THE INFLUENCE OF KNOWLEDGE AQUIRED AT STUDY ON YOUNGER AND OLDER ADULTS' SOURCE MEMORY

by

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ABSTRACT

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AT STUDY ON YOUNGER AND OLDER

ADULTS' SOURCE MEMORY

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The current experiments were intended to investigate the tendency of younger and older adults to use knowledge acquired during encoding to guide source memory judgments at test. Participants studied a list of words with each word belonging to one of four categories. Each category, and the words chosen for that category, were assigned to a corner of the computer screen which contained one of four mathematical probability structures, 100%, 75%, 50%, and 25%, reflecting how many exemplars from a given category was to be presented in it. Both older and younger adults learned and later used the probability structure to guide source memory judgments. Additionally, Experiment 1 observed that dividing the attention of younger adults hindered their ability to do this. Experiment 2 found that the implementation of this new knowledge appears to be automatic considering that requiring younger adults to respond quickly did not hinder their ability to infer a word's source based on the probability structure.

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CHAPTER 1

INTRODUCTION

By the year 2030, it is predicted that adults 65 years of age and older will make up roughly one fifth of the population (Administration on Aging, 2007). Such a staggering number stresses the importance of identifying the concerns of older adults and how best to accommodate them. Older adults commonly report memory difficulties with the fear of losing their memory being one of their chief concerns (Cavanaugh, 1996). Such concerns are well justified. Normative age-related changes in memory are well established, emphasizing the importance of developing strategies that can be used to improve the memories of older adults. Yet, the development of such strategies requires a basic understanding of memory and how it changes across the lifespan. A fundamental goal of the proposed research is to add to the current understanding of normative age-related changes in memory function.

Past research has established that 1) memory is composed of many aspects, and 2) there are normative age-related changes in some aspects of memory, but not others (Jennings & Jacoby 1993; 1997; Mitchell, Johnson, & Mather, 2003; Mitchell, Johnson, Raye, Mather, & D'Esposito, 2000). In these regards, a distinction is commonly drawn between memory for items that occurred in the past and memory for the source of those items. Research has shown that older adults have lower performance on source memory tasks opposed to younger adults, but perform equivalently to younger adults on item memory tasks (Chalfonte & Johnson, 1996; Mitchell et al., 2003; Mitchell et al., 2000). For example, Chalfonte and Johnson (1996) had younger and older adults study pictures of common objects placed in cells of a 7 x 7 array. Participants were to attend to the objects and their location. When later asked to complete a recognition memory test for the previously studied objects, older and younger adults performed equally well. However, when participants tried to identify the objects and the location in which they were presented within the 7 x 7 array, older adults performed significantly worse than the younger adults. These and related data (Jennings & Jacoby, 1993; 1997; Mitchell et al., 2003, Mitchell et al., 2000) clearly demonstrate older adults to have deficits in their ability to identify the source in which an item was presented. Yet, these data also highlight that the ability to recognize past events remains relatively invariant across the lifespan.

1.1 Recollection and Familiarity

One explanation offered for age-related deficits in source memory is drawn from research examining the contribution of recollection and familiarity to memory judgments (Jacoby, 1999; Jennings & Jacoby, 1993; 1997). According to this account, normative age-related deficits in source memory are explained by changes in the ability of individuals to recollect the past. When individuals recollect an event, they experience their memory for the event at a conscious level of awareness. Recollected events include contextual details, such as source identifying information. In contrast, familiarity is experienced at an unconscious level of awareness, and it is an automatic opposed to controlled process. Furthermore, familiarity does not include contextual details, and consequently individuals make memory decisions based on the extent to which an event seems familiar to them.

Jacoby (1991; 1996) used source judgments to differentiate between recollection and familiarity in his process dissociation procedure. For example, Jennings and Jacoby (1993) had older and younger adults study a list of names. Some names were visually presented while others were auditorally presented. Afterwards, participants completed a recognition memory test under either inclusion or exclusion instructions. For inclusion instructions, participants were asked to accept all old names regardless of the form in which they were presented during study. For exclusion instructions, participants were asked to accept only those names they had heard. Older adults were just as successful as the younger adults at recognizing previously studied names under the inclusion instructions. Yet, under exclusion instructions, older adults were not as capable as younger adults at correctly rejecting visually presented names. Thus, they falsely accepted more of those names they had read at study relative to younger adults. Such data suggest older adults relied more on familiarity than recollection. Whereas, younger adults were better able to recollect the past and use this ability to more accurately respond under the exclusion instructions. Given these findings, age-related differences in source memory could result from the decreased ability of older adults to recollect the past (Rhodes, Castel, & Jacoby, 2008). Moreover, an overreliance on familiarity results in older adults committing more source memory errors than younger adults (Jennings & Jacoby, 1993; 1997).

1.2 Knowledge-Based Memory Strategies

Yet, the two processes of recollection and familiarity cannot account for the observed age differences in memory in their totality. For example, participants could use their knowledge of the world to guide their memory performance, and older adults could potentially use such knowledge to compensate for deficits in source memory. In certain instances, knowledge can be acquired during study and used to assist individuals at performing memory tasks. Higham and Brooks (1997) demonstrated participants to use a tacit strategy (i.e., mathematical average such as word frequency and word length) to aid recognition memory. During their first experiment, participants studied a list of low frequency nouns consisting of 7-8 letters on average. At test, participants viewed words that had not been presented to them at study, along with words that had been presented. Test words that had not been presented at study were either inconsistent with the study environment in that they did not share the same word frequency or word length as studied words, or consistent in that they conformed to those characteristics. Participants used their knowledge of the study environment to accurately reject nonpresented words, which did not conform to the characteristics of the words presented at study, thus providing evidence for the use of a knowledge structure (i.e., knowledge of perceptual characteristics used at study) to constrain judgments on later memory tasks.

However, these results do not directly contradict a familiarity account. Participants could have responded to items based on feelings of familiarity stemming from the ease at which test items are recognized based on their speed of processing (i.e., perceptual fluency; Jacoby & Dallas, 1981). In particular, the inconsistent items likely would not have been processed with the same ease as items that were consistent with the structure of the study environment, thus evoking relatively lower feelings of familiarity.

Similarly, Mather and Johnson (2003) conducted a study to investigate the use of schematic knowledge in memory reconstruction and memory performance. Older and younger adults read a story, and then thought about the facts of the story (factual review), their emotions elicited by the story (affective review), or countries that begin with *A* (no review). Participants then completed a distractor task, followed by a questionnaire in which they described what they thought about during the review session. When the participants returned the following week, they completed a second questionnaire in which they again described what they thought about during the review session. They then performed an unrelated distractor task and completed recall and recognition tests. The recognition test included previously presented items (i.e., targets), inference items that were new, but schematically consistent with the story, and new items that were schematically inconsistent. Following the memory tests, older adults completed neuropsychological testing that measured higher order reflective processes.

Both older and younger adults used schematic knowledge to guide their recognition memory judgments and falsely accepted inference items that were schematically related to target items. However, the degree to which the older and younger adults relied on their schematic knowledge varied. Older adults relied heavily on schematic knowledge to guide recognition memory performance in both the affective and factual review conditions. Yet, younger adults only relied heavily on schematic knowledge in the affective condition. The authors concluded, based on the results from the memory tests in conjunction with the neuropsychological tests, that the older adults relied on schematic knowledge to compensate for deficits in their ability to implement more complex reflective processes that could have assisted them in making source memory judgments.

In a subsequent study conducted by Mitchell, Johnson, and Mather (2003), younger and older adults studied video scenes. Afterwards, they completed a series of questions that included details that actually occurred in the original scene along with details that had not been present (i.e., post-suggested information). After a short delay, participants completed a source memory test, which included items that were composed of video-only information, post-suggested information, both, and neither. They were asked if they recognized the item, and then asked to provide its source. Older and younger adults correctly recognized previously presented items at equivalent rates. However, older adults were more likely to misattribute details that had only been introduced during questioning as having been present in the video. The authors suggested that these findings could have resulted from a tendency for older adults to rely on semantic information and their lack, failure, or inability to use perceptual or temporal source information to properly differentiate between information presented in different sources. Yet, the findings of Mitchell and her colleagues as well as those of Mather and Johnson (2003) could arguably be explained by recollection and familiarity. Specifically, source memory judgments could have been based on feelings of familiarity evoked by a test item's perceptual, schematic, or semantic relation to studied items.

However, there are instances in which participants will rely on a strategy for making memory judgments in addition to familiarity. For example, Odegard, Koen, and Gama (2008) observed individuals to use a strategy to guide their memory responses. Participants studied pairs of words that were semantically related to a particular category (e.g., CAT – HORSE, DOG - COW, TRAIN – CAR, BOAT – AIRPLANE). At test, participants were presented with a series of word pairs, some of which were intact (e.g., CAT – HORSE) and others that were rearranged. Rearranged word pairs were recombinations of pairs of words that had been presented at study. These word pairs were either consistent (e.g., CAT – COW), or inconsistent (e.g., BOAT - HORSE) with the semantic relationship provided at study. Even though both words in the inconsistent word pair had been previously presented, participants correctly rejected all of them. Such data indicate that a strategy was likely implemented to make these memory judgments. Moreover, the inconsistent rearranged word pairs should have been highly familiar because they were made up of studied words. Yet, these word pairs were always rejected, likely based on a strategy, such as rejecting any word pair that was inconsistent with the study environment.

Subsequently, Cooper and Odegard (under review) have replicated and extended the procedures of Odegard et al. (2008) to more directly test their conclusions by having participants self-report why they accepted or rejected test items. Furthermore, older adults participated in the study to determine the extent to which they could use this type of strategy. Older adults were just as good at correctly rejecting the inconsistent rearranged word pairs as were the younger adults. These results indicate that both younger and older adults can, at times, use a strategic process based on knowledge acquired at study to reject inconsistent rearranged word pairs. Moreover, older and younger adults self-reported having rejected these items based on their overall consistency with the nature of the study environment (e.g., “these words are not related so they could not have been shown together”). Additionally, younger and older adults correctly accepted the intact word pairs at equivalent rates. However, the self-report data indicate younger and older adults to have used different processes to achieve this equivalent performance. Younger adults self-reported using recollection, while the older adults self-reported using knowledge of the study environment. Such data demonstrate that the older adults relied on knowledge-based memory processes, while the younger adults relied predominately on recollection. However, there are drawbacks to relying on knowledge-based memory processes to guide memory judgments. Older adults falsely accepted more consistent rearranged word pairs than the younger adults due to their overreliance on knowledge-based memory processes.

Such findings (Cooper & Odegard, under review; Odegard et al., 2008) cannot be completely explained by recollection and familiarity. Instead, memory judgments based on strategic processes of memory can be better explained by the source monitoring framework (Johnson, Hashtroudi, & Lindsay, 1993). This framework suggests that source memory requires more differentiation than item memory (i.e., old/new recognition) and that source memory judgments are based on the characteristics of the memory in combination with judgment processes. More specifically, the characteristics that accompany a memory are monitored for their likely source. For example, in order to determine if an action was enacted or only imagined, a person would weigh the characteristics of the memorial representation of that action. In such instances, kinesthetic information (i.e., memory for body movements) would be highly diagnostic (Johnson, Foley, Suengas, & Raye, 1988; Johnson & Raye, 1981). Thus, memories for actions that are accompanied by greater kinesthetic information would likely be judged as having been enacted. In line with the source monitoring account, participants are more likely to indicate that an event had been enacted if more kinesthetic information accompanies its memorial representation, even if it had only been imagined (Lampinen, Odegard, & Bullington, 2003).

Additionally, Gonsalves and Paller (2000) conducted a study to investigate the ability of individuals to correctly judge whether or not common objects had been imagined or visually presented. During study, participants were cued with words corresponding to common objects, and were asked to visualize the object that went with that word. After the word was presented, and the participant had time to visualize the object, a picture of that object was either visually presented or nothing was presented. At test, participants occasionally stated having seen pictures of objects they had only imagined (i.e., false-memory illusion). Memories for imagined objects were accompanied by varying amounts of perceptual detail as measured by event-related potentials. Those imagined objects that had higher amounts of perceptual detail were judged as having been presented at study.

