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**Generation and Category Effects on Item and Source Recall:**

**Age-related Differences**

by

**Susan Farella-Busch**

**A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York**

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**Abstract****Generation and Category Effects on Item and Source Recall:****Age-related Differences****By****Susan Farella-Busch****Advisor: Wilma A Winnick, Ph.D.**

Younger adults' source and item memory rarely differ, while older adults' source memory is usually more impaired than their item memory. In the present experiment item memory and two types of source memory were tested: encoding source memory and the proposed category cued source memory. The source memory scores for these two groups were predicted to differ depending on the source task demands.

In two experiments 27 older participants (65-89 years old) and 27 younger participants (18-30 years old) were presented three encoding tasks at study: read a target word at the end of a full sentence (read only), complete an incomplete sentence with the target word (generate word), and generate a sentence to a given target word (generate sentence). Half of these target words belonged to three categories, and half of the words could not be grouped into common categories.

Differences between the two experiments were introduced at the retrieval stage. Experiment 1 measured item memory by free recall, encoding source memory by source identification, and category influences by category-cued recall. Experiment 2 omitted free recall and changed the encoding source measure to encoding cued

recall; i.e., participants were to name the words that had been encoded in each of the three ways. Thus, the retrieval measures were made comparable (i.e., both cued recall tasks).

Robust effects of the three-step encoding processes were found in item and encoding source memory for both groups, in which memory scores for the generative conditions were higher than memory scores for the read only condition. Cued category recall scores were higher than encoding source scores for older adults, whereas these scores were not significantly different for younger adults. Age effects were suggested by the comparison of results between Experiments 1 and 2, which showed that the young group had higher overall scores in Experiment 2 (using encoding source cued recall), while the older group performed more poorly on the second experiment. Results were interpreted within the framework of relevant memory and aging theories.

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## INTRODUCTION

Experimental studies of verbal memory typically follow the presentation of a list of words with either a recognition or a recall test of memory for the items studied. Additional test questions may follow to ask, for example, whether a word had been seen in capital letters or was located at the beginning of the list. Such questions, probing memory for context or circumstances accompanying each word, provide an operational definition of source memory.

Source has been described as "...a variety of characteristics that, collectively, specify the conditions under which a memory is acquired, (e.g., the spatial, temporal, and social context of an event; the media and modalities through which it was perceived"; Johnson, Hashtroudi, & Lindsay, 1993, p.3). The authors of that article also emphasized that source memory is a critical component of cognition and a vital part of memory. Consistent with this perspective, Anderson and Craik (2000) maintain that what is now called explicit memory may, in fact, be source memory.

The current investigation has examined item and source memory in young and old persons in a study paradigm that included categorized and "noncategorized" words studied with three kinds of processing tasks. The processing instructions were: to read the word in a sentence; to use the word to complete the sentence; and to use the word to form a new sentence. These encoding conditions were predicted to affect both item and source memory scores differentially in young and old adults.

Source memory is typically affected by age more than item memory; while, in younger adults, item and source memory scores often do not differ. Hence, another important aspect of the present study was the inclusion of older adults since previous

findings suggest that older adults may process information differently from younger adults. These studies have provided evidence that the limited spontaneous processing of complex materials by old persons is at least partially responsible for their poorer explicit memory scores (Anderson & Craik, 2000; Craik, 1984; Craik & Jennings, 1992).

Creating a sentence and completing an incomplete sentence with a target word are both generative tasks, and generation, as the encoding task, has been found to induce more elaborative encoding for item and source memory in older adults (Heth, 2000; Mitchell, Hunt, & Schmitt, 1986; Rabinowitz, 1989).

One source proposed in the present paradigm is new: namely the category affiliation of the words, such that each word belonged to one of three categories or had no common category belongingness. The category variable was composed of words belonging to categories (i.e. animals, foods, and physical structures) as well as “noncategorized” words, or words that did not fall into one of those three categories. Of note, the words in the “noncategorized” group did not fall into common category formulations. Interest was in the role that category belongingness might play in item as well as source memory. As a semantic category is a characteristic of the words themselves, this possible source is sharply different from the encoding variable as source. Specifically, category affiliation is passive and covert, in its lack of involvement in active and differential responding at study, while the encoding variable entails active responding to each of the instructions, rendering the sources very different.

