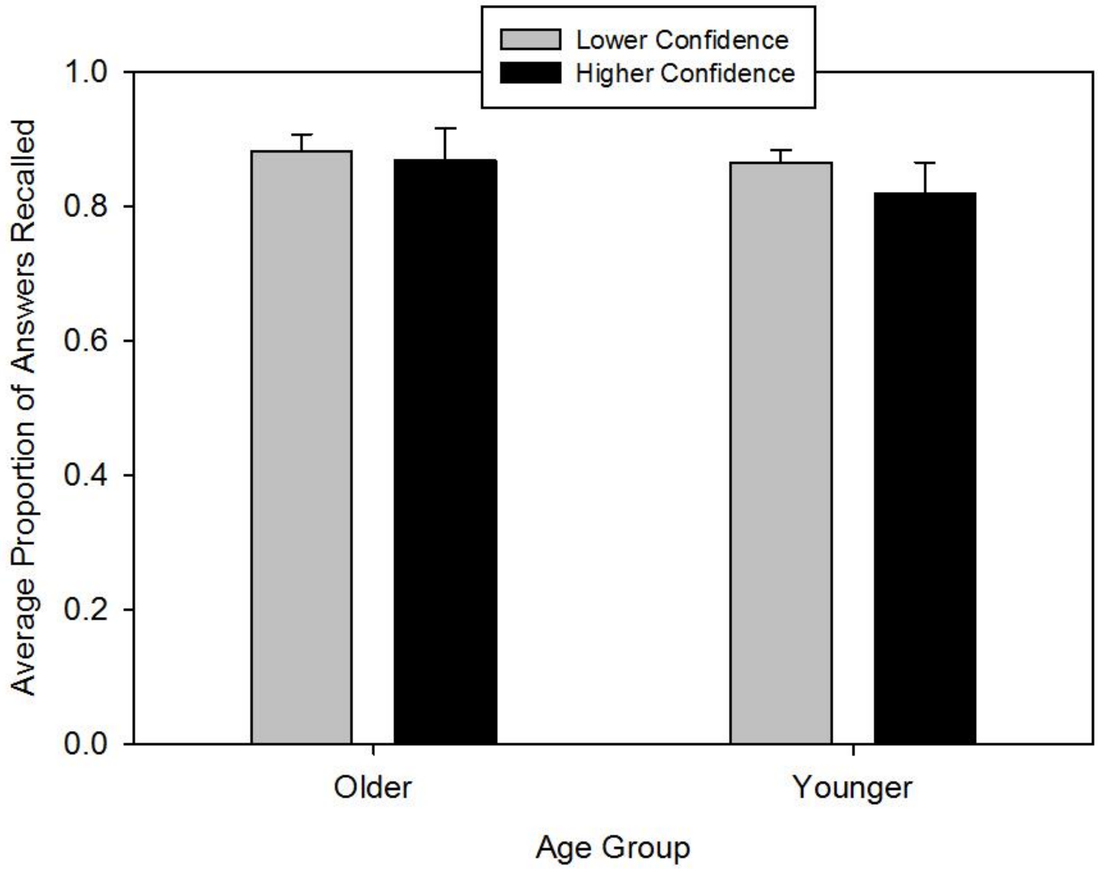

Figure 5.2. Figure 5.2 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions given higher versus lower confidence ratings in Experiment 5. Error bars represent standard error of the mean.

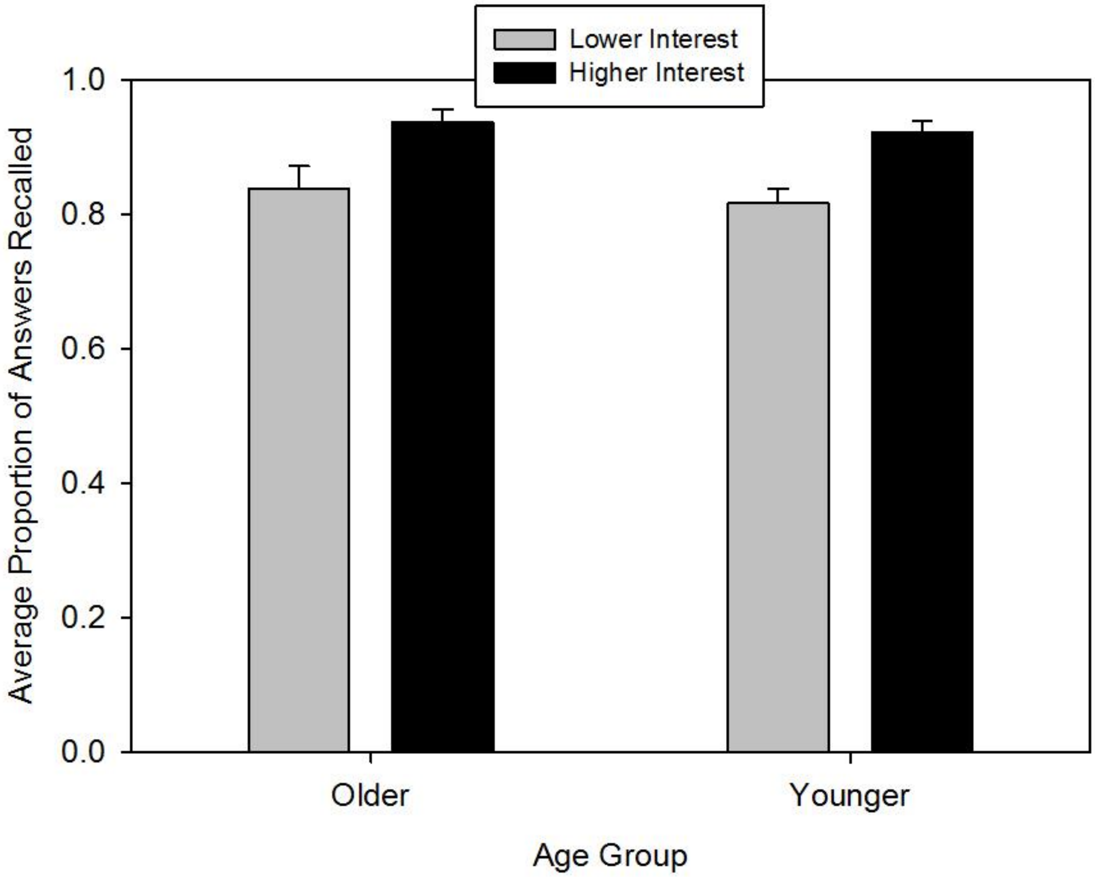

Figure 5.3. Figure 5.3 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions given higher versus lower post-answer interest ratings in Experiment 5. Error bars represent standard error of the mean.