Both Lampinen et al. (2003) and Gonsalves and Paller (2000) observed participants to weigh certain memory characteristics (i.e., records of kinesthetic information or perceptual information) to make source judgments. In addition memory records of cognitive operations engaged during encoding, such as organizing, elaborating, retrieving, and identifying can also be used to aid source memory judgments (Johnson et al., 1993). For example, schemas activated during encoding can be reactivated at test and used in combination with judgment processes to guide source memory (Mather & Johnson, 2003). Furthermore, the reactivation of semantic information that was present at study, in combination with judgment processes, can also be used to increase recognition memory performance (Cooper & Odegard, under review; Odegard et al., 2008). However, the use of knowledge to aid in the reconstruction of the past does not always result in correct source decisions (Gonsalves & Paller, 2000; Lampinen et al., 2003; Mitchell et al., 2003).

1.3 Overview of Present Experiments

The current experiment is intended to investigate the tendency of younger and older adults to use knowledge acquired during encoding to guide source memory judgments. Additionally, the proposed research aims to examine whether there is an accuracy tradeoff when knowledge is used to guide source memory decisions. To achieve these goals, participants studied a list of words with each word belonging to one of four categories. Each category, and the words chosen for that category (i.e., exemplars), will be assigned to one of four corners of the computer screen, allowing for one category in each corner (i.e., quadrant). Each quadrant of the computer screen will contain one of four mathematical probability structures, 100%, 75%, 50%, and 25%, reflecting how many exemplars from a given category will be presented in it. The remaining exemplars from that category will be randomly placed into the other three quadrants.

The semantic relation of the exemplars, and the semantic knowledge participants have of category membership coming into the study, should allow for the participants to identify the categorical nature of the study list. Such knowledge should allow the participants to learn the probability structure that controls where the words are most likely to be presented based on category membership. At test, participants will be presented each study word, as well as new words, in a neutral location (i.e., center of computer screen). Some of the unstudied words will be semantically related to the words presented at study (i.e., missing exemplars), while others will not be semantically related to studied words (i.e., distractor exemplars). More specifically, participants will be asked to indicate if they saw the words at study (i.e., item memory) by identifying the location each was presented (i.e., source memory). Item and source memory accuracy will allow for the examination of how much participants rely on their semantic knowledge, as well as their probability knowledge, to guide their memory judgments during the memory test.

CHAPTER 2

EXPERIMENT 1

A hallmark of cognitive aging is a reduction in the cognitive resources available during encoding. Researchers have pointed to the fact that dividing the attention of younger adults while they are studying new information equates their performance to that of older adults on later memory tests as evidence of the reduced cognitive resources available to older adults during encoding (Anderson, Craik, & Naveh-Benjamin, 1998; Craik, 1982). Specifically, younger adults who have their attention divided at study have a decreased ability to recollect the past leading them to rely more on familiarity, and this pattern of performance is analogous to that of older adults (Jennings and Jacoby, 1993). Moreover, dividing attention at study greatly impacts the ability of individuals to remember the source in which they encountered studied items (i.e., source memory; Jennings and Jacoby, 1993; Troyer, Winocur, Craik, & Moscovitch, 1999), but reliance on familiarity can allow younger and older adults to recognize these items at equivalent rates. Considering source memory performance declines as a result of dividing attention, the current experiment was conducted to test the extent to which a probability structure may assist source memory judgments, and the extent to which dividing attention at study hinders the ability of individuals to acquire this information for use on a later memory test.

First, we need to address the impact of dividing attention on source memory. Specifically, why does dividing attention effect source memory? Attention is required to bind memorial features into a single bound memory representation. Thus, to the extent that attention is unavailable at encoding, the individual features that make up an experience may be encoded but they are not as likely to be bound into a single trace. When later presented with a studied item, a participant may well recognize the item as having been presented but it would likely not be bound to the specific location in which it was presented (Chalfonte & Johnson, 1993).

However, the categorical relationships shared among the studied words should be automatically acquired. Thus, dividing attention would not hinder the ability of an individual to encode a representation that items from a category were presented. Yet, binding this categorical representation to a particular location would likely still require attention (Brainerd, Reyna, & Mojardin, 1999; Odegard & Lampinen, 2005). However, if a participant realizes that all of the exemplars from a given category were presented in the same location, then all they have to do is remember the location in which one of the exemplars was presented and apply this location to all the items of that category.

2.1 Hypotheses

In the sections that follow, hypothesized age-related differences in item and source memory are outlined. Older adults typically demonstrate deficits in source memory, but show equivalent performance in item memory relative to younger adults. Yet, based on past research, such age-related deficits in source memory should be minimized when older adults use their knowledge of the past to help guide their memory judgments. For example, older adults should be able to use their memory of the studied categories to help identify which words were previously presented (i.e., item memory). Additionally, older adults should also be able to use the probability structure introduced at study to assist them in making source decisions (i.e., source memory). The use of knowledge in this manner could feasibly allow older adults to compensate for age-related memory deficits. Specifically, older adults have been observed to be less capable than younger adults at binding features into a singe memorial representation. Yet, if older adults are able to encode a representation of the studied categories, then remembering the spatial location of one exemplar in a category would allow the older adults to infer the location of other exemplars from the same category.

However, a reliance on such knowledge would also make older adults more vulnerable to certain kinds of memory errors. For example, their reliance on memory for the categories presented during study opposed to the specific exemplars that were presented would likely result in the older adults falsely accepting more missing exemplars than the younger adults. A reliance on knowledge of the studied environment to compensate for age-related source memory deficits would also result in older adults committing systematic source memory errors. In particular, probability consistent source errors could occur. Such errors occur when a falsely recognized missing exemplar is misattributed to the quadrant in which the majority of the exemplars from its category were presented in during study.

2.1.1 Item Memory

Older adults do not tend to show deficits in item memory. This could likely be due to relying on the gist of what was studied, or familiarity, as opposed to recollection. As a result, older adults should be able to correctly recognize previously studied words (i.e., targets) at equivalent rates to younger adults. However, their reliance on semantic information should also increase the rate at which older adults falsely accept unstudied words that share the same category membership as the targets (i.e., missing exemplars) relative to younger adults. Yet, dividing the attention of younger adults during study should increase the rate at which they falsely accept missing exemplars relative to younger adults who do not have their attention divided. Dividing the attention of younger adults should lead them to rely on familiarity evoked by the semantic relationship the missing exemplars share to the studied words. This use of familiarity would allow older adults and younger adults in the divided attention condition to accept targets at equivalent rates to the younger adults in the full attention condition.

2.1.2 Source Memory

Older adults should be able to compensate for age-related deficits in source memory by relying on the probability structure provided at study. Older and younger adults should demonstrate equivalent source memory performance for the words in the 100% and 75% conditions. However, due to their superior source memory, younger adults will not need to rely on the probability structure as much as the older adults to provide correct source judgments. Thus, in the 50% and 25% conditions younger adults will have greater performance relative to older adults. However, when forced to divide their attention at study, younger adults will have source memory performance equivalent to the older adults. Yet, if the younger adults in the divided attention condition are unable to learn the probability structure, they would have lower source memory performance than that of older adults.

A reliance on a probability structure to assist source memory would likely result in probability consistent source errors. These errors are best illustrated by source judgments for missing exemplars falsely recognized as having been presented at study. Missing exemplars from categories in the 100% and 75% conditions would likely be judged to have occurred in the quadrant of the screen where exemplars from those categories were most likely to have been presented at study. Source errors that conform to the probability structure are referred to as *probability consistent*. Conversely, source errors that do not conform to the probability structure are referred to as *probability inconsistent*. These consistent source errors will be higher for the 100% and 75% probability structure conditions. If both the older adults and younger adults in the full attention condition are able to learn the probability structure and use it when making source judgments, then both groups will likely commit the same amount of probability consistent source errors. However, younger adults who are in the divided attention condition may not commit an equivalent amount of probability consistent source errors as the older adults and younger adults in the full attention condition.

2.2 Method

2.2.1 Participants and Design

The experiment conformed to a 3 (Group: Younger Adults – Full Attention, Younger Adults – Divided Attention, Older Adults) x 3 (Item Type: Target, Missing Exemplar, Distractor Exemplar) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors design. In regards to group, a group of younger adults studied the items under full attention, while another group of younger adults studied the items under divided attention. Additionally, a group of older adults also participated, and studied the items under full attention. Item type and probability structure were manipulated within participants.

Thirty-six participants completed the experiment. Twenty-four of the participants were younger adults between 18-30 years of age. The remaining 12 participants were older adults between 60-80 years of age. Younger adults were recruited from a local university, and received partial fulfillment of a course research requirement in exchange for their participation. Older adults were recruited from local recreation centers, and were compensated fifteen dollars for their participation. In order to assess the overall cognitive status of the older adults, they were screened with the 6-Item Orientation-Memory-Concentration Test, also referred to as the Short Blessed Test (SBT; Katzman, Brown, Fuld, Peck, Schechter, & Shimmel, 1983). The SBT consists of items that assess an individual's time orientation, memory, and ability to concentrate. Normal cognitive status, as defined by Katzman and colleagues (1983), is a score ranging from 0 to 6. Only data from the older adults who scored in the normal range were analyzed. Please refer to Appendix A for the SBT form and subsequent scoring procedure.

2.2.2 Materials

The words that were presented in this experiment were sampled from two lists, list A and list B, with each consisting of 16 exemplars sampled from six categories (see Appendix B for lists). The categories and their exemplars were chosen from an updated and expanded version of the Battig and Montague category norms (Van Overschelde, Rawson, & Dunlosky, 2003). The two lists allowed for two study-test phases to be created without categorical overlap. Counterbalancing of the categories, and their corresponding exemplars, produced 12 study-test phases for each list, allowing each exemplar to serve as one of the three item types: target, missing exemplar, and distractor exemplar an equal number of times. The experiment consisted of two study-test phases, which necessitated the construction of 12 counterbalanced orders. One study-test phase was created from the list A categories, and the other from the list B categories. For six of the counterbalanced orders, words from list A were presented during the first study-test phase. For the remaining six orders, words from list B were presented during the first study-test phase. Finally, an additional 24 words were chosen to serve as filler items. Fillers were exemplars sampled from 24 categories that were used to generate target exemplars. These filler items allowed for an equivalent number of words to be shown in each of the four quadrants of the computer screen. Fillers were not included in statistical analyses.

2.2.2.1 Study Phase

During each study phase, eight of the 16 exemplars from four target categories were presented in addition to 12 fillers, for a total of 44 words. The probability that exemplars from a category were presented in the same quadrant of the computer screen was manipulated. The eight exemplars from each of the four target categories were assigned to one of four occurrence probabilities. Specifically, each category was assigned to a specific quadrant, 1, 2, 3, or 4, containing one of the four probability structures. The four probabilities were 100%, 75%, 50%, and 25%. For the 100% condition, all eight exemplars from a target category were presented in the same quadrant. For example, if animals are chosen for presentation in quadrant 1, then all eight animal exemplars were presented in that quadrant. For the 75% condition, six of the eight exemplars for a target category were presented in the same quadrant. The remaining two exemplars were randomly placed into quadrants assigned to the 50% and 25% conditions. For example, if male names were in the 75% condition and chosen to be presented in quadrant 2, then six of the male names were presented in quadrant 2, while the other two were presented in quadrants 3 and 4. For the 50% condition, four of the eight exemplars of a target category were presented in the same quadrant. The remaining four exemplars were randomly placed into the quadrants assigned to the 100%, 75%, and 25% conditions with the constraint that only one word was placed in the quadrant assigned to the 100% condition. For example, if earth formations were assigned to quadrant 3, then four earth formations were presented in quadrant 3, while two were presented in quadrant 4, one was presented in quadrant 1, and the last earth formation was placed in quadrant 2. Finally, two exemplars from the category assigned to the 25% condition were placed in each quadrant. Once each target was assigned to its given quadrant, the filler items were randomly placed in the quadrants allowing for 11 words presented in each quadrant. In order to control for the number of times a given probability was assigned to each quadrant, both lists were randomized to allow for each probability structure to appear in each quadrant an equivalent number of times.