Differences in the cognitive operations of young and old persons strongly suggest that memory scores for these two possible sources would differ as a function of age.

Each of the effects of the variables of generation, category, source, and aging and memory will be examined in the following sections.

### *Generative Encoding Effects*

The encoding processes employed in the present study were a variation of those used in an original generation study by Slamecka and Graf (1978). Their processing paradigm presented a cue word (e.g. "sweet") with instructions specifying the kind of word to be given in response (e.g. an antonym "sour"). The control condition presented both cue and target word (e.g. sweet-sour) to be read. Their finding was that when target words were generated by the participants, they showed higher memory scores than when the same words had merely been read.

Slamecka and Graf (1978) carried out experiments to study the "robust" generation effect "...across a variety of testing procedures, encoding rules..." (p. 592) and various measures of memory. In these experiments, participants were asked, when given the cue, to generate the target word, or to read the cue and the word, in the control condition. Several generation rules were used within each experiment. For instance, participants were instructed to generate an associated word (*lamp-light*), another member of the same category (*ruby-diamond*), an antonym (*long-short*), a synonym (*sea-ocean*), or a rhyme (*save-cave*). In order to ensure that the words generated were the same as those words presented in the read condition, the first letter of the target word along with the cue was given to participants (e.g. *lamp-l \_\_\_\_*). The results of these five experiments showed a robust increase in memory scores in the generative condition regardless of rules or testing method. The generation effect was found with timed or self-paced

presentation, with between or within-subjects designs, and with participants both informed and uninformed about the memory test.

The paradigm described has since been modified with variations in materials and encoding rules. Specifically, the dichotomous experimental variable (read-generate) has been extended in an attempt to modify the amount of elaborative processing. For instance, Rankin and Collins (1986), Hashtroudi, Parker, Luis, and Reisen (1989a), and Heth (2000) varied the degree of generation rather than using the traditional dichotomous paradigm. Rankin and Collins' generative elaboration for participants was to add 'because' (precise) or 'and' (imprecise) to base sentences. These forms of elaboration were: base sentence (e.g. The thin dog knocked over the trash can.), precise elaborator provided (e.g. The large thin dog knocked over the trash can that held the garbage.), precise elaborator generated (e.g. The thin dog knocked over the trash can because...), imprecise elaborator provided (e.g. The thin dog knocked over the trash can by the back porch.), and imprecise elaborator generated (e.g. The thin dog knocked over the trash can and...). Rankin and Collins' results suggested that young and old differences in memory scores became greater with generation of precise elaborators. Specifically, younger participants who were requested to generate precise elaborators showed higher recall scores than those young adults who were provided precise elaboration. However, older adults showed higher cued recall scores when the precise elaborators were provided than when precise elaborators were generated.

Hashtroudi, Parker, Luis, and Reisen (1989) reported contradictory findings from their investigation of the generation effect on memory scores (cued-recall) using similar variations of elaboration. Their paradigm had four levels: base sentences (e.g. The old

man bought the paint.), imprecise elaborators which added 'less comprehensible' words to the base sentence (e.g. The old man bought the paint that was on the top shelf.), precise elaborators which added more comprehensible words to the base sentence (e.g. The old man bought paint to color his cane.), and self-elaboration or generation level which required that words be added as a meaningful continuation of the base sentence. The researchers found that the processing conditions had different effects in older and younger adults. Older adults did not differ in their performance in the baseline, imprecise, or precise conditions; but self-generation significantly improved recall. In younger adults, precise elaborators and self-generation were beneficial for recall while imprecise generators reduced recall. In the self-generating condition the difference between age groups was also reduced.

In her study of item memory in young and old adults, Grix (1998) introduced the target word as cue for sentence generation in a study comparing generation and level of processing. This task was less constrained than the tasks used by Rankin and Collins (1986), Hashtroudi, Parker, Luis, and Reisen (1989), and Heth (2000). Grix compared sentence generation to the control condition of generating five words beginning with the same letter of each target word presented. A generation effect was found, where recognition scores for the sentence generation condition were significantly higher than recognition scores for the same-letter generation condition. Although sharp differences were found in the levels of processing, the recognition scores of older adults and younger adults were not significantly different in the sentence generation conditions. Vollaro (2000) also used target words as a means of generating sentences and reported similar results.