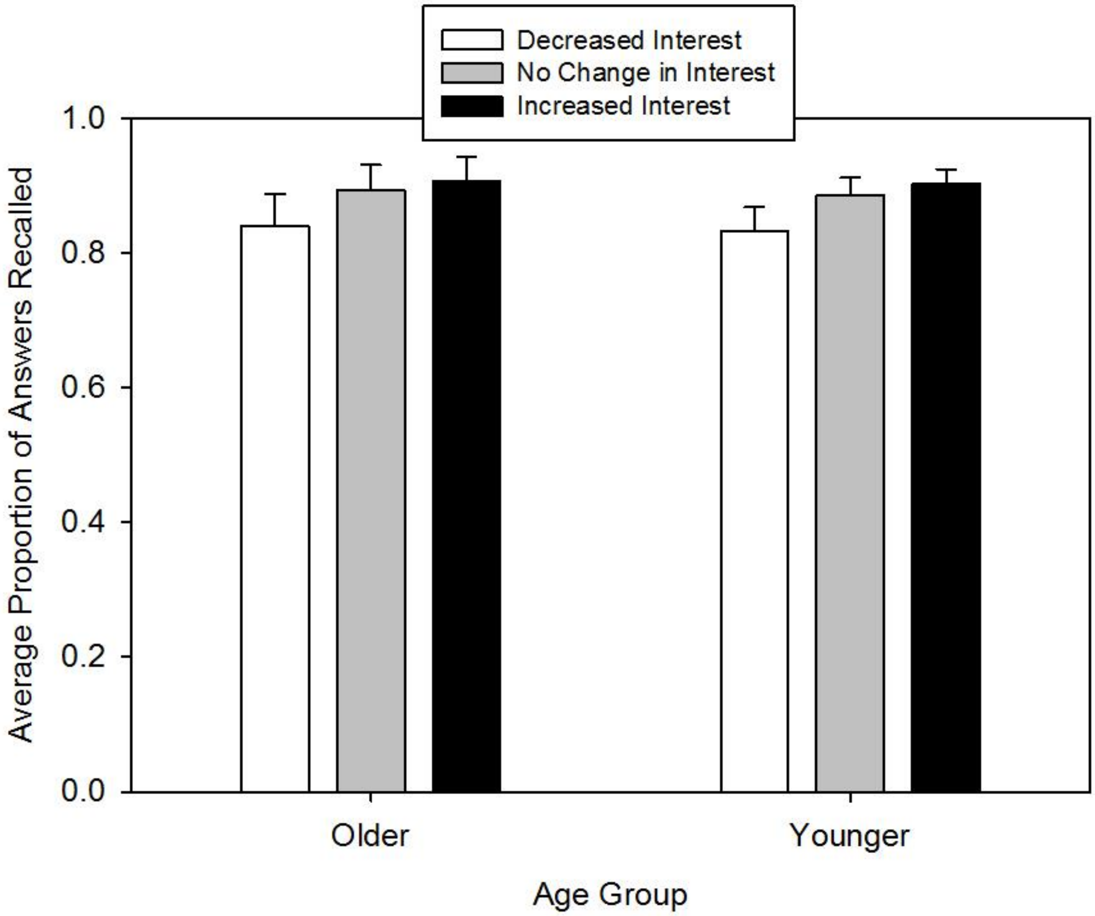

Figure 5.4. Figure 5.4 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions that had decreased, the same, or increased ratings of interest compared with the initial curiosity in Experiment 5. Error bars represent standard error of the mean.

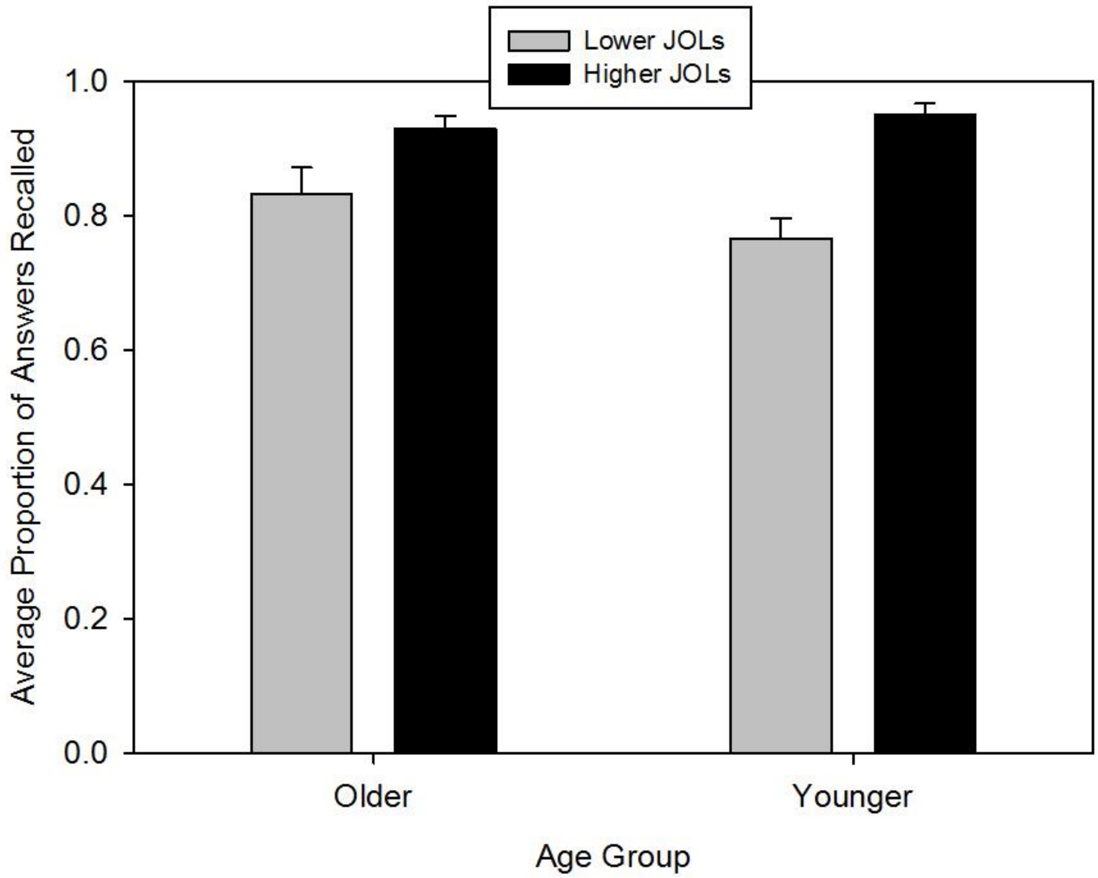

Figure 5.5. Figure 5.5 displays the average proportion of answers recalled by younger and older adults after a shorter delay (~ 1 hour) for questions given higher versus lower JOLs in Experiment 5. Error bars represent standard error of the mean.