2.2.2.2 Divided Attention Task

The divided attention task was a number tracking task, which consisted of the auditory presentation of numbers ranging from one to nine. A number was presented at the beginning, middle, and end of each presentation of a study word (i.e., every 1500 ms).

2.2.2.3 Test Phase

Two source memory tests consisting of 32 targets, 32 missing exemplars, and 32 distractor exemplars were constructed for each of the 12 orders. Targets were those words presented at study, but the missing exemplars and the distractor exemplars were not presented at study. The missing exemplars were the remaining eight exemplars from the four target categories, which were presented at study. The distractor exemplars were the 16 words that belong to the remaining two categories, which were not presented at study.

2.2.2.4 Knowledge Test Phase

A knowledge test was created for each of the 12 orders. The test contained targets and missing exemplars that had been presented on the second source memory test. The knowledge test was used to assess if the participant acquired the knowledge of the probability structure used during the second study. Therefore, the distractor exemplars were not used.

2.3 Procedure

The experimental protocol was administered to participants on an individual basis. Informed consent was acquired from each participant, after which older adults completed the SBT followed by the two study-test phases and the knowledge test. Younger adults did not complete the SBT, and began the study-test phases followed by the knowledge test directly after consenting to participate.

2.3.1 Study Phase

Participants completed two study-test phases. During each study, 44 words were visually presented by E-prime (Psychology Software Tools Inc., 2005) in the corners of a computer display (i.e., quadrants). Participants were instructed to attend to the words being presented in the corners of the display. They were further informed that only one word will appear at a time and that their goal was to remember the words and their location for a future memory test. Each word was presented for 3000 ms, with an inter-stimulus interval of 1500 ms represented by a white asterisk. The white asterisk refocused the participants' attention back to the center of the screen, preparing them for the presentation of the next item. Each study phase lasted approximately 4 min.

2.3.2 Test Phase

After each study phase, participants completed a source memory test. They were instructed that each test item would appear in the center of the computer display for 4000 ms during which time participants were to indicate if each test item had been presented at study. If the participants recognized an item as having been presented, they indicated in which corner of the screen the word had appeared by pressing one of four buttons on a keyboard. If they saw the word in the top left corner, the participants pressed the blue "1" key. For the top right corner, the corresponding key was the yellow "2". The correct answer for the bottom left corner was the green "3." Finally, the bottom right corner was the red "4." If the participants judged the word to not have been presented at study, they indicated this by pressing the orange "New" key. The color coding of the memory responses was visually presented in their proper corner during the presentation of each test word (for example see Figure 2.1). Participants were informed that they needed to provide an answer for each item while it appeared on the screen. Each test item was followed by an inter-stimulus interval of 2000 ms during which time a white asterisk appeared in the center of the display. Each test phase lasted approximately 10 min.

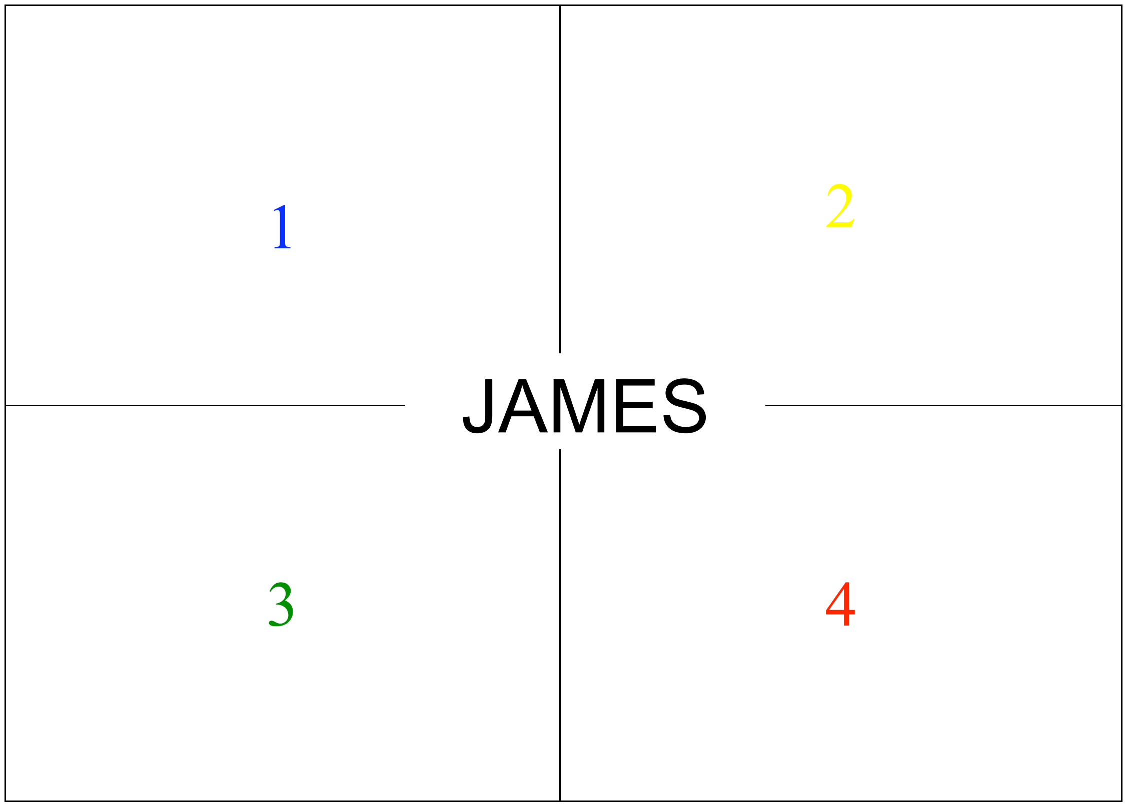

Figure 2.1 Example of Test Item and Corresponding Answer Options

2.3.3 Divided Attention

The younger adults in the divided attention condition were instructed to try to remember each word and the corner it appeared in for a later memory test. Additionally, they were instructed to hit the "1" key each time they heard three odd numbers in a row, and that it was important to try to respond to each three odd number series presented. Those participants in the full attention condition were only instructed to try to remember each word and the corner in which it appeared.

2.3.4 Knowledge Test Phase

After completing both study-test phases, participants performed the knowledge test. For this test, participants were instructed that the majority of the words that were presented during the previous test would be presented again. They were asked to sort the words into the quadrants that they were most likely to have been presented in at study. Participants were also informed that although the corner in which they believed the word should be placed might be the corner it was actually presented in at study, it does not have to be placed in the same corner it was presented in at study. They were then informed that they could no longer use the “New” key. Therefore, the participants needed to place each word into one of the four quadrants. Similar to the test phases, an inter-stimulus interval of 2000 ms represented by a white asterisk was presented between each test item that appeared for 4000 ms. For this test, participants were also told that a response needed to be given for each item while it appeared on the screen. Since the knowledge test only contained the target items and the missing exemplars, it lasted approximately 6.5 min.

Once the participants completed the knowledge test, the experimenter asked them if they noticed anything about the study phases. This allowed for the experimenter to identify if the participants noticed the probability structure used at study, and to further investigate if the participants used this knowledge to their advantage at test. If the participants did not provide adequate information with the open-ended questioning, the experimenter then reverted to close-ended questions such as “did you notice that the words belonged to categories,” and “did the majority of the words from certain categories appear in certain corners of the screen?” After the experimenter obtained adequate information, participants were debriefed further, thanked for their time, and then dismissed.

2.4 Results

In the sections that follow, memory performance data are presented for item memory as well as accurate and erroneous source memory. Specifically, memory performance for studied items that were correctly recognized by younger and older adults will be presented followed by their correct source judgments. Finally, source memory data for items that were not presented at study, but falsely recognized as having been presented and provided with a source memory judgment will be discussed.

2.4.1 Item Memory

Based on past findings, it was predicted that item memory would be equivalent among the three groups, and it was expected that probability would not impact recognition of studied items. To assess these predictions, analyses were conducted on the proportion of test items that were correctly recognized as having been presented at study. These values were corrected for guessing by subtracting the proportion of distractor exemplars accepted from the proportion of accepted targets (see Table 2.1). The corrected values were entered into a 3 (Group: Younger Adults – Full Attention, Younger Adults – Divided Attention, Older Adults) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors ANOVA.

There was a main effect of group on the ability of participants to correctly recognize targets, $F(2, 32) = 13.71$, $MSE = .11$, $\eta_p^2 = .46$, $p = .001$. Replicating past research, older adults ($M = .70$, $SE = .05$) recognized just as many targets as did the younger adults ($M = .81$, $SE = .05$) in the full attention condition, $p = .13$. In contrast, both the older adults and the younger adults in the full attention condition correctly recognized significantly more targets than the younger adults in the divided attention condition ($M = .46$, $SE = .05$), $p = .002$; $p = .001$. As expected, probability did not impact the ability of participants to recognize previously studied words, nor was there a significant interaction of group and probability, $F(2, 96) = 1.33$, $MSE = .01$, $\eta_p^2 = .04$, $p = .27$; $F(6, 96) < 1$, $MSE = .01$, $\eta_p^2 = .05$, $p = .51$.

Although item memory for targets did not differ among the older adults and the younger adults in the full attention condition, it was predicted that older adults and younger adults in the divided attention condition would falsely accept more missing exemplars than younger adults in the full attention condition due to their reliance on familiarity or gist-based memory processes. To test these predictions, analyses were conducted on the corrected proportion of missing exemplars falsely accepted as having been presented at study (see Table 2.1). These values were corrected for response bias in the same manner as the targets and were entered into a 3

(Group: Younger Adults – Full Attention, Younger Adults – Divided Attention, Older Adults) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors ANOVA.

There was a marginally significant effect of group on the amount of missing exemplars falsely accepted, $F(2, 32) = 2.82$, $MSE = .06$, $\eta_p^2 = .15$, $p = .09$. Contrary to predictions, post hoc analyses revealed the younger adults in the full attention condition ($M = .22$, $SE = .03$) to have accepted more missing exemplars than the younger adults in the divided attention condition ($M = .13$, $SE = .03$), $p = .05$. However, the younger adults in the full attention condition and the older adults ($M = .13$, $SE = .04$) did not significantly differ from one another, $p = .07$. Furthermore, there was no difference in the rate at which the older adults and the younger adults in the divided attention condition accepted missing exemplars, $p = .94$. Additionally, there was a marginally significant effect of probability on the rate at which participants falsely accepted missing exemplars, $F(3, 102) = 2.47$, $MSE = .01$, $\eta_p^2 = .07$, $p = .07$. There was no significant interaction between group and probability, $F(6, 96) < 1$, $MSE = .01$, $\eta_p^2 = .04$, $p = .64$.