Heth's (2000) study used two generative tasks that required generation of the target word from its definition and of the definition for each target word. Performance on these generative tasks was compared with the control condition of reading words and their definitions. She thereby varied the degree of elaboration. In both age groups the generative tasks produced higher scores than the read task. Older adults benefited maximally from generation, with the greatest benefit occurring for the generation of definitions to target words.

The present study used a three-step hierarchy of generative processing similar to Heth's study with less constraint than Hashtroudi, Parker, Luis, and Reisen (1989), Rankin and Collins (1986), and Heth (2000). Generating one's own sentence to a target word allows a maximal amount of freedom for the individual. It has the advantage of having little constraint on the amount and nature of context material to be generated. Generating a sentence requires the participant to take into account grammar and meaningfulness of the sentence. Using a procedure similar to Heth's (2000), the present study utilized words and sentences rather than words and definitions to investigate whether this three-step hierarchy of generative processing (e.g. read, generate a word, generate a sentence) would reduce the difference in young-old memory scores. In addition, this paradigm may reveal an incremental memorial benefit, based on the degree of elaboration in these two generative conditions, should it occur. In Heth's study, generation of definitions produced the greatest benefit for recognition scores. Therefore, it would be expected that generation of sentences would produce the largest benefit for memory scores in the current study.

Although generative encoding processes have been discussed, the retrieval processes were also relevant. In the present study free recall was chosen for item memory as one retrieval measure. Although the generation effect occurs with younger and older adults using recognition as the retrieval measure (e.g. Heth, 2000), few studies have found a generation effect in older adults with free recall as the retrieval task (but, see MacFarland, Warren & Crockland, 1985). In addition, as far as is known, no one has compared word generation (from an incomplete sentence) to sentence generation. Relative performance on free recall following these two processing conditions for older and younger adults is a basic concern of this study.

Other studies of the generation effect using recognition as the retrieval task have found comparable memory scores for older and younger adults. However, it was not clear whether similar effects would be found with recall. There is evidence that recognition and recall are independent of each other (e.g. Allan, Wildling, & Rugg, 1998; Delbecq-Derouesné, Beauvois, & Shallice, 1990). Evidence also suggests that recall tasks are more difficult for older adults than recognition tasks and therefore age-related decrements have been more pronounced in recall tasks (Anderson et al., 1998; Craik, 1986; Craik & McDowd, 1987; Rabinowitz, 1986; Schonfield & Robertson, 1966). As Craik and Jennings (1992) stated: "...recognition memory involves substantial environmental support because the target item is re-represented in contrast to free recall which necessarily involves more self-initiated activity" (p. 92). Ceiling effects are often found when recognition tests follow generation, which may have obscured results in those studies (Grix, 1998; Mitchell et al., 1986; Rabinowitz, 1989). Importantly, in life, people may need to recall more often than merely to recognize information. Therefore, it

was of interest to study the effects of generative encoding with free recall as the retrieval measure. In addition, free recall protocols provide the means to examine whether semantic clustering (defined as the number of same category words preceding or following another word from that category in free recall) occurred since half of the target words were affiliated with three different categories. If clustering occurs, it could be assumed that participants semantically organized when attempting to recall all of the items.

#### *Category Variable in Item and Source Recall*

The use of category-affiliated words is a key variable in these experiments. Categorization is an essential feature of cognition. Even infants appear to possess the ability to habituate to members of a certain category (e.g. Bornstein, Kessen, & Weiskopf, 1976). Evidence suggests that the original formation of category symbols in infants is not dependent on language or teaching, and these category representations appear to form a rudimentary base from which adult conceptions are developed (Quinn, 2002). Language, thinking, and problem-solving are guided by this organizational structure. As Estes (1994) stated, "Suffice it to say that classification [categorization] is basic to all of our intellectual activities" (p. 4).

Instances in the clinical literature of identifiable impairments in category-affiliated information may inform our views of category influences in normals. Category-specific deficits have been found in cases with specific brain lesions (Damasio, 1990; Damasio, Grabowski, Tranel, Hichwa, & Damasio, 1996; Gainotti, 2000; Martin, Wiggs, Ungerleider, & Haxby, 1996; Warrington & Shallice, 1984). For instance, Warrington and Shallice (1984) described four patients who exhibited a selective

impairment for identification of living things, such as animals or plants. Since that time, many other patients have been described with category specific deficits for living things. The majority of these patients were diagnosed with herpes simplex encephalitis and showed bilateral damage to similar areas in the brain (i.e. bilateral temporal areas). In addition, category-specific deficits for nonliving things (e.g. tools) with preservation of the category of living things, has also been reported (e.g. Warrington & McCarthy, 1983; Gainotti, 2000), thereby, demonstrating an underlying organized structure for the representation and storage of categories.