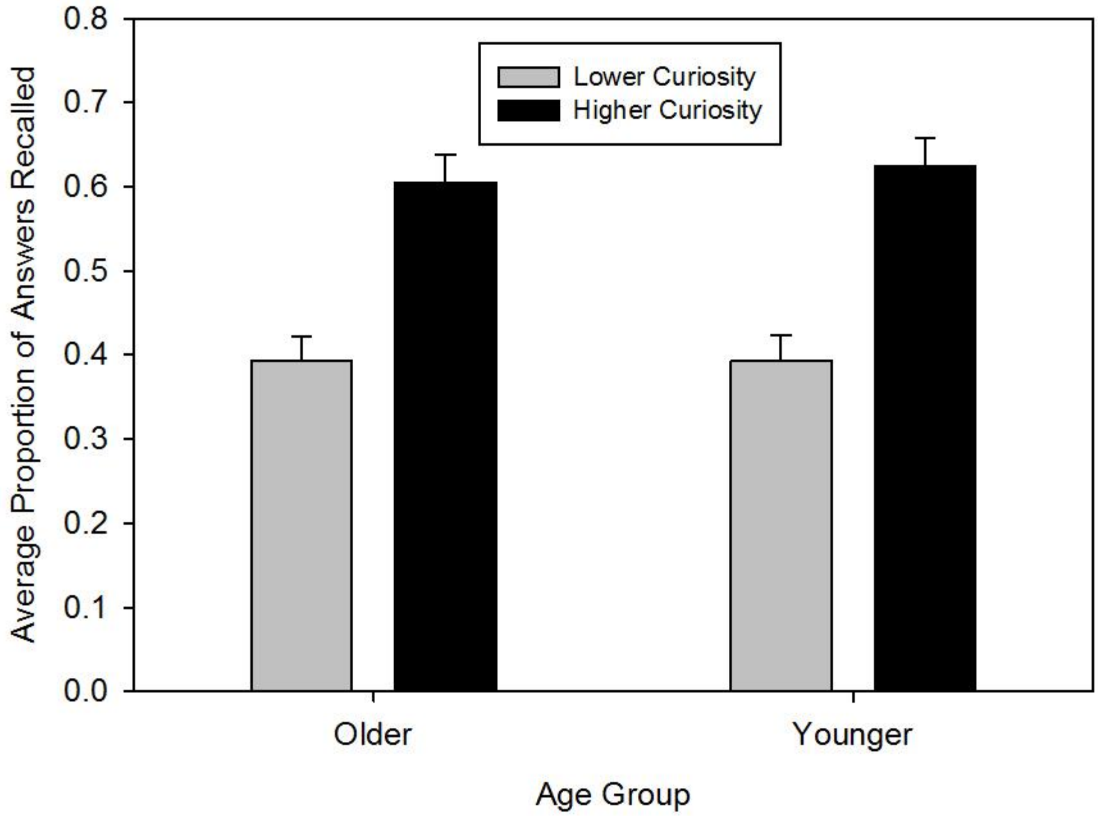

Figure 5.6. Figure 5.6 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 1 week) for questions given higher versus lower ratings of initial curiosity in Experiment 5. Error bars represent standard error of the mean.

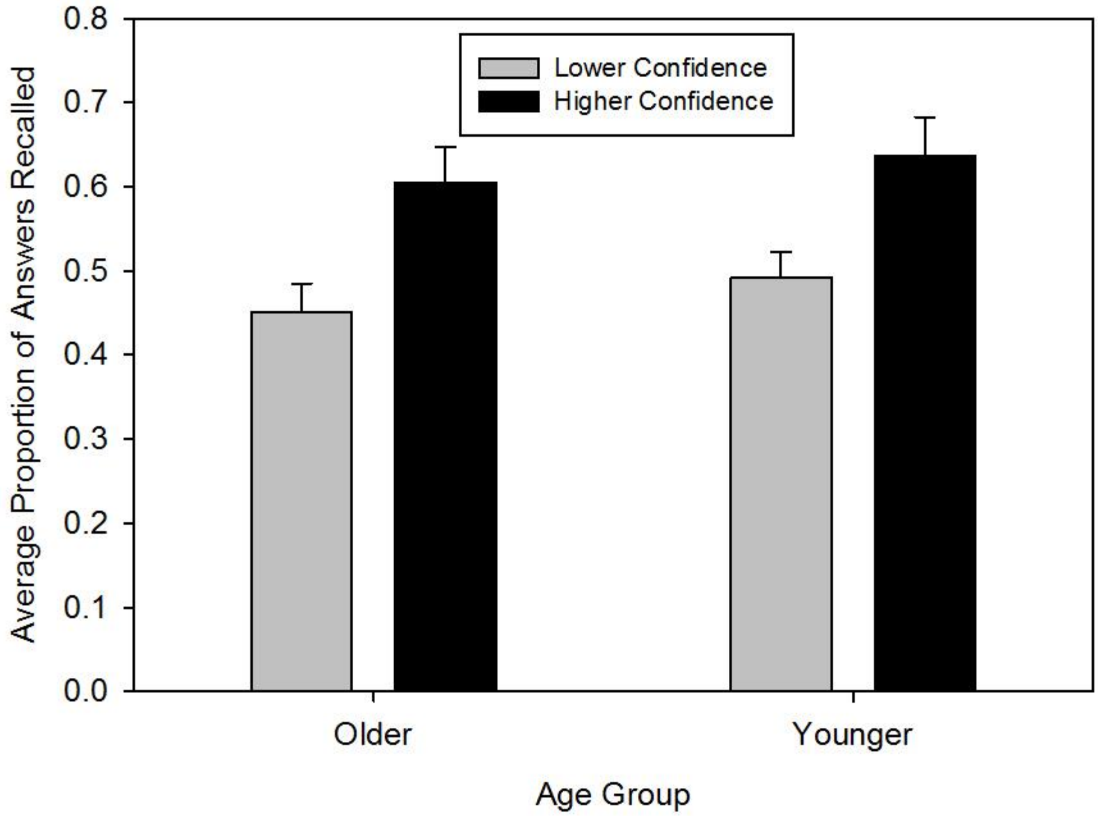

Figure 5.7. Figure 5.7 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 1 week) for questions given higher versus lower confidence ratings in Experiment 5. Error bars represent standard error of the mean.