Table 2.1 Mean Proportion of Old Responses Given to Targets, Missing Exemplars, and Distractor Exemplars in Experiment 1 as a Function of Group and Probability

	Item Type X Group				
	Uncorrected			Corrected	
Probability	Targets	Missing Exemplars	Distractor Exemplars	Targets	Missing Exemplars
	Younger Adults – Full Attention				
100	.87 (.02)	.32 (.05)		.82 (.02)	.27 (.04)
75	.86 (.03)	.29 (.06)	.05 (.02)	.81 (.03)	.24 (.06)
50	.88 (.03)	.20 (.05)		.83 (.03)	.15 (.05)
25	.84 (.04)	.29 (.05)		.79 (.05)	.24(.05)
	Younger Adults – Divided Attention				
100	.65 (.05)	.36 (.06)		.40 (.06)	.11 (.05)
75	.72 (.06)	.39 (.07)	.26 (.06)	.46 (.06)	.13 (.06)
50	.73 (.04)	.35 (.07)		.48 (05)	.09 (.04)
25	.77 (.05)	.43 (.06)		.51 (05)	.17 (.03)
	Older Adults				
100	.78 (.04)	.26 (.08)		.67 (.07)	.15 (.04)
75	.81 (.04)	.22 (.07)	.11 (.07)	.70 (.07)	.11 (.04)
50	.83 (.04)	.22 (.07)		.72 (.07)	.11 (.04)
25	.81 (.05)	.26 (.05)		.71 (.08)	.15 (.04)

Note. Standard errors provided in parentheses

2.4.2 Source Memory

2.4.2.1 Accurate Source Memory

Based on past research, it was predicted that younger adults in the full attention condition would have greater source memory than older adults. It was further predicted that younger adults who had their attention divided would perform like that of older adults due to decreased attentional resources available at study. Additionally, probability was expected to have a positive impact on source accuracy for targets in the higher probability conditions. To test these predictions, the proportion of targets that received an accurate source judgment was entered into a 3 (Group: Younger Adults – Full Attention, Younger Adults – Divided Attention, Older Adults) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors ANOVA (see Table 2.2).

Indeed, both group and probability had a significant effect on the rate at which participants correctly identified the source of accepted targets, $F(2, 32) = 14.86$, $MSE = .06$, $\eta_p^2 = .48$, $p = .001$; $F(3, 96) = 18.17$, $MSE = .02$, $\eta_p^2 = .36$, $p = .001$. Post hoc comparisons revealed younger adults in the full attention condition ($M = .58$, $SE = .04$) to have had better source memory than the older adults ($M = .43$, $SE = .04$) and the younger adults in the divided attention condition ($M = .31$, $SE = .04$), $p = .005$; $p < .001$. Additionally, older adults had better source memory than the younger adults in the divided attention condition, $p = .03$. As expected, participants had better source memory for targets as the probability increased from 25% ($M = .33$, $SE = .03$) to 50% ($M = .38$, $SE = .03$) to 75% ($M = .48$, $SE = .03$) to 100% ($M = .55$, $SE = .05$), $F(1, 34) = 35.76$, $MSE = .03$, $\eta_p^2 = .51$, $p < .001$.

These results raise the question as to whether or not the probability structure aided all participants equally in correctly identifying the source of presented items. In this regard, there was a significant interaction of group and probability on accurate source memory, $F(6, 96) = 4.08$, $MSE = .02$, $\eta_p^2 = .20$, $p = .001$ (see Table 2.2). Specifically, both younger adults in the full attention condition and older adults had greater source accuracy as the probability increased,

$F(1, 11) = 118.57$, $MSE = .01$, $\eta_p^2 = .92$, $p < .001$; $F(1, 10) = 13.40$, $MSE = .03$, $\eta_p^2 = .57$, $p = .004$. This was not the case for the younger adults in the divided attention condition, $F(1, 11) < 1$, $MSE = .01$, $\eta_p^2 = .07$, $p = .39$. These results suggest that the younger adults in the full attention condition and the older adults used the probability structure to improve their source memory judgments, whereas younger adults in the divided attention condition did not do so.

Moreover, younger adults in the full attention condition should have greater source accuracy than older adults and younger adults in the divided attention condition when a probability structure is unavailable to aid source memory. As expected, the younger adults in the full attention condition had better source memory than the older adults and younger adults who had their attention divided in the 50% and 25% conditions, all *p*s < .05. Furthermore, given that dividing attention impairs source memory, younger adults in the divided attention condition should have source memory equivalent to that of older adults. As expected, older adults and younger adults in the divided attention condition had equivalent source memory in 50%, and 25% conditions, $p = .50$; $p = .55$.

In contrast, older adults and younger adults in the divided attention condition should have equivalent source memory to that of younger adults in the full attention condition when a probability structure is available to aid source memory. However, younger adults in the full attention condition had better source memory than the older adults and younger adults in the divided attention condition in the 100% and 75% conditions, all *p*s < .02. As expected, older adults and younger adults in the divided attention condition had equivalent source accuracy in the 75% condition, $p = .09$. However, older adults had better source memory than the younger adults in the divided attention condition for the 100% probability condition, $p = .003$.

Table 2.2 Mean Proportion of Accurate Source Memory Judgments Provided to Targets in Experiment 1 as a Function of Group and Probability

	Group		
Probability	Younger Adults – Full Attention	Younger Adults – Divided Attention	Older Adults
100	.79 (.03)	.30 (.06)	.57 (.08)
75	.63 (.04)	.35 (.05)	.47 (.04)
50	.48 (.04)	.31 (.06)	.36 (.05)
25	.42 (.04)	.27 (.03)	.31 (.06)

Note. Standard errors provided in parentheses

2.4.2.2 Erroneous Source Memory

Additional analyses were conducted to investigate the impact of the probability structure on the tendency of participants to make probability consistent and probability inconsistent source memory errors. Probability consistent source errors occurred when a missing exemplar was judged to have been presented in the quadrant that the majority of exemplars from its category were presented in at study. These errors should be more pronounced in the 100% and 75% condition because participants should use the probability structure to guide their source memory judgments. In addition, probability inconsistent source errors occurred when a missing exemplar was judged to have been presented in a quadrant of the display other than the quadrant that the other exemplars in its category were presented in at study. These errors should be more pronounced in the 50% and 25% conditions where there was not a probability structure available to guide source memory errors.

To test these predictions, a 3 (Group: Younger Adults – Full Attention, Younger Adults – Divided Attention, Older Adults) x 2 (Error: Consistent, Inconsistent) x 3 (Probability Structure: 100%, 75%, 50%) mixed factors ANOVA was conducted on the proportion of missing exemplars provided with a source memory judgment (see Table 2.3). There was a significant probability by error interaction, $F(2, 64) = 7.17$, $MSE = .02$, $\eta_p^2 = .18$, $p = .002$. As is evident in Figure 2.2, the proportion of consistent errors increased as the probability structure increased, which would be expected if participants were using the probability structure to inform their source memory judgments, $F(1, 34) = 18.12$, $MSE = .01$, $\eta_p^2 = .35$, $p < .001$. Conversely, inconsistent errors decreased as the probability structure increased, $F(1, 34) = 5.06$, $MSE = .01$, $\eta_p^2 = .13$, $p = .03$.

Table 2.3 Mean Proportion of Consistent and Inconsistent Source Errors Provided to Missing Exemplars in Experiment 1 as a Function of Probability, Group and Error Type

	Group x Error Type					
	Unconditional Proportions					
	Younger Adults – Full Attention		Younger Adults – Divided Attention		Older Adults	
Probability	Consistent	Inconsistent	Consistent	Inconsistent	Consistent	Inconsistent
100	.24 (.05)	.08 (.03)	.13 (.02)	.24 (.05)	.20 (.07)	.07 (.03)
75	.16 (.05)	.14 (.04)	.17 (.04)	.22 (.04)	.12 (.05)	.11 (.05)
50	.09 (.02)	.11 (.04)	.06 (.02)	.30 (07)	.11 (.06)	.15 (.04)
25	X	.29 (.05)	X	.43 (.06)	X	.29 (.05)
	Conditional Proportions					
	Younger Adults – Full Attention		Younger Adults – Divided Attention		Older Adults	
Probability	Consistent	Inconsistent	Consistent	Inconsistent	Consistent	Inconsistent
100	.68 (.10)	.32 (.10)	.42 (.08)	.58 (.08)	.78 (.10)	.22 (.10)
75	.48 (.12)	.52 (.12)	.44 (.08)	.56 (.08)	.62 (.13)	.38 (.13)
50	.59 (.12)	.41 (.12)	.25 (.07)	.75 (.07)	.34 (.13)	.66 (.13)

Note. Standard errors provided in parentheses

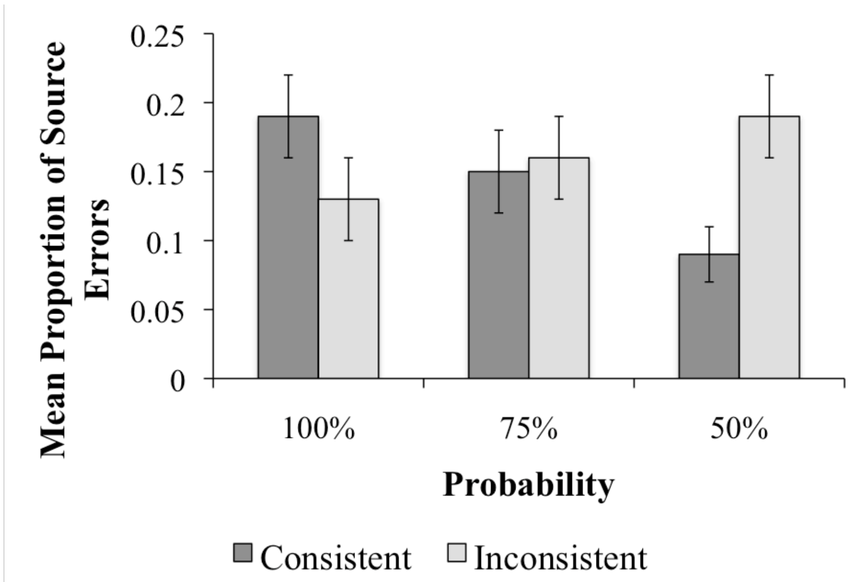

Figure 2.2 Source Judgments for Missing Exemplars Falsely Accepted in Experiment 1 as a Function of Probability and Error Type

Additionally, there was a significant error by group interaction, $F(2, 32) = 5.75$, $MSE = .03$, $\eta_p^2 = .26$, $p = .01$ (see Figure 2.3). Younger adults in the divided attention condition made more inconsistent ($M = .76$, $SE = .14$) than consistent ($M = .37$, $SE = .07$) source errors, $F(1, 11) = 11.50$, $MSE = .08$, $\eta_p^2 = .51$, $p = .006$. Whereas, the amount of consistent and inconsistent errors did not differ between the older adults and the younger adults in the full attention condition, $F(1, 10) < 1$, $MSE = .13$, $\eta_p^2 = .04$, $p =.53$; $F(1, 11) = 1.95$, $MSE = .07$, $\eta_p^2 = .15$, $p = .19$.

Conditional values were calculated to determine the proportion of falsely accepted missing exemplars for which source memory errors consistent with the probability structure introduced at study were made. Specifically, these values were computed by dividing the proportion of consistent errors made to missing exemplars by the total proportion of missing exemplars that were falsely recognized at test (see Table 2.3). These values were then entered into a 3 (Group: Younger Adults – Full Attention, Younger Adults – Divided Attention, Older Adults) x 3 (Probability Structure: 100%, 75%, 50%) mixed factors ANOVA. There was a significant effect of probability on the rate at which participants committed errors consistent with the probability structure, *F*(2, 52) = 3.59, *MSE* = .11, η_p^2 = .12, *p* = .04. Participants committed more consistent source memory errors as the probability structure increased from 50% (*M* = .39, *SE* = .07) to 75% (*M* = .51, *SE* = .06) to 100% (*M* = .61, *SE* = .06), *F*(1, 26) = 10.32, *MSE* = .08, η_p^2 = .28, *p* = .003. There was also a significant effect of group, *F*(2, 26) = 4.89, *MSE* = .10, η_p^2 = .27, *p* = .02. Both older adults (*M* = .58; *SE* = .06) and younger adults (*M* = .58; *SE* = .06) in the full attention condition committed more source memory errors consistent with the probability structure than did the younger adults in the divided attention condition (*M* = .37; *SE* = .05), *p* = .02; *p* = .01. However, older adults and younger adults in the full attention condition did not significantly differ from one another, *p* = .95. There was not a significant interaction between group and probability on the rate at which participants committed consistent source memory errors for missing exemplars, *F*(4, 52) = 1.28, *MSE* = .11, η_p^2 = .09, *p* = .29.