Memory is one of the intellectual endeavors of humans, and category information has been identified as a component of semantic memory, which is our store of knowledge and facts. A variety of theories of the organization of semantic memory have been put forth. For instance, Collins and Quillian (1969) have developed a hierarchical semantic network model of semantic memory. According to the model, the first level would be the category (e.g. animals, etc.), the second level would be a subset within that category such as birds or fish, and the third level would be the specific members of the subset (e.g. robin, bass). Another possible model is the prototype model originally developed by Posner (1969). "A prototype is an idealized and abstract representation that captures an average of the members of the category" (Haberlandt, 1999, p.92). In this model, specific items are not considered, but the average item in a category is used as an example or representation of that category. A third model put forth as a possible organization of semantic memory is the exemplar model (Medin & Shaffer, 1978). The researchers who developed this model stated that when presented with a novel item

people compare the new item to items that may be similar to it that are already known.

The search for the organization of semantic memory still continues today.

For the present research, interest was in the role of category organization in memory; the overwhelming finding has been of superior memory for categorized words when using sets of category-affiliated words, whether blocked or randomly presented at study, compared to words not categorized. A classic study by Bousfield (1953) illustrates this finding. He presented participants with a list of 60 words comprising 15 words that were members of four categories, and he found that participants clustered category words together.

Tulving and Pearlstone (1966) used an item list that included category-affiliated words with category labels and when participants were given category names at recall, they retrieved more words than when tested by free recall. They made a distinction between availability and accessibility of items, and stated that items may have been encoded and stored (availability); however, without the category cues some of these items were not accessible for free recall. Along the same lines, presenting category cues, with randomly intermixed categorized and “noncategorized” words, researchers found that items were better recalled when cued with category names at recall than when free recall was used (e.g. Bower, Clark, Lesgold, Winzenz, 1969; Epstein & Dupree, 1977; Epstein, Dupree, & Gronikowski, 1979). This category effect with randomly presented words has also been shown with older adults (e.g. Craik, Byrd, & Swanson, 1987; Rabinowitz, Craik, & Ackerman, 1982). Category membership of intermixed words at study may facilitate memory performance because when discovered by the participant this membership is used as an organizational structure, and, also the category items seen

on the list may be “tagged” for recency (Light & Carter-Sobell, 1970). Therefore, at recall when category cues are presented the participant may perform a “limited search” of semantic memory for the items that appeared on the list (i.e., were recently seen; Light & Carter-Sobell, p. 1).

In addition, as stated, category or semantic clustering has been used in many studies as a measure of organization in free recall. Semantic clustering refers to the number of instances in which semantically related words precede or follow each other in free recall. As early as Bousfield (1953) and Bower et al. (1969) it was found that the subsequent free recall of categorized words was characterized by category clustering. In the area of semantic clustering, memory, and aging, the predominant finding is that semantic clustering of items decreases at advanced ages (e.g. Denney, 1974; Hultsch, 1969; Mueller, Rankin, & Carlomusto, 1979; Sanders, Murphy, Schmitt, & Walsh, 1980; Wegesin, Jacobs, Zubin, Ventura, & Stern, 2000; Witte, Freund, & Brown-Whistler, 1993; Witte, Freund, & Seby, 1990). More specifically, researchers have found that younger individuals organize incoming information spontaneously, whereas older adults benefit from experimenter-imposed organization ( Craik, 1984; Shaw & Craik, 1989; Wegesin et al., 2000). In one study, Wegesin et al. investigated item memory in younger and older participants using two encoding formats: items presented blocked by semantic category versus equivalent items presented in a random order. It was found that the semantic blocking condition was beneficial to older adults, but did not benefit younger adults. On item recall, older adults were more impaired on semantic clustering than younger adults. The authors state that organization (semantic clustering) of items to be

remembered may be adversely affected by age unless the task is guided more for older individuals.