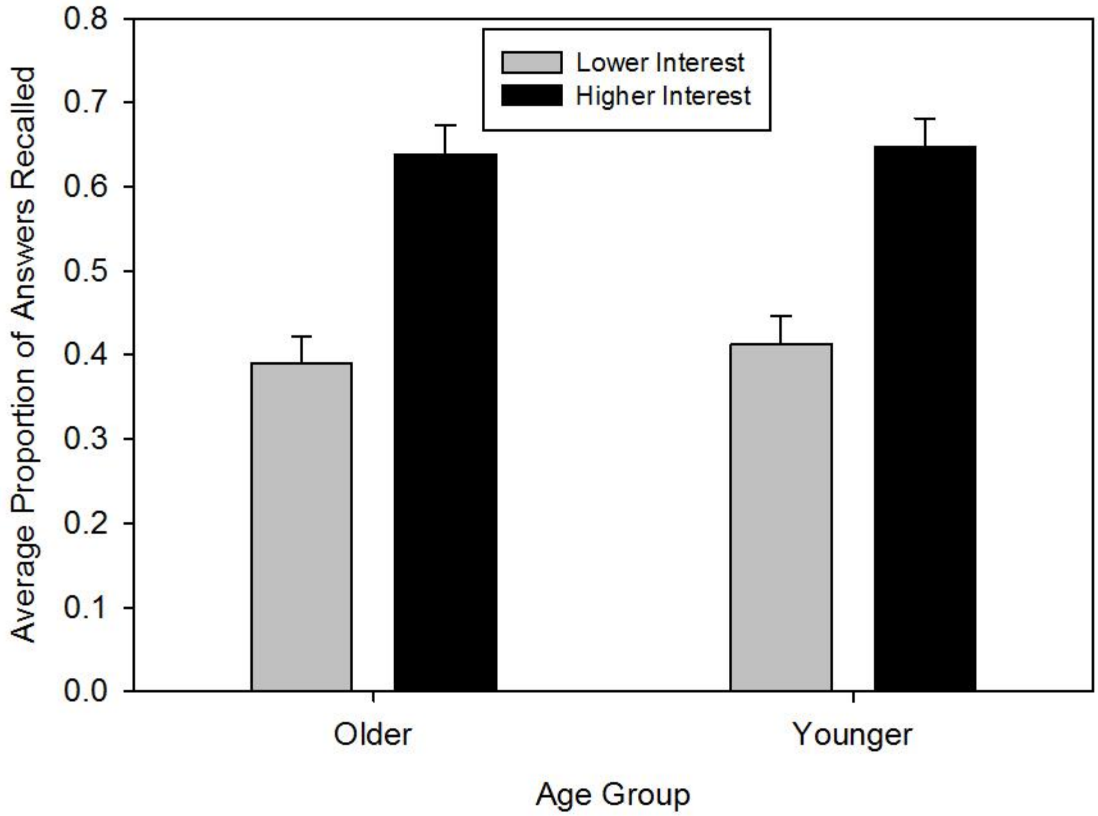

Figure 5.8. Figure 5.8 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 1 week) for questions given higher versus lower post-answer interest ratings in Experiment 5. Error bars represent standard error of the mean.

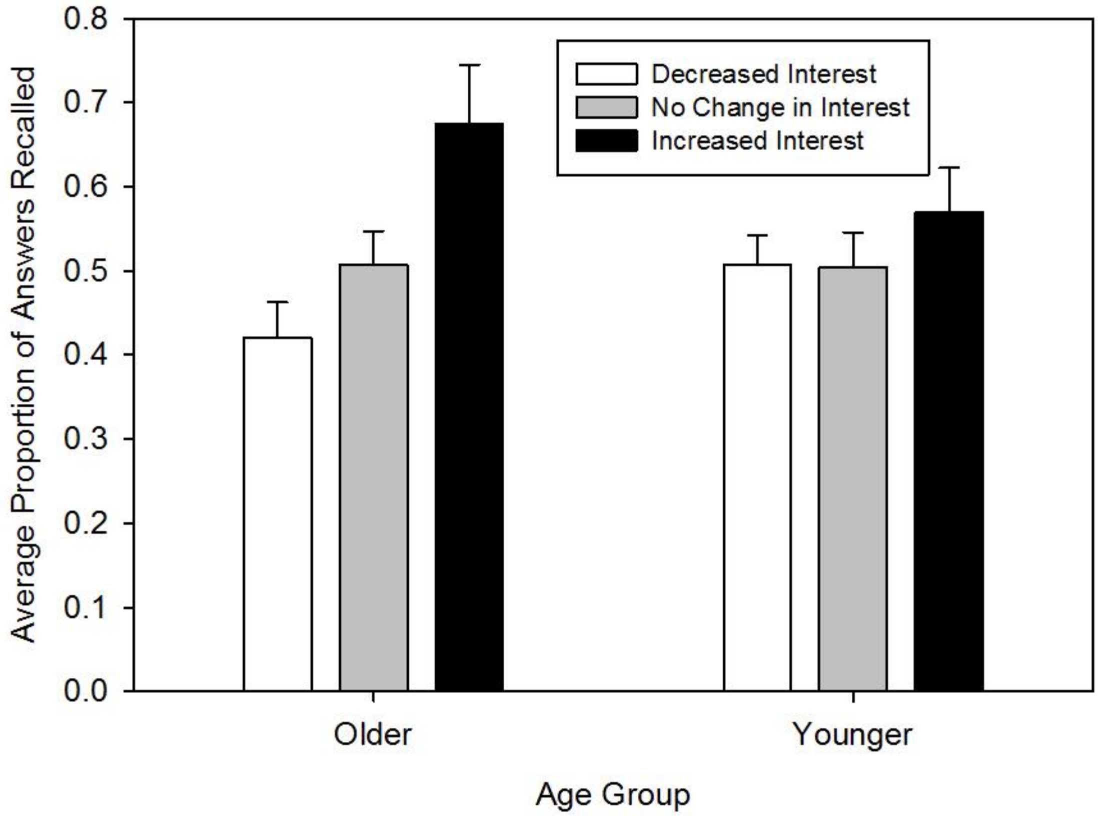

Figure 5.9. Figure 5.9 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 1 week) for questions that had decreased, the same, or increased ratings of interest compared with the initial curiosity in Experiment 5. Error bars represent standard error of the mean.