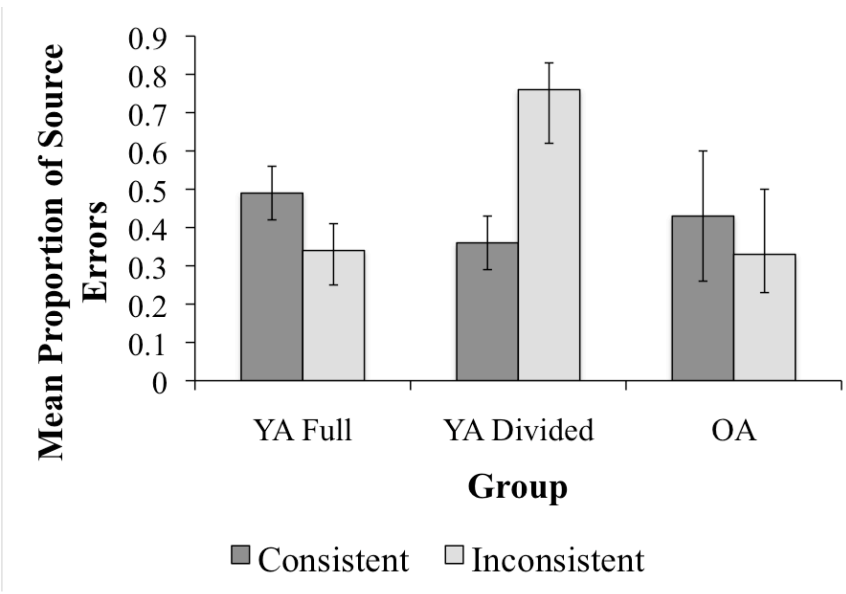

Figure 2.3 Source Judgments for Missing Exemplars Falsely Accepted in Experiment 1 as a Function of Group and Error Type

2.5 Discussion

Replicating past research, younger and older adults had equivalent item memory performance. Specifically, these participants correctly recognized previously studied items at roughly the same rate. However, dividing the attention of younger adults hindered their ability to recognize targets at the same rate as older adults. Also replicating past research, younger adults had better source memory than older adults. Yet, older adults used the probability structure provided at study to improve their source memory responses as did the younger adults in the full attention condition. However, dividing the attention of younger adults hindered their ability to learn and later use the probability structure to aid source memory judgments.

These results suggest that attentional resources are needed at study in order to learn the probability structure, thus making it available for use at test. This conclusion is based on the participants' ability to remember the quadrant of the screen in which the targets were presented and the quadrant of the screen in which the missing exemplars were falsely attributed to having been presented. Of the quadrants on the display, three would be inconsistent with the probability structure established at study. Thus by chance alone, the majority of the source errors would be inconsistent. However, learning the probability structure at study would allow participants to constrain their source memory judgments to this structure at test. This was found to be the case for the younger adults in the full attention condition and the older adults, but not for the younger adults in the divided attention condition suggesting that they could not constrain their responses like predicted. The impact of dividing attention on the ability of participants to learn the probability structure during study raises the question as to the extent to which attentional resources are needed at test to monitor and make source memory judgments based on the probability structure.

CHAPTER 3

EXPERIMENT 2

In Experiment 1, attentional resources at study were manipulated by asking participants to monitor a series of numbers while studying words for a later test. A primary goal of Experiment 2 was to investigate the amount of attentional resources needed at test to use the knowledge acquired at study to inform source memory judgments. In the current experiment, attentional resources were manipulated at test by limiting the amount of time some participants had to make memory responses. A hallmark of cognitive aging is a general slowing in processing speed, and such slowing is believed to negatively impact older adults' source memory performance (Salthouse, 1996; 2005). Forcing younger adults to respond quickly to test items is thought to simulate cognitive slowing associated with sour.

In order to observe the relationship of processing speed and memory accuracy, younger adults were assigned to either a self paced or speeded response condition. Jones (2005) observed younger adults to commit more source memory errors when they were required to provide speeded responses at test. Moreover, Odegard, et al. (2008) found these errors to be consistent with the study environment when categorical relationships were used for the study and test materials. They suggested that forcing participants to respond quickly decreased their ability to use recollection resulting in a reliance on familiarity and their knowledge of the study environment. Reliance on this information resulted in participants committing more source memory errors. These past findings suggest that younger adults in the speeded response condition should be able to use familiarity to correctly recognize previously studied items allowing these participants to have item memory equivalent to that of the younger adults in the self paced condition. However, they should commit more source memory errors than the younger adults in the self paced condition.

Yet, in those conditions in which the probability structure can inform source memory judgments, younger adults in the speeded response condition should use this knowledge to improve their source memory judgments as did the older adults in Experiment 1. Thus, in addition to relying on familiarity to guide item memory, younger adults in the speeded response condition may also rely on the knowledge they acquired from the study environment to guide source memory judgments. Yet, a consequence of relying on familiarity is that participants would likely accept a larger proportion of the missing exemplars. Moreover, using the probability structure to guide source memory judgments should result in participants making probability consistent source errors.

A secondary goal of the present experiment was to confirm that the age-related memory differences observed in Experiment 1 were due to aging and not the result of forcing older adults to respond within 4000 ms. Thus, older adults were assigned to either a self paced or a speeded response condition of 4000 ms. In regards to response deadline, older adults in the self paced and speeded response conditions are predicted to have equivalent memory performance. Such a result would confirm that the age-related differences found in Experiment 1 were due to aging and did not result from requiring older adults to respond in a limited time frame.

3.1 Hypotheses

The hypotheses for Experiment 2 are identical to those of Experiment 1 with some exceptions to those hypotheses specific to the response deadline manipulation.

3.1.1 Item Memory

Similar to older adults, younger adults in the speeded response condition should accept targets at equivalent rates as the younger adults in the self paced condition. However, older adults and those younger adults in the speeded response condition should falsely accept more missing exemplars than younger adults in the self paced condition.

3.1.2 Source Memory

Younger adults in the speeded response condition will have equivalent source memory performance to that of older adults, which should be lower than that of younger adults in the self paced condition. Additionally, all participants should rely on the knowledge they acquired at study to inform their source memory judgments, thus increasing their source memory accuracy as the probability structure increases. However, replicating Experiment 1, all participants will make more probability consistent source errors as the probability structure increases. This pattern should hold even for those younger adults in the speeded response condition, to the extent to which using the knowledge of the probability structured acquired at study is a fairly fast automatic process.

3.2 Method

3.2.1 Participants and Design

This experiment was similar in many respects to Experiment 1, and conformed to a 2 (Age Group: Older Adult, Younger Adult) x 2 (Response Deadline: Self Paced, Speeded) x 3 (Item Type: Target, Missing Exemplar, Distractor Exemplar) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors design. As in Experiment 1, age group referred to the adult age group from which participants were sampled, and item type and probability structure were manipulated within participants. Unlike Experiment 1, the amount of time participants had to respond to test items was manipulated.

Forty-eight participants completed the experiment. As in Experiment 1, twenty-four of the participants were younger adults between 18-30 years of age, and were recruited from a local university. The remaining 24 participants were older adults between 60-80 years of age, and were recruited from local recreation centers and senior living communities. Compensation for participating was identical to that of Experiment 1. Normal cognitive status was assessed by the same methods as used in Experiment 1.

3.2.2 Materials and Procedure

The materials and experimental protocol used for Experiment 2 were identical to those used in Experiment 1 with a few exceptions. Specifically, the test phases were similar in every respect to Experiment 1 except the time that participants had to respond to test items was manipulated. Half of the participants were randomly assigned to the self paced condition, and asked to respond as fast and as accurately as possible. The remaining participants were assigned to the speeded response condition, and were asked to respond to each test item while it appeared on the computer screen, and each test item would quickly disappear. Additionally, the amount of time each test item appeared on the screen was 1500 ms for the younger adults and 4000 ms for the older adults in the speeded response condition.

3.3 Results

In the sections that follow, memory performance data are presented for item memory as well as accurate and erroneous source memory. Specifically, memory performance for studied items that were correctly recognized by younger and older adults will be presented followed by their correct source judgments. Finally, source memory data for items that were not presented at study, but falsely recognized as having been presented and provided with a source judgment will be discussed.

3.3.1 Item Memory

Item memory was predicted to be equivalent across the four groups, as well as across the four probability conditions. To test these predictions, a 4 (Group: Younger Adults – Self Paced, Younger Adults – Speeded Response, Older Adults – Self Paced, Older Adults – Speeded Response) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors ANOVA was conducted on the corrected proportion of targets recognized as having been presented at study (see Table 3.2; refer to Table 3.1 for uncorrected values). As predicted, there was no effect of group on the ability of participants to correctly recognized targets, $F(3, 44) < 1$, MSE =.10, $\eta_p^2 = .04$, $p = .64$. In addition, both younger ($M = .70$, $SE = .04$) and older ($M = .63$, SE =

.04) adults recognized targets at equivalent rates replicating Experiment 1, $F(1, 45) = 2.11$, $MSE = .12$, $\eta_p^2 = .05$, $p = .15$. Contrary to predictions, there was a significant effect of probability on the amount of targets correctly recognized, $F(3, 132) = 3.42$, $MSE = .01$, $\eta_p^2 = .07$, $p = .02$. Specifically, the 75% ($M = .64$, $SE = .03$) probability condition was significantly lower than the 100% ($M = .71$, $SE = .03$), 50% ($M = .68$, $SE = .02$), and 25% ($M = .69$, $SE = .03$) conditions, $p = .002$; $p = .06$; $p = .03$. Note that the difference between the 75% and 25% condition was only marginally significant. All other pairwise comparisons were not significant, all *p*s > .15. Finally, there was not a significant interaction between group and probability, $F(9, 132) < 1$, $MSE = .01$, $\eta_p^2 = .05$, $p = .62$.

Due to their reliance on familiarity or gist-based memory processes, it was predicted that older adults and younger adults in the speeded response condition would falsely accept more missing exemplars than younger adults in the self paced condition. To test these predictions, a 4 (Group: Younger Adults – Self Paced, Younger Adults – Speeded Response, Older Adults – Self Paced, Older Adults – Speeded Response) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors ANOVA was conducted on the corrected proportion of missing exemplars falsely accepted as having been presented at study (see Table 3.2; refer to Table 3.1 for uncorrected values). Contrary to predictions, there was no effect of group on the rate at which participants falsely accepted missing exemplars, $F(3, 44) < 1$, $MSE = .03$, $\eta_p^2 = .03$, $p = .71$. Furthermore, younger ($M = .17$, $SE = .03$) and older ($M = .19$, $SE = .03$) adults falsely recognized missing exemplars at equivalent rates, $F(1, 46) < 1$, $MSE = .03$, $\eta_p^2 = .01$, $p = .79$. Additionally, there was a marginally significant effect of probability on the rate at which participants falsely accepted missing exemplars, $F(3, 132) = 2.28$, $MSE = .02$, $\eta_p^2 = .05$, $p = .08$. Finally, there was not a significant interaction between group and probability, $F(9, 132) = 1.64$, $MSE = .03$, $\eta_p^2 = .10$, $p = .11$.