Quite different from category involvement in item memory is the possible conceptualization of category as source, which was introduced in this study. Johnson, Hashtroudi, & Lindsay (1993) stated that source is a characteristic that specifies the condition under which a memory is acquired. Context or source of previously experienced events can include features like perceptual context, semantic context, spatial context, and temporal context. Hunt and Seta (1984) suggested that category labels, although not studied as source, occur “automatically” for a participant when an exemplar is presented. They maintain that different associations may occur “between the target word and context cues, which includes category information” (p. 463). In the present study, category affiliation of the word (e.g. the category of animal for the word dog) is proposed as a basis for source. Category affiliation may be considered a source or context of a word because it is a characteristic that may be encoded when the word itself is presented. In other words when one sees the word “raccoon,” the category of animal may coincidentally be activated.

Categorization is unique as a possible source because items are not arbitrarily assigned to sources, but are semantically related to their source, and because words belonging to categories are a matter of general knowledge. Examples of how prior general knowledge can facilitate context or source performance have been provided (Bayen, Nakamura, Dupuis, & Yang, 2000; Mather, Johnson, & De Leonardis, 1999, Spaniol & Bayen, 2002). For example, Bayen et al. investigated whether source identification was better for expected or unexpected information presented by two

different sources. One experiment requested participants to identify which groups of listed items were originally presented: the bathroom list (e.g. shampoo) or the kitchen list (e.g. pot). The results indicated that source identification was better for expected items than for unexpected items, and their analysis found that when participants were uncertain of source they guessed that items were located on the “expected” list or source. The results support the view that source identification may be aided by reliance on previous knowledge.

#### *Source and item memory*

In the preceding section, categorization was examined as having the potential to serve as a source. However, it is important to review the more traditional item and source memory studies. Critical to the present study are age-effects in source memory since source memory has frequently been found to be disproportionately more impaired than item memory in older than younger adults (e.g. Bayen & Mumane, 1996; Cohen & Faulkner, 1989; Ferguson, Hashtroudi, & Johnson, 1992; Janowsky, Shimamura, & Squire, 1989; Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991; Spencer & Raz, 1995; Trott, Freidman, Ritter, & Fabini, 1997). Many investigators have examined different aspects of source memory and age-related changes. For example, older persons have difficulty in deciding whether words had been read or generated at study (Mitchell et al., 1986; Rabinowitz, 1989), whether words had been thought or said (Hashtroudi, Johnson, & Chrosniak, 1989), and whether actions were imagined as being performed or were actually performed (Cohen & Faulkner, 1989; Guttentag & Hunt, 1988; Hashtroudi, Johnson, & Chrosniak, 1990). Age differences were found in identifying whether information was presented in the experimental session or not (McIntyre & Craik, 1987),

which experimenter presented the information (Hashtroudi, Johnson, & Chrosniak, 1989), or the gender (male or female) of the presenter (Kausler & Puckett, 1981a, b). Age-related declines have also been found for identification of the manner in which a stimulus was presented (upper vs. lower case; Kausler & Puckett, 1980), the color of the material presented (Park & Puglisi, 1985), the spatial location of items (Park, Puglisi, & Lutz, 1982) and the temporal order of information (Newman, Allen, & Kasniak, 2001).

Since generative encoding has produced benefits for item memory in young and old adults, the question that arose was whether the three-step hierarchy would be effective in source as well as item memory. Generation as a type of encoding activity has been studied as a form of source by Mitchell, Hunt, and Schmitt (1986), Rabinowitz (1989), Multhaup and Balota (1997), and Heth (2000). Mitchell et al. (1986) examined generation as source by asking participants to report whether each item recalled correctly had been read (e.g., "The horse jumped the *fence*"; p. 80) or generated (e.g., "The agent sold the \_\_\_\_\_"; pp. 80). A cued-recall task (e.g., providing the participant with the word 'agent') was administered for items and, overall, a generation effect occurred, where the words generated produced higher cued recall scores than the words that were read. However, older adults performed more poorly than younger on cued recall tests. As for the encoding source identification task (read or generate), older adults (excluding three who scored near chance) performed almost as well as younger adults. The authors identified a possible ceiling effect for younger adults that may have clouded the results.

Also studying generation as source, Rabinowitz (1989) asked young and old persons either to read target words or to generate words using word fragments as cues (e.g., w\_r\_). An item recognition test was then given, and for each word recognized

participants were asked to identify the encoding source (e.g., whether words were originally read or generated). Younger adults outperformed older adults on the item portion of this task and were also able to identify the source of items significantly better than older adults.