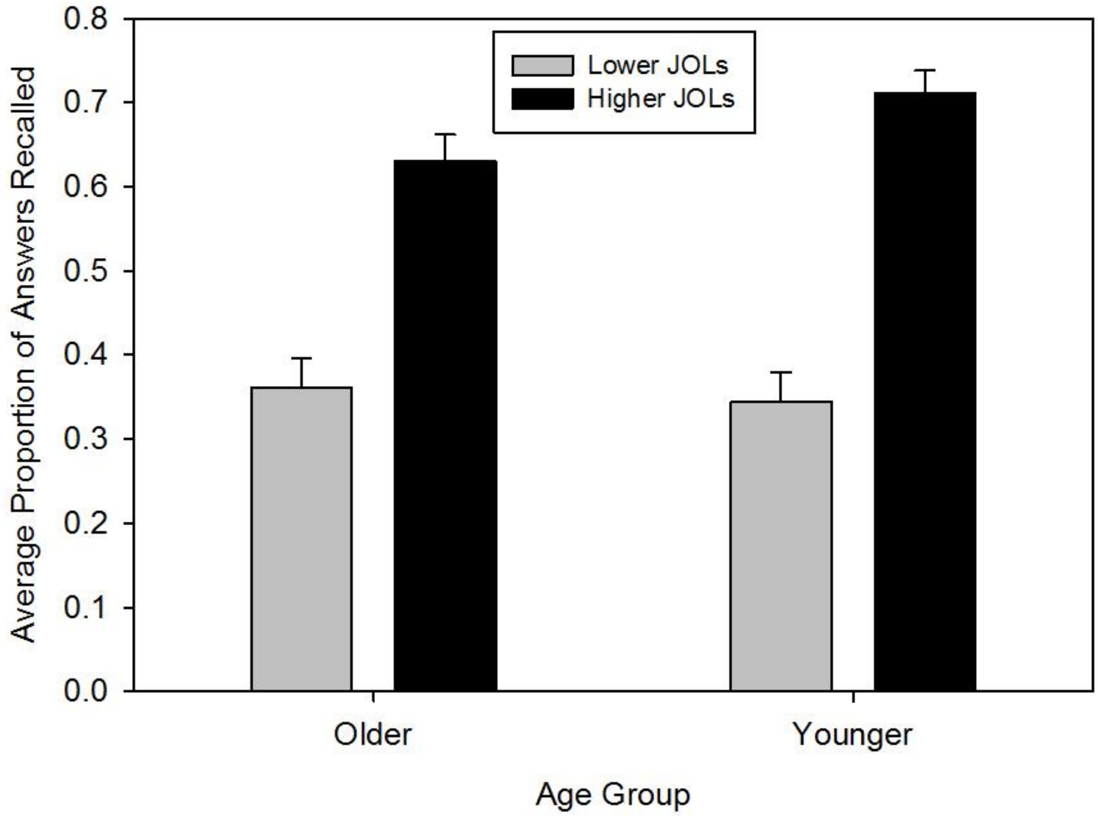

Figure 5.10. Figure 5.10 displays the average proportion of answers recalled by younger and older adults after a longer delay (~ 1 week) for questions given higher versus lower JOLs in Experiment 5. Error bars represent standard error of the mean.

Chapter 4 – Summary, Conclusions, and Future Directions

Summary of Findings

The studies in the current dissertation were conducted in order to assess older and younger adults' ability to remember information that is subjectively more valuable, important, or interesting. Furthermore, the studies examined the degree that metacognitive processes both influenced and were influenced by ratings of either value or interest. Experiments 1, 2 and 3, examined older and younger adults' ability to utilize strategic metacognitive monitoring and control to recall information that was assigned value by the participants, whereas Experiments 4 and 5 examined the extent to which factors such as subjective interest and curiosity to learn impacted older and younger adults' memory performance and metacognitive judgments.

A novel metacognitive paradigm in which participants provided value-driven judgments of learning was used in Experiments 1, 2, and 3. Within the task, participants were asked to assign point values to words, word pairs, or items associated with scenarios, and consequences were associated with these judgments. The primary aim of these studies was to examine the extent that factors such as task experience, associative relatedness of the items, and semantic knowledge influenced older and younger adults' ability to use and assign value in a strategic manner, and investigate the extent to which individuals were able to recall this higher value information.

In Experiment 1, older adults recalled fewer words than younger adults, consistent with typical findings of age-related deficits in memory (e.g., Craik & Salthouse, 2008), and task experience did not moderate this age-related difference. Despite age differences in memory, no age-related differences in metamemory accuracy were observed, consistent with prior research (Connor et al., 1997; Hertzog & Dunlosky, 2011; Hertzog et al., 2002; Hertzog et al., 2010).

Younger and older adults displayed a roughly equivalent ability to recall the information assigned higher subjective value judgments. Importantly, metacognitive accuracy increased substantially with task experience. Overall point scores also showed sizeable increases with task experience, although older adults obtained lower point totals compared with younger adults. In regard to the strategic use of value, both younger and older adults increased the number of 0 values used with task experience, correcting initial overconfidence in how many items could be recalled. With task experience, both younger and older adults assigned the 10 point value more often (although it took longer for older adults to adopt this pattern). Given the increase in metacognitive accuracy, the increase in point scores, and the very low number of words recalled that were assigned a 0, it suggests that both age groups were able to implement appropriate strategies and effectively recall words assigned the highest values.