Table 3.1 Mean Proportion of Old Responses Given to Targets, Missing Exemplars, and Distractor Exemplars in Experiment 2 as a Function of Group and Probability

	Group x Item Type					
	Younger Adults – Self Paced			Younger Adults – Speeded Response		
Probability	Targets	Missing Exemplars	Distractor Exemplars	Targets	Missing Exemplars	Distractor Exemplars
100	.80 (.04)	.20 (.05)	.08 (.02)	.78 (.06)	.38 (.06)	.07 (.02)
75	.74 (.04)	.22 (.05)		.76 (.06)	.31 (.07)	
50	.82 (.02)	.28 (.07)		.77 (.04)	.23 (.05)	
25	.80 (.05)	.21 (.06)		.78 (.04)	.18 (.04)	
	Older Adults – Self Paced			Older Adults – Speeded Response		
Probability	Targets	Missing Exemplars	Distractor Exemplars	Targets	Missing Exemplars	Distractor Exemplars
100	.89 (.02)	.32 (.07)	.13 (.05)	.74 (.08)	.31 (.07)	.09 (.04)
75	.74 (.04)	.29 (.09)		.67 (.08)	.28 (.07)	
50	.80 (.04)	.33 (.08)		.71 (.07)	.30 (.06)	
25	.79 (.04)	.26 (.07)		.76 (.06)	.29 (.07)	

Note. Standard errors provided in parentheses

Table 3.2 Mean Proportion of Corrected Old Responses Given to Targets and Missing Exemplars in Experiment 2 as a Function of Group and Probability

	Group x Item Type			
	Younger Adults – Self Paced		Younger Adults – Speeded Response	
Probability	Targets	Missing Exemplars	Targets	Missing Exemplars
100	.71 (.04)	.11 (.04)	.71 (.07)	.31 (.06)
75	.66 (.04)	.13 (.04)	.69 (.07)	.24 (.07)
50	.73 (.03)	.20 (.06)	.70 (.05)	.16 (.06)
25	.72 (.05)	.12 (.05)	.71 (.05)	.11 (.04)
	Older Adults – Self Paced		Older Adults – Speeded Response	
Probability	Targets	Missing Exemplars	Targets	Missing Exemplars
100	.75 (.04)	.19 (.05)	.66 (.06)	.22 (.07)
75	.61 (.06)	.15 (.06)	.58 (.05)	.19 (.05)
50	.67 (.05)	.19 (.06)	.62 (.06)	.21 (.05)
25	.66 (.06)	.13 (.06)	.67 (.05)	.20 (.06)

Note. Standard errors provided in parentheses

3.3.2 Source Memory

3.3.2.1 Accurate Source Memory

Based on past research, it was predicted that younger adults in the self paced condition would have better source memory than older adults. It was further predicted that younger adults in the speeded response condition would have source memory performance similar to that of older adults. Additionally, given the results of Experiment 1, probability was expected to have a positive impact on source accuracy for targets in the higher probability conditions. To test these predictions, a 4 (Group: Younger Adults – Self Paced, Younger Adults – Speeded Response, Older Adults – Self Paced, Older Adults – Speeded Response) x 4 (Probability Structure: 100%, 75%, 50%, 25%) mixed factors ANOVA was conducted on the proportion of targets that received an accurate source judgment (see Table 3.3). Replicating Experiment 1, probability had a significant effect on the rate at which participants correctly identified the source of their accepted targets, $F(3, 132) = 24.20$, $MSE = .03$, $\eta_p^2 = .49$, $p < .001$. Source accuracy increased as the probability increased from 25% ($M = .34$, $SE = .03$) to 50% ($M = .37$, $SE = .03$) to 75% ($M = .44$, $SE = .03$) to 100% ($M = .60$, $SE = .04$), $F(1, 44) = 41.43$, $MSE = .04$, $\eta_p^2 = .49$, $p < .001$. However, there was not a significant effect of group on source accuracy, $F(3, 44) < 1$, $MSE = .11$, $\eta_p^2 = .06$, $p = .41$.

Yet, it could be the case that older adults masked age-related source memory deficits by using the probability structure to inform their source judgments. If this were the case, then older adults should have poorer source memory for those targets from categories for which a probability structure was not available to guide source memory judgments relative to younger adults in the self paced condition. Therefore, planned comparisons were conducted to test whether or not older adults had impaired source memory for targets in the 25% probability condition relative to younger adults in the self paced condition. These analyses were performed by pooling data across the older adults in the self paced and speeded response conditions because older adults in the self paced condition did not take significantly longer than 4000 ms to respond to targets, $t(11) < 1$, $p = .67$. These analyses demonstrated older adults ($M = .29$, $SE = .05$) to have had poorer source memory in the 25% condition than the younger adults ($M = .43$, $SE = .04$), $t(31) = 2.20$, $p = .04$. Whereas, there were no differences between younger and older adults' source memory accuracy in the other three probability conditions, all ts < 1.59, all ps > .11.

Table 3.3 Mean Proportion of Accurate Source Memory Judgments Provided to Targets in Experiment 2 as a Function of Group and Probability

	Group			
Probability	Younger Adults – Self Paced	Younger Adults – Speeded Response	Older Adults – Self Paced	Older Adults – Speeded Response
100	.65 (.06)	.54 (.08)	.60 (.07)	.61 (.09)
75	.50 (.04)	.46 (.07)	.43 (.07)	.37 (.07)
50	.44 (.05)	.33 (.04)	.39 (.05)	.32 (.07)
25	.43 (.04)	.33 (.06)	.31 (.08)	.28 (.06)

Note. Standard errors provided in parentheses

3.3.2.2 Erroneous Source Memory

To the extent to which using the knowledge of the probability structure introduced at study to inform source memory judgments is an automatic process, all participants should rely on the knowledge they acquired at study to inform their source memory judgments. This would lead participants to commit more probability consistent source errors as the probability structure increases. Whereas, inconsistent source errors should decrease as the probability increases. To test these predictions, additional analyses were performed on the tendency of participants to make probability consistent and probability inconsistent source memory errors. These values were entered into a 4 (Group: Younger Adults – Self Paced, Younger Adults – Speeded Response, Older Adults – Self Paced, Older Adults – Speeded Response) x 2 (Error: Consistent, Inconsistent) x 3 (Probability Structure: 100%, 75%, 50%) mixed factors ANOVA (see Table 3.4).

As predicted, there was a significant error by probability interaction, $F(2, 88) = 8.17$, $MSE = .01$, $\eta_p^2 = .16$, $p = .001$. As depicted in Figure 3.1, as the probability structure increased, the amount of consistent source errors increased and inconsistent source errors decreased, $F(1, 47) = 8.56$, $MSE = .01$, $\eta_p^2 = .15$, $p = .005$; $F(1, 47) = 9.34$, $MSE = .01$, $\eta_p^2 = .17$, $p = .004$. However, no other main effects or interactions were significant, all *F*s < 1.60.

Table 3.4 Mean Proportion of Consistent and Inconsistent Source Errors Provided to Missing Exemplars in Experiment 2 as a Function of Probability, Group and Error Type

	Group x Error Type			
	Younger Adults – Self Paced		Younger Adults – Speeded Response	
Probability	Consistent	Inconsistent	Consistent	Inconsistent
100	.14 (.05)	.06 (.03)	.27 (.06)	.11 (.04)
75	.11 (.03)	.11 (.04)	.20 (.05)	.12 (.04)
50	.13 (.04)	.15 (.05)	.13 (.05)	.11 (.03)
25	X	.21 (.06)	X	.18 (.04)
	Older Adults – Self Paced		Older Adults – Speeded Response	
Probability	Consistent	Inconsistent	Consistent	Inconsistent
100	.19 (.05)	.13 (.04)	.25 (.07)	.06 (.02)
75	.16 (.07)	.13 (.04)	.16 (.06)	.12 (.05)
50	.16 (.06)	.18 (.05)	.16 (.03)	.14 (.04)
25	X	.25 (.07)	X	.28 (.08)

Note. Standard errors provided in parentheses

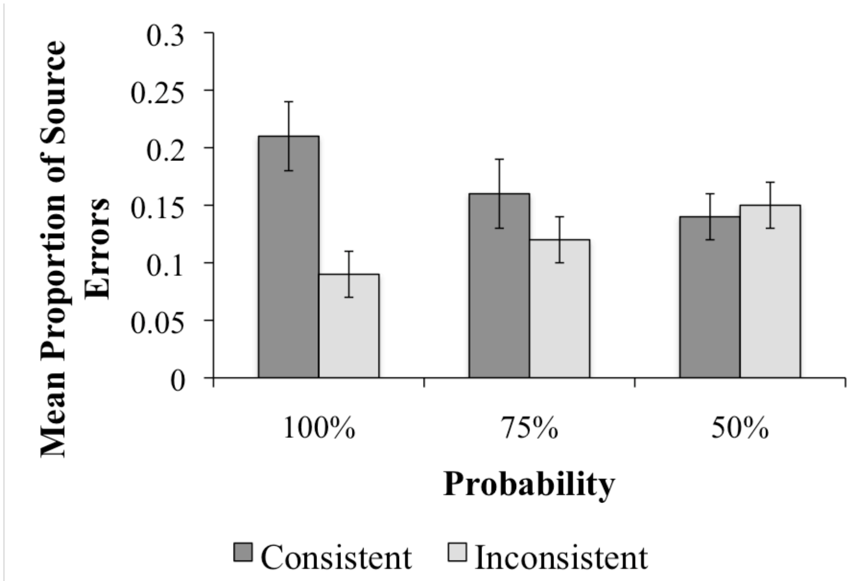

Figure 3.1 Source Judgments for Missing Exemplars Falsely Accepted in Experiment 2 as a Function of Probability and Error Type

To further assess the extent to which individuals used the probability structure to guide source memory judgments for falsely recognized missing exemplars, a 4 (Group: Younger Adults – Self Paced, Younger Adults – Speeded Response, Older Adults – Self Paced, Older Adults – Speeded Response) x 3 (Probability Structure: 100%, 75%, 50%) mixed factors ANOVA was performed on the conditional proportion of consistent source errors made to missing exemplars (see Table 3.5). There was a significant effect of probability on the rate at which participants committed errors consistent with the probability structure, $F(2, 66) = 7.16$, $MSE = .07$ $\eta_p^2 = .18$, $p = .002$. As observed in Experiment 1, participants committed more consistent source memory errors as the probability structure increased from 50% ($M = .45$, $SE = .05$) to 75% ($M = .57$, $SE = .06$) to 100% ($M = .69$, $SE = .06$), $F(1, 33) = 12.51$, $MSE = .08$, $\eta_p^2 = .28$, $p = .001$. There was however not a significant effect of group, nor was there a significant interaction between group and probability on the rate at which participants committed consistent source memory errors for missing exemplars, both Fs < 1.

Table 3.5 Mean Conditional Proportion of Consistent and Inconsistent Source Errors Provided to Missing Exemplars that were Falsely Accepted in Experiment 2 as a Function of Probability and Group

	Group x Error Type			
	Younger Adults – Self Paced		Younger Adults – Speeded Response	
Probability	Consistent	Inconsistent	Consistent	Inconsistent
100	.66 (.14)	.34 (.14)	.75 (.10)	.25 (.10)
75	.50 (.14)	.50 (.14)	.67 (.09)	.33 (.09)
50	.40 (.10)	.60 (.10)	.41 (.13)	.59 (.13)
	Older Adults – Self Paced		Older Adults – Speeded Response	
Probability	Consistent	Inconsistent	Consistent	Inconsistent
100	.54 (.14)	.46 (.14)	.77 (.09)	.23 (.09)
75	.55 (.11)	.45 (.11)	.54 (.13)	.45 (.13)
50	.34 (.12)	.66 (.12)	.62 (.08)	.38 (.08)

Note. Standard errors provided in parentheses

3.4 Discussion

Replicating Experiment 1 and past research, older adults had item memory performance equivalent to that of younger adults. Additionally, forcing younger adults to respond in a limited time frame did not hinder their ability to recognize previously presented words. However, counter to hypotheses, older adults and younger adults in the speeded response condition did not falsely accept more missing exemplars than younger adults in the self paced condition. Also, contrary to hypotheses, requiring younger adults to respond within a limited time frame did not impair their source memory judgments compared to younger adults in the self paced condition. Contrary to the result of Experiment 1, younger and older adults had equivalent source memory for the 100%, 75%, and 50% conditions. However, older adults had poorer source accuracy for items in the 25% condition. These results suggest that older adults were able to use the probability structure provided at study to improve their source memory judgments.