Experiment 2 adapted the paradigm and replaced the materials with related and unrelated word pairs. While older adults bet on fewer items, recalled fewer items, and achieved lower scores compared with younger adults, both age groups displayed exceptionally high metacognitive accuracy, and in fact older adults' accuracy was slightly higher than that of younger adults. Furthermore, age-related differences in recall and overall point value were eliminated for the related word pairs. Age-differences observed for the unrelated word pairs is consistent with typical age-related deficits in associative learning (Naveh-Benjamin, 2000; Naveh-Benjamin et al., 2003; Old & Naveh-Benjamin, 2008). Also consistent with prior research, when older adults were able to rely to some extent on verbal or semantic knowledge (i.e., when the word pairs were related), age differences were reduced (McCabe et al., 2010; Naveh-Benjamin et al., 2003). In regard to task experience, both older and younger adults' point score increased with experience, although older adults took longer than younger adults to display this improvement. Metacognitive accuracy showed only marginal improvements with task experience, and only among older adults, although accuracy was close to perfect for both age groups. Lastly, both younger and older adults demonstrated strategic assignments of point values with task experience. Both younger and older adults assigned more 10 point values with task experience, particularly for related pairs, suggesting effective strategies that helped maximize score. Furthermore, older adults, who had larger initial overconfidence, utilized the 0 point value more frequently on later lists, and learned to assign lower values to the unrelated word pairs.

Experiment 3 more closely examined the influence of semantic, or more specifically, schematic knowledge on memory and metacognitive accuracy and strategy. No age-related differences were observed in regard to recall performance, point score, or metacognitive accuracy. The lack of age-related differences in overall recall, while uncommon, is consistent with studies that suggest that older adults show a substantial benefit in memory performance when schematic support is available (Besken & Gulgoz, 2009; Castel, 2005). However, unlike what was found in Experiments 1 and 2, metacognitive accuracy did not improve with task experience. Point scores did show some improvement for both younger and older adults with task experiences, and looking at the pattern of results displayed in Figures 3.4B and 3.4C, this could be accounted for by the increase in the number of 10 point values assigned on later lists, indicating potential prioritization or sensitivity to gains (i.e., obtaining higher point scores).

Experiments 1-3 all utilized a paradigm in which motivation to recall the items assigned higher values was at least partially driven by the goals and demands of task (e.g., emphasis place on gaining points and avoiding losing points). Experiments 4 and 5, however, examined the extent that motivation to remember occurred as a result of varying levels of subjective interest or curiosity in the content of the material itself. Furthermore, these experiments examined whether higher confidence errors resulted in better memory performance (Experiments 4 and 5), and the degree that interest and curiosity impacted metacognitive judgments, as well as the accuracy of metacognitive judgments overall (Experiment 5).

In Experiment 4, higher ratings of curiosity in learning answers to unknown questions led to increased benefits in memory for both younger and older adults after a long delay, consistent with and expanding upon what has been found with younger adults (Kang et al., 2009; Murayama & Kuhbandner, 2011). Furthermore, the magnitude of the effect of curiosity on memory was roughly equivalent for both younger and older adults, although older adults recalled fewer correct answers than younger adults. Higher confidence errors were also associated with increased memory performance after a delay by younger and older adults, consistent with findings of the hypercorrection effect and suggesting increased processing may occur in order to correct high confidence errors (Butterfield & Metcalfe, 2001, 2006; Cyr & Anderson, in press).

Experiment 5 was conducted in order to replicate and expand upon that which was observed in Experiment 4. Along with initial curiosity and confidence ratings, after participants were shown the answer, ratings of interest and metacognitive judgments (i.e., JOLs) were collected. Assessing subjective interest both before and after an answer was learned allowed for the examination of change in interest level (i.e., difference between the rating of initial curiosity to learn the answer and interest rating once the answer was known). After a week delay, both older and younger adults recalled an equivalent number of answers, recalled more answers to questions given higher compared with lower initial curiosity ratings, confidence ratings, post-answer interest ratings, JOLs, as well as well as for questions in which interest level increased from initial levels compared to when it decreased after the answer was displayed. The magnitude of the gamma correlations (except change in interest) suggest that ratings of curiosity, magnitude of confidence in errors, post-answer interest, as well as JOLs are able to distinguish between what is more or less likely to be later recalled. However, the gamma correlations between interest ratings and memory, and between JOLs and memory showed the highest degree of association. Furthermore, curiosity, post-answer interest, and JOLs were also highly correlated with one another; confidence ratings were only correlated with initial curiosity, and only for younger adults. These results suggested that interest and curiosity were possibly used to help inform JOLs during learning. Lastly, the results indicated that some effect of initial curiosity, interest, and monitoring accuracy are present after a one hour delay, but extremely high levels of memory performance by both age groups makes this conclusions somewhat speculative.

Conclusions and Implications

For many decades, much of the cognitive aging literature has focused on deficits. Furthermore, a number of cognitive aging theories focus largely on causes of why memory deficits are present in older adulthood. While, of course, it is vital to understand the limitations older individuals may face, and potential causes of deficits, it is equally as important to fully explore and understand the constellation of factors that mitigate deficits and speak to older individuals' ability to maintain a high quality of life and healthy functioning. In fact, in recent years there has been a call among cognitive aging researchers to test and further explore factors that can moderate age-related memory deficits (e.g., Hess & Emery, 2012; Hess, Germain, Rosenberg, Leclerc, & Hodges, 2005; Zacks & Hasher, 2006). The current studies directly examined how subjective value and interest, which are a fundamental part of our everyday lives, impacted both memory and metacognitive performance among older and younger adults.

The findings of intact metacognitive functioning across all of the experiments suggest that insight into, and understanding of one's memory capabilities is not negatively impacted during the aging process, and at times older adults might even be more accurate than younger adults (Experiment 2). In Experiments 1-3 older and younger adults were able to strategically assign value and later recall these higher value items, displaying proficiency in both monitoring and control over encoding processes. In typical tasks assessing metamemory monitoring, there is no real incentive for judgments of learning to be accurate. However, in the real world, there are often consequences associated with metacognitive judgments. The results suggest that when consequences are present, individuals are likely to exhibit better metacognitive accuracy than is typically observed in most studies, and perhaps metacognitive abilities of both younger and older adults has been somewhat underestimated.

This relative sparing of metacognitive abilities, in light of some deficits in explicit memory abilities, suggests that older adults may be able to use metacognitive strategies or awareness to help overcome or compensate for age-related declines in memory performance. In fact, it has been suggested that training metamemory monitoring and control could serve to better inform or perhaps be even more beneficial than general memory training strategies for older adults (Hertzog & Dunlosky, 2011). The results of the current studies suggest that robust metamemory capabilities are present in older adults, and with some motivation or incentive, older adults can learn to effectively employ their understanding of their own memory in a strategic manner in order to achieve goal-relevant outcomes. This finding has implications not only for memory training programs, but also speaks to older adults' ability to maintain healthy cognitive functioning in everyday life.