Replicating Experiment 1, younger and older adults used the probability structure to improve their source memory for previously presented items. Additionally, the use of this probability structure resulted in participants committing more source memory errors that were consistent, opposed to inconsistent, with the probability structure. Moreover, the results of Experiment 2 suggest that using the knowledge of the study environment to inform source memory judgments at test is a fairly fast and potentially automatic process. This conclusion is based on the ability of the younger adults to use the probability structure to improve source accuracy in the speeded response condition as well as the self paced condition. Additionally, older adults, who experience a general decline in processing speed, were able to use the probability structure to improve their source memory. However, these conclusions should be qualified by the fact that the younger adults in the self paced condition had worse memory performance than the younger adults in Experiment 1.

CHAPTER 4

GENERAL DISCUSSION

4.1 Discussion of Present Experiments

The present experiments were conducted to replicate and extend past research investigating age-related deficits in memory. Past research has found that older adults are quite capable of recognizing previously presented items, yet have impaired source memory relative to younger adults. Several competing explanations have been offered to account for these findings. The source monitoring framework suggests that older adults have a decreased ability to monitor the source of the information in question and this is likely due to decreased functioning in the prefrontal cortex (Buckner, 2004; Craik & Grady, 2002; Henkel, Johnson, De Leonardis, 1998; Raz, Lindenberger, Rodrigue, Kennedy, Head et al., 2005). Jacoby and colleagues (Jennings and Jacoby, 1993; 1997; Rhodes et al., 2008) suggest that recollection, the ability to consciously remember bound memory traces, decreases across the lifespan, negatively impacting the ability of older adults to remember the source of previous experiences. Decreased function of the hippocampus observed across the lifespan hinders the ability of older adults to bind memorial details into a single representation, impairing their ability to later recollect details from their past (Dickerson, Salat, Bates, Atiya, Killiany et al., 2004; Driscoll, Hamilton, Petropoulos, Yeo, Brooks et al., 2003; Johnson & Chalfonte, 1994; Persson, Nyberg, Lind, Larsson, Nilsson et al., 2006; Raz, Lindenberger, Rodrigue, Kennedy, Head et al., 2005). Although recollection decreases, older adults have preserved item memory due to their ability to use familiarity allowing them to recognize past experiences.

Given that older adults demonstrate source memory deficits, a focus of the present experiments was to investigate the use of knowledge to inform source memory judgments in both younger and older adults. Specifically, the ability of individuals to use prior knowledge, such as categorical relations, to learn something novel about the study environment and later use this information to guide source memory judgments was investigated. Several findings of Experiments 1 and 2 replicate past research that has demonstrated item memory to be relatively stable across the lifespan. Additionally, the age-related deficits in source memory that have been observed in past research were observed in the present research. However, older adults learned the probability structure introduced at study and used it to improve their source memory accuracy. Yet, the use of a knowledge structure to increase source accuracy came at a cost. Older, as well as younger, adults falsely accepted test items that were not studied, but were related to studied items. These false acceptances lead participants to commit source errors that were consistent with the probability structure they learned at study.

Experiment 1 revealed the importance of attention at encoding to learn the probability structure introduced at study to later inform source memory. Specifically, younger adults who had their attention divided were unable to learn the probability structure, which led them to have decreased source memory relative to both younger adults with full attention and older adults. Additionally, when accepting unstudied words that were related to the study environment, the younger adults who had their attention divided made a high amount of source errors that were inconsistent with the probability structure. Interestingly, Experiment 2 revealed that the use of this form of knowledge to guide source memory judgments appears to be relatively fast and automatic. Younger adults who were forced to respond to test items in a limited time frame were still able to use the probability structure to inform accurate source memory judgments. In addition, these individuals made source errors consistent with the probability structure when falsely accepting unstudied words.

In all, the finding that people use knowledge to inform source memory judgments replicates existing research. The ability to use knowledge to guide source memory judgments is found across the lifespan, even in children as young as 7 years old when using topics they are highly knowledgeable of such as SpongeBob and Harry Potter (Odegard, Cooper, Lampinen, Reyna, & Brainerd, in press). However, in the latter years of the lifespan, individuals rely more heavily on pre-existing knowledge when making source memory judgments (Mather & Johnson, 2003; Mitchell, Johnson, & Mather, 2003). For example, Mather and Johnson (2003) observed older adults to rely on schematic knowledge to remember stories they read more so than younger adults. Additionally, when remembering something they witnessed such as video scenes, older adults relied heavily on semantic knowledge to judge the source of the information in question (Mitchell, Johnson, & Mather, 2003). The vast majority of these past studies have also shown the downside of using knowledge to make memory judgments. Specifically, participants were found to make memory errors consistent with their pre-existing knowledge structure (Mather & Johnson, 2003; Mitchell, Johnson, & Mather, 2003; Odegard et al., in press).

However, the current research extends these past findings to situations in which participants have to learn new knowledge to inform memory judgments opposed to relying solely on pre-existing knowledge. In this regard, past research has investigated the ability of individuals to acquire knowledge of the study environment, and later use this knowledge to inform memory judgments (Cooper & Odegard, under review; Higham & Brooks, 1997; Odegard et al., 2008). For instance, Higham and Brooks (1997) found that participants used knowledge acquired at study to correctly reject items on a memory test that did not conform to the study environment (i.e., length of words presented). Yet, these researchers demonstrated participants to use knowledge acquired at study to inform recognition memory judgments, but they did not investigate the extent to which such knowledge could be used to inform source memory judgments.

Subsequently, Odegard et al. (2008) observed participants to reject word pairs at test that did not conform to the semantic structure of studied word pairs. Moreover, these researchers investigated the use of knowledge to inform source memory judgments. Specifically, some of the word pairs presented at study were rearranged to form novel word pairs that were presented at test. Individuals were able to identify and correctly reject word pairs that were rearranged to be inconsistent with the study environment. Importantly, Cooper and Odegard (under review) replicated these findings in older adults, yet observed the older adults to over rely on the semantic relationships learned at study, leading them to accept more rearranged word pairs that were consistent with the structure of the study environment. Yet, these results only demonstrated individuals to be capable of identifying when words had been presented in the wrong context or source. This research did not investigate the extent to which individuals can use knowledge of the study environment to infer the probable context or source in which the items had been presented.

As previously stated, the present research demonstrated younger and older adults to be able to use knowledge to inform source memory judgments. Moreover, this knowledge was probabilistic opposed to all-or-none, as was the case in previous research (Cooper & Odegard, under review; Odegard et al., 2008). Additionally, attentional resources were needed to learn the probability structure of the study environment making it available for later use. However, older adults were able to learn and use this information suggesting that they had enough attentional resources to learn the knowledge structure even though past research has observed older adults to have decreased attentional resources relative to younger adults (Anderson, Craik, & Naveh-Benjamin, 1998; Craik, 1982; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996). Additionally, the cognitive slowing experienced by older adults did not appear to hinder their ability to use this knowledge at test (Salthouse, 1996; 2005). This conclusion is supported by the fact that forcing younger adults to respond quickly at test did not impair their ability to use the knowledge they acquired at study to inform their source memory judgments.

These results raise the question as to how they fit into past accounts of source memory deficits exhibited by older adults. One prevailing explanation is that these deficits result from a decreased ability of older adults to recollect past experiences leading them to rely on feelings of familiarity when making source memory judgments. However, as stated before, these two processes cannot fully account for all of the past findings. In particular, these processes cannot account for the ability of younger and older adults to use knowledge to inform their source memory judgments. Moreover, familiarity alone cannot account for the ability of younger and older adults to use a probability structure to aid them in inferring the likely source in which an item was presented in during study. However, the ability of younger and older adults to do so can be accounted for by the source monitoring framework. In the section that follows, a model is outlined that incorporates aspects of the recollection and familiarity account with aspects of the source monitoring framework.

4.2 Process Model

As depicted in Figure 4.1, when presented with an item on a memory test, an individual could recollect having seen that item previously. If this were to happen, this would result in the individual correctly identifying the source of the information because they would have access to a bound memorial representation that would include source-specifying details. However, if this does not occur, individuals must rely on other processes to 1) determine if the item was presented and 2) if they determine it to have been presented, they must judge its source. Specifically, individuals gauge how familiar the item seems based on perceptual fluency. Individuals can also judge how similar a test item is to previously studied items. Test items that are highly familiar or similar are judged to have been previously presented. However, the item is likely to be rejected in the absence of familiarity or similarity.

Once an item is judged to have been presented, individuals must then determine the context in which the item was presented. In the current experiments, individuals would likely monitor the source of their memory based on category membership and the extent to which a probability structure is associated with that category. If the category member belonged to a high probability corner, then the individual would be able to use this information to infer the corner of the screen in which the category was presented. Additionally, this would result in the individual making a source memory judgment consistent with the probability structure. Yet, this would not be the case for instances in which a category was not predominately presented in one corner, thus leading the individual to randomly place the item in one of the four corners.

The results of the present two experiments can be understood in terms of the present model. Older adults appear to have low recollection based on their poorer source memory performance in the low probability conditions (i.e., 25%) relative to the younger adults. Additionally, dividing the attention of younger adults impaired their ability to recollect the past. These younger adults had poor source memory performance in the low probability conditions. One possible explanation for these findings is the ability of these individuals to adequately bind features into a bound representation. Older adults experience deficits in memorial binding (Chalfonte & Johnson, 1996; Lyle, Bloise, & Johnson, 2006), and the current findings suggest that dividing the attention of younger adults negatively impacts their ability to bind memorial details together. These data reinforce the notion that attention is required to allow for a bound memorial representation to be encoded that can be later recollected to inform source memory judgments.

However, the older adults appear to be able to guide their source memory judgments based on knowledge acquired during encoding to more closely approximate the performance of younger adults. In contrast, younger adults who had their attention divided were unable to do so. Dividing the attention of younger adults does not seem to impair their ability to identify the categories presented, but rather it appears to hinder their ability to learn the probability structure. This result provides further evidence that attentional resources are needed to identify the probability structure and to bind this knowledge to the categories. Learning the probability structure during encoding would occur only if the individuals could hold bound traces of the words and their locations in memory long enough to identify the probability structure and associate it with the category. Thus, learning the probability structure requires feature binding, which requires attention. Past research demonstrates that attention is needed to perceptually and memorially bind an object to its location (Reinitz, Morrissey, & Demb, 1994; Treisman &

Gelade, 1980).

It could be argued that the probability structure is reconstructed during test opposed to being learned during encoding. That is to say that individuals could retrieve exemplars from a given category and their locations. This would allow them to identify if there was a single location associated with a given category. Doing so would require that participants have multiple bound representations of the majority of the exemplars for a given category. However, this was not the case. Younger adults in the full attention condition had accurate source memory for less than half of the targets in the 25% probability condition and older adults performed even worse. Yet, participants in both of these conditions used the probability structure to inform their source memory judgments in the 100% condition. Furthermore, past research has demonstrated generating such knowledge at test based on retrieving exemplars presented at study is a time consuming process (Reder, 1982; 1987). However, forcing younger adults to respond quickly did not impede them from using the probability structure to facilitate source memory judgments suggesting that participants are not engaging in a time consuming retrieval process.

The current experiments replicate past research demonstrating younger and older adults to use knowledge to improve source memory judgments, However, in this past research, individuals used prior knowledge to do so whereas in the present research they learned something novel about the study environment to do so. Given that prior knowledge is an aspect of crystallized intelligence, which increases across the life span (Horn, 1982; Park & Reuter-Lorenz, 2009; Salthouse & Davis, 2006), it may not seem all that surprising that older adults use a relative strength to improve their source memory. In contrast, drawing inferences and learning new relationships are aspects of fluid intelligence, which decreases across the life span (Horn, 1982). Thus, it seems noteworthy that older adults were able to learn and later use the probability structure to inform source memory judgments. Future research could investigate the extent to which older adults are able to learn other forms of novel episodic knowledge to inform and improve their source memory judgments.