A central and perhaps quite critical memory-related goal in many individual's lives, and perhaps particularly older adults, is to be able to remember information that one actually cares about or is interested in. Experiment 4 and 5 found increased interest as well as curiosity in learning an unknown fact was equally associated with long-term memory in both older and younger adults. Although some prior studies, as well as the selective optimization with compensation theory, would suggest that perhaps older adults' memories would be affected to a larger degree by interest than would younger adults (e.g., Baltes & Baltes, 1990; Germain & Hess, 2007; Hess et al., 2001), this differential effect of age was not observed. What is clear, however, are that the mechanisms that lead one to be able to recall more interesting information compared with less interesting information are intact during the aging process. Despite potential deficits in attentional resources (Anderson et al., 1998; Craik & Byrd, 1982; Park et al., 1989; Rabinowitz et al., 1982), the results suggest that interest might serve to direct attentional resources and facilitate encoding of information. The findings from all of the studies indicate that when motivation to remember, either in the form of task-related goals or goals related to one's own unique interests are present, older adults are able to recruit the necessary attentional resources that can ultimately result in better memory for the important information.

In addition to the relationship between metacognitive monitoring judgments and memory, and interest and memory, Experiment 5 was perhaps the first to demonstrate the close relationship between interest and judgments regarding what one believes will be remembered. The results suggest that not only is one's interest level predictive of later memory performance, but it is cue that both younger and older adults likely consider when forming a JOL. Furthermore, the finding that JOLs were somewhat more accurate than ratings of interest in differentiating between what was remembered versus forgotten indicate that participants' judgments were not overly "captured" by their interest level. Despite the fact that JOLs were provided immediately after the interest ratings, it would appear that both younger and older adults are able to use cues beyond just their interest to help inform a more accurate judgment of whether the fact would be later remembered.

From a broader perspective, the current studies could help inform and improve theories of cognitive aging, and well as theories of learning and memory more generally. Specifically, the findings suggest that motivational and goal-related influences from both internal sources (e.g., subjective interest or curiosity in Experiments 4 and 5) as well as external sources (e.g., remembering the information given a higher strategic value in Experiments 1-3) have a sizable impact on older and younger adults' memory performance. The findings also suggest that while older adults are selective in how they engage their cognitive resources (SOC theory; Baltes & Baltes, 1990), younger adults, at times, also demonstrate a similar degree of selectivity.

Future Directions

Although subjective value judgments and ratings of interest and curiosity were highly predictive of later memory performance, the underlying mechanisms as to why this occurred were not examined in the current studies. In Experiments 1-3, participants were quite accurate in recalling items they had assigned higher values. However, the studies did not ask participants to report whether they were engaging in behaviors such as using mnemonic strategies for items assigned these higher values. Thus, it is unclear if the extent to which assigning a high value and knowing there was a consequence associated with that judgment led to increased rehearsal, attention, or additional elaborative processing of that item.

Furthermore, the potential causes of why older and younger adults were able to recall more answers to questions that received higher ratings of curiosity and interest were not examined. In Kang et al. (2009), higher curiosity in younger adults was associated with activation in brain regions associated with reward learning, and it is suggested that this reward incentive can serve to increase attention. It would be informative to investigate whether disrupting attention during encoding by implementing a divided attention task would be sufficient in reducing the effect of interest on memory performance, and whether this would have a large detrimental impact on older or younger adults' memory. Utilization of divided attention paradigms could help better ascertain the extent that attention is the ultimate mechanism promoting better memory for interesting materials.

It should also be noted that at the time of the long-delay test, there were other potential factors that could have impacted one's ability to recall specific trivia question answers. One simple explanation is that high interest questions also resulted in higher rates of spontaneous rehearsal. That is, participants may have continued to think about some of the new facts learned, or even talked about them with other individuals. Although casual comments made by many of the participants during the long-delay test would suggest this was not the case for all individuals, it certainly could have had some effect on the results, and should be better quantified in future studies in order to rule out this possibility.

Another factor that was not examined that could have had an influence on both memory performance as well as ratings of curiosity, confidence, interest, and JOLs is prior knowledge. Although all questions that individuals knew the answer to were not included in any analyses, prior knowledge of a general topic could still have impacted the results. Topics we know quite a bit about are often those in which we are interested in, which could have led to higher ratings of curiosity, confidence that a guess would be correct, and interest once the answer was known. Importantly, when one already has a semantic knowledge network surrounding a specific topic, it can then be somewhat easier to incorporate and learn a new piece of information that is associated with this knowledge base (e.g., Soederberg-Miller, 2003). For example, if one has a great deal of knowledge about constellations but does not necessarily know which one is the largest, when told it is hydra this information is likely to be better incorporated into one's knowledge set compared with an individual who knows very little about constellations. Thus, future studies investigating subjective interest would be well served to also consider and assess individual differences in prior knowledge as a potentially important moderating variable.

Although the current studies examined subjective value and interest, objective value has also been shown to have a large impact on older and younger adults' memory performance and metacognitive strategies (e.g., Castel et al., 2002; Castel et al., 2013; Soderstrom & McCabe, 2011). An interesting future avenue of research could investigate the relative strengths and interaction between both objective and subjective measures of importance, as well as the extent to which these factors were associated with memory after a delay. Prior studies that have reported better recall of information participants are explicitly told is more important typically do not measure memory performance at a long delay. Thus, it is unclear whether objective value has the same long-term effect on memory performance as does subjective importance or interest. A similar study to Experiment 5 could be conducted, with a portion of the questions marked as "high value," and associated with monetary rewards if remembered. It would be beneficial to do an immediate test (where most of the answers would be known) in order reduce expectancy of a long-delay test, but of course include the surprise test after a 1-2 week delay. It could be the case that subjective value would influence memory after the delay (as was observed in the current studies), but perhaps the effect of objective value would be less robust.

In conclusion, there are numerous factors, including but not limited to value, that have a substantial ability to impact one's memory. It is crucial to fully explore and understand the relationships between these various memory-moderating factors as well as the degree to which they affect memory, particularly for older adults. Older adulthood is often accompanied by a number of major life-decisions in areas such as health care, retirement, and financial planning. Making effective decisions often requires learning new information and ultimately prioritizing and organizing that information. Once the factors and mechanisms supporting the facilitation of memory (and metacognitive control) are better understood and fully explored, they could serve to assist fields such as information dissemination in a way that assists learning, prioritization and enhances quality of everyday functioning for older adults.

Appendix A

Lists of items used in each of the scenario lists in Experiment 3.

Going Camping	Going on Vacation	Child's Party	Going to Class	Making Lasagna	Going on a Picnic
bug spray	pants	cake	calculator	butter	plates
soap	shampoo	games	notebook	parmesan	blanket
cups	socks	presents	snack	ground beef	coleslaw
tarp	shorts	cooler	watch	olive oil	thermos
tent	book	video camera	highlighter	spinach	basket
wood	camera	face paint	chapstick	onions	cookies
table cloth	sunscreen	music	pencil	salt	juice
chair	shirts	clown	cell phone	fennel seeds	jacket
cards	razor	streamers	kleenex	eggs	napkins
boots	towel	pens	sweater	parsley	cheese
lantern	toothbrush	band aids	paper	milk	radio
ax	batteries	juice	keys	basil	candles
marshmallows	swimwear	pretzels	comb	flour	bread
whistle	medication	pizza	eraser	noodles	apples
hot dogs	snorkel	balloons	water	tomatoes	watermelon
clock	map	flowers	wallet	oregano	potato salad
sleeping bag	sandals	grapes	glasses	garlic	pillows
shovel	passport	piñata	tape recorder	mushrooms	frisbee
matches	ziploc bags	invitations	ruler	ricotta	chicken
trash bags	sewing kit	tables	textbook	bell pepper	knife

Appendix B

Trivia questions and answers used in Experiment 4 and 5. The questions marked with an asterisk (at the end of the list) are those that were removed in Experiment 5, and the questions that replaced these are included at the bottom of the Appendix.

Question	Answer
What is the slowest swimming fish in the world?	seahorse
What mammal sleeps the shortest amount each day?	giraffe
What city has the shortest name in the world?	Y (France)
Who was the first person to use the V sign as a victory sign?	Winston Churchill
What is the only planet in our solar system that rotates clockwise?	Venus
What is the only consumable food that won't spoil?	honey
What product is second, only to oil, in terms of the largest trade volumes in the world?	coffee
What is most common first name in the world?	Mohammed
What country has the highest population density?	Monaco
What fish produces more than 200 million eggs at a time?	sunfish
What handicap did Thomas Edison suffer from?	deafness
What snack food can be used as an ingredient in the explosive dynamite?	peanuts
What was the first animated film to be nominated for an Oscar for best picture?	Beauty and the Beast
What Beatles song lasted the longest on the American charts?	Hey Jude
What part of a woman's body were ancient Chinese artists forbidden to paint?	foot
What food will made a drug test show up positive?	poppy seeds
Setting a world record, how many days can a human stay awake?	11
What is the longest common English word without any vowels?	rhythm(s)
There are five halogen elements including Fluorine, Chlorine, Bromine, and Astatine. What is the name of the fifth?	Iodine
What is the name of the island country that lies off the southeast coast of India?	Sri Lanka
What was a gladiator armed with in addition to a dagger and spear?	net
In what country is Angel falls, the tallest waterfall, located?	Venezuela
What is the monetary unit of Korea?	Won
What is the biggest constellation in the sky?	hydra
What is the oldest written code of law in history	Hammurabi's code
What was the first product to have a bar code?	Wrigley's gum
What note do most American car horns beep in?	F
What is the name of the instrument used to measure wind speed?	anemometer
What instrument was invented to sound like a human singing?	violin
What organ of the buffalo did Plains Indians use to make yellow paint?	gallbladder
What city is referred to as the Pittsburgh of the South?	Birmingham, Alabama
What animal's excrements are consumed as a luxury food?	bats
What industry used 20% of China's harvested plants?	medicine
What city has the only drive thru post office in the world	Chicago
What did girls in medieval Spain put in their mouths to avoid unwanted kisses?	toothpicks
Who was the first Christian Emperor of Rome	Constantine
What world capital city has the fewest cinemas in relation to its population?	Cairo, Egypt

The Gold Coast is now known as what country?	Ghana
In parts of India, the older brother must marry first. If he cannot find a wife, what can choose to marry?	a tree
What was the first nation to give women the right to vote?	New Zealand
What is the only country in the world that has a bible on its flag?	Dominican Republic
What trade was Greek philosopher Socrates trained for?	stonecutting
What reptile, according to ancient legend, was able to live in fire?	salamander
What unit of measurement is used for fuel wood?	cord
*In what Western city did the Pony Express route end?	Sacramento
*What crime is punishable if attempted, but not if committed?	suicide
*What is the only type of lizard that has a “voice”?	gecko
*What Disney character’s name mean pine head in Italian?	Pinocchio
*What creature proved to be much faster than a horse during a race in 1927?	kangaroo
*What is the most common, non-contagious, disease in the world?	tooth decay
*What country has a national flag with five corners in its shape?	Nepal
*What book is the most shoplifted book in the world?	The Bible
*What is the only type of animal, beside a human, that can get a sunburn?	pig
*In what country is the Angkor Wat located?	Cambodia
*What is the abbreviated name of the geopolitical and economic unit located in southeast Asia?	ASEAN
*What organ is only found in vertebrates (animals with a backbone)?	liver
*What has a national anthem with only 32 characters?	Japan
*What city has the longest name in the world?	Bangkok (Krung Thep Maha Nakhon)
*What is the only type of mammal, besides a human, that can play the video game Pac Man?	Bonobo monkey
*What invention should make T’sai Lun, a second century inventor, a household name?	paper

Questions used in Experiment 5 to replace those marked with an * from Experiment 4.

Question	Answer
What is the hardest natural substance known?	diamond
What has the only type of product ever promoted by Elvis Presley in a television commercial?	donuts
Before the barometer, what animal did German meteorologists use to predict air pressure changes?	frog
What was the name of Smokey the Bear’s mate?	Goldie
What is the only type of bird that has nostrils at the tip of its beak?	kiwi
What novel contains the longest sentence in literature with 832 words?	Les Miserables
Which scientist was the first to receive the Nobel Prize twice?	Marie Curie
What is the name of scientific scale used for measuring the hardness of rocks?	Moh’s scale
What vegetable did ancient Egyptians place in their right hand when taking an oath?	onion
What 17^{th} century artist painted more than 60 self-portraits?	Rembrandt
Which metal is the best conductor of electricity?	silver
What organ destroys old red blood cells?	spleen
What American novel was the first to sell over 1 million copies	Uncle Tom’s Cabin
What gas forms almost 80% of Earth’s atmosphere	nitrogen
What was Dr. Frankenstein’s first name?	Victor
With what product did the term “brand name” originate?	whiskey

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