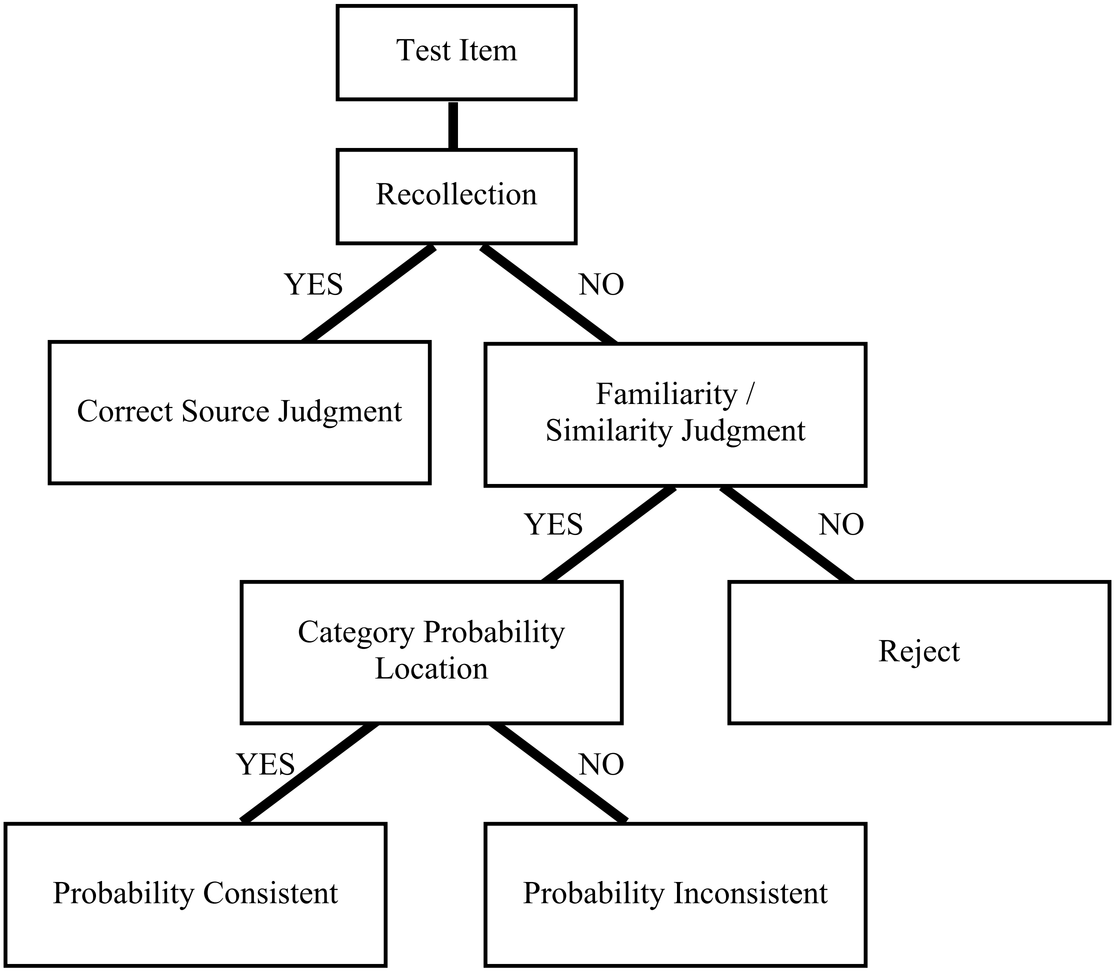

Figure 4.1 Schematic Representation of the Processes Underlying Source Memory Judgments in the Current Experiments

APPENDIX A

SHORT BLESSED TEST (SBT) FORM, ADMINISTRATION AND SCORING GUIDELINES

Participant Number: ________________ **DATE:**____________

Age: ___________

Short Blessed Test (SBT)

"Now I would like to ask you some questions to check your memory and concentration. Some of them may be easy and some of them may be hard."

1. What year is it now?______________ Correct Incorrect
   (0) (1)

2. What month is it now?_____________ Correct Incorrect
   (0) (1)

Please repeat this name and address after me:

John Brown, 42 Market Street, Chicago

John Brown, 42 Market Street, Chicago

John Brown, 42 Market Street, Chicago

(underline words repeated correctly in each trial)

Trials to learning________(can't do in 3 trials = C)

Good, now remember that name and address for a few minutes.

3. Without looking at your watch or clock, tell me about what time it is.
   (If response is vague, prompt for specific response) Correct Incorrect
   (within 1 hour) _______ (0) (1)
   Actual time: _____________

4. Count aloud backwards from 20 to 1 0 1 2 Errors
   (Mark correctly sequenced numerals)

If subject starts counting forward or forgets the task, repeat instructions and score one error

20 19 18 17 16 15 14 13 12 11

10 9 8 7 6 5 4 3 2 1

5. Say the months of the year in reverse order.

If the tester needs to prompt with the last name of the month of the year, one error should be scored

(Mark correctly sequenced months)

D N O S A JL JN MY AP MR F J 0 1 2 Errors

6. Repeat the name and address I asked you to remember.
   (The thoroughfare term (Street) is not required)
   (John Brown, 42 Market Street, Chicago) 0 1 2 3 4 5 Errors
   _____, ______, ___, ___________, ________

<u>**Check correct items**</u> <u>**USE ATTACHED SCORING GRID & NORMS**</u>

Short Blessed Test (SBT) Administration and Scoring Guidelines

A spontaneous self-correction is allowed for all responses without counting as an error.

1. What is the year?

Acceptable Response: The exact year must be given. An incomplete but correct numerical response is acceptable (e.g., 01 for 2001).

2. What is the month?

Acceptable Response: The exact month must be given. A correct numerical answer is acceptable (e.g., 12 for December).

3. The clinician should state: "I will give you a name and address to remember for a few minutes. Listen to me say the entire name and address and then repeat it after me."

It is important for the clinician to carefully read the phrase and give emphasis to each item of the phrase. There should be a one second delay between individual items.

The trial phrase should be re-administered until the subject is able to repeat the entire phrase without assistance or until a maximum of three attempts. If the subject is unable to learn the phrase after three attempts, a "C" should be recorded. This indicates the subject could not learn the phrase in three tries.

Whether or not the trial phrase is learned, the clinician should instruct "Good, now remember that name and address for a few minutes."

4. Without looking at your watch or clock, tell me about what time it is?

This is scored as correct if the time given is within plus or minus one hour. If the subject's response is vague (e.g., "almost 1 o'clock), they should be prompted to give a more specific response.

5. Counting. The instructions should be read as written. If the subject skips a number after 20, an error should be recorded. If the subject starts counting forward during the task or forgets the task, the instructions should be repeated and one error should be recorded. The maximum number of errors is two.

6. Months. The instructions should be read as written. To get the subject started, the examiner may state "Start with the last month of the year. The last month of the year is ________________." If the subject cannot recall the last month of the year, the examiner may prompt this test with "December"; however, one error should be recorded. If the subject skips a month, an error should be recorded. If the subject starts saying the months forward upon initiation of the task, the instructions should be repeated and no error recorded. If the subject starts saying the months forward during the task or forgets the task, the instructions should be repeated and one error recorded. The maximum number of errors is two.

7. Repeat. The subject should state each item verbatim. The address number must be exact (i.e. "4200" would be considered an error for "42"). For the name of the street (i.e. Market Street), the thoroughfare term is not required to be given (ie. Leaving off "drive" or "street") or to be correct (ie. Substituting "boulevard" or lane") for the item to be scored correct.

8. The final score is a weighted sum of individual error scores. Use the table on the next page to calculate each weighted score and sum for the total.

Final SBT Score & Interpretation

Item #	Errors (0-5)	Weighting Factor	Final Item Score
1		X 4	
2		X 3	
3		X 3	
4		X 2	
5		X 2	
6		X 2	
			Sum Total = _______ *(Range 0-28)*

Interpretation

A screening test in itself is insufficient to diagnose a dementing disorder. The SBT is, however, quite sensitive to early cognitive changes associated with Alzheimer's disease. Scores in the impaired range (see below) indicate a need for further assessment. Scores in the "normal" range suggest that a dementing disorder is unlikely, but a very early disease process cannot be ruled out. More advanced assessment may be warranted in cases where other objective evidence of impairment exists.

- In the original validation sample for the SBT (Katzman et al., 1983), 90% of normal scores 6 points or less. Scores of 7 or higher would indicate a need for further evaluation to rule out a dementing disorder, such as Alzheimer's disease.

0 – 6 Normal Cognition
7 - 28 Questionable Impairment (need to evaluate for determining any dementia or severity of dementia).

APPENDIX B

LIST A AND B CATEGORIES, EXEMPLARS, AND FILLER WORDS

List A Categories and Exemplars

Fruits	States	Professions	Animals	Male Names	Earth Formations
Apple	California	Doctor	Dog	John	Mountain
Banana	Florida	Lawyer	Lion	Bob	Ocean
Pear	Maryland	Firefighter	Cow	Chris	Lake
Strawberry	Alabama	Accountant	Elephant	Brian	Hill
Plum	Georgia	Dentist	Mouse	Steve	Cave
Cherry	Maine	Secretary	Giraffe	David	Glacier
Blueberry	Oregon	Policeman	Rabbit	Tim	Stream
Lime	Nevada	Carpenter	Sheep	Adam	Desert
Orange	Colorado	Teacher	Horse	Mike	River
Grape	Texas	Nurse	Bear	Matt	Volcano
Peach	Virginia	Professor	Tiger	Joe	Valley
Kiwi	Washington	Psychologist	Deer	Tom	Canyon
Mango	Arizona	Engineer	Pig	Dan	Plateau
Lemon	Ohio	Manager	Squirrel	Mark	Cliff
Cantaloupe	Utah	Banker	Goat	Bill	Island
Melon	Arkansas	Janitor	Zebra	James	Waterfall

List B Categories and Exemplars

Furniture	Body Parts	Countries	Birds	Vegetables	Female Names
Chair	Leg	America	Eagle	Carrot	Sarah
Couch	Foot	France	Bluejay	Broccoli	Jessica
Desk	Head	England	Hawk	Peas	Jennifer
Loveseat	Eye	Spain	Parrot	Potato	Lauren
Ottoman	Nose	China	Pigeon	Onion	Ashley
Stool	Mouth	Russia	Dove	Squash	Jane
Armoire	Neck	Ireland	Falcon	Cauliflower	Kristen
Cabinet	Elbow	India	Owl	Radish	Megan
Table	Arm	Canada	Woodpecker	Lettuce	Mary
Bed	Finger	Mexico	Hummingbird	Cucumber	Anne
Dresser	Toe	Germany	Crow	Corn	Katie
Nightstand	Hand	Italy	Sparrow	Celery	Amy
Recliner	Ear	Japan	Seagull	Spinach	Beth
Futon	Knee	Brazil	Parakeet	Beans	Kelly
Bookshelf	Ankle	Australia	Canary	Cabbage	Lindsay
Sofa	Shoulder	Sweden	Raven	Asparagus	Michelle

List A and List B Filler Words

List A	List B
Gasoline	Diamond
Polyester	Cousin
Spoon	Gray
Magazine	Noun
Steel	Rope
Dollar	Hammer
Drum	Golf
Ball	Tornado
Pencil	Oxygen
Church	Ballet
Soda	Carnation
Train	Tie

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BIOGRAPHICAL INFORMATION

Crystal Marie Cooper Cortes received her Bachelor of Science degree in Psychology at the University of Texas at Arlington in 2007. While in her graduate training, Crystal's primary research has focused on the compensatory nature of human memory across the lifespan. Some of her current research, and interest, focuses on the biological mechanisms behind normal and abnormal changes in the aging brain and how it affects human learning and memory. She aims to earn her PhD in Health Psychology and Neuroscience in 2012 from the University of Texas at Arlington.