In Experiment 2, Rabinowitz asked participants to generate words by completing a word fragment (Alcohol -v\_d\_a) or asked participants to generate an exemplar to that given category (Alcohol - \_\_\_\_\_; e.g., the participant could generate the word whiskey), and later participants were asked to judge the source of those items (completing the word fragment or naming category exemplars). Recognition scores on the generation tasks were similar for both groups with a ceiling effect for the young masking young/old differences. Younger adults were more accurate in source judgments of read or generate than older adults. Heth's (2000) paradigm also included encoding type as a source, and she found generation of definitions to produce higher recognition scores for young and older adults on item and source memory tasks, compared to read or word generation.

Multhaup and Balota (1997) asked older participants to distinguish between sentences read or sentences completed by the participants themselves. Unlike previous studies comparing young and old, they compared older adults to patients with early Alzheimer's disease. All of the participants, including the patient group, showed a generation effect, where generated words were better recognized than words that were read. They asked the participants about the encoding source and found that older adults were able to differentiate read and generated words; but source memory was disproportionately impaired in the patients with Alzheimer's disease.

How does generation affect source memory? The act of generating may produce a stronger integration between the target word and its encoding source (read, generate word, or generate sentence). Such generation usually involves semantic processing because the participant must search for the target word that intelligibly completes the incomplete sentence, and must take into account word meaning, and syntax for sentence generation. Chalfonte and Johnson (1996) put forth one view of source memory, stating that source memory judgments are dependent on intact memory for the item feature, intact memory for item and source features, and intact memory for the binding of those features. They theorized that source memory impairments in older adults may be partially due to the feature and binding deficits that older adults may exhibit. They compared younger and older adults on recognition memory tasks of item, color, and location of objects. Participants were presented with colored items that were located in different locations on a page and later were asked to recognize the items, the colors, and the locations or two of the features together (e.g. item/color or item/location). Older adults showed poorer recognition memory for information that was "bound" (e.g. item/color or item/location), with scores comparable to memory scores of younger adults for the item alone. Continuing this line of research, Mitchell, Johnson, Raye, Mather and D'Esposito (2000) duplicated these results and went on to conclude that the age-related source memory deficits may be due to encoding difficulties "...where disrupted or inefficient reflective processes [or processing resources] result in less well bound complex memories" (p. 538). Mitchell, Johnson, Raye, and D'Esposito (2000), using functional Magnetic Resonance Imaging (fMRI), found evidence that older and younger adults process information differently at explicit encoding, therefore adding support to

the notion that the difference in source memory for old and young may be due to decreased processing resources in older adults.

Others have reported evidence that reduced processing resources at encoding may be responsible, in particular, for source memory decrements in older adults, since source memory depends on the attentional or processing resources needed to encode both the item and the source (Troyer & Craik, 2000). Previously, researchers in this area have distinguished between different types of context or source: one intrinsic source (e.g. the color of the presented item), which is considered automatic; and the other extrinsic source (e.g. the order in which items are presented), which is considered more effortful (Baddeley, 1982; Geiselman & Bjork, 1980). Troyer and Craik examined the relationship between these two types of context or source and their relative drain on attentional resources, hypothesizing that the intrinsic source would drain attentional resources at encoding less than the extrinsic source. In their study, the intrinsic measure was the color of the word, while the extrinsic measure was the order of the target word presented in a list. A divided attention paradigm was used at encoding and retrieval in order to quantify the amount of attentional resources utilized by the second task. They found that extrinsic context was associated with more attentional or processing resources used at encoding, than intrinsic context, thereby supporting their hypothesis. This outcome also indicated that the processing resources necessary to encode source information are dependent on the type of that source information.

The present study examined memory for both encoding instructions as source and category affiliation as a proposed source. An important difference between the two sources is that the encoding instructions at study are overt and extrinsic, whereas

response to the category affiliation at study is viewed as covert and “intrinsic”. The encoding instructions required an active response, which was more extensive for sentence generation than word generation, causing awareness of these conditions and their differences. Furthermore, generative responses have a relationship to task materials (i.e., the words were used to complete a sentence or the words were used to create a sentence fostering semantic relatedness). In contrast, the category affiliation was considered to be a perceptual semantic attribute of a word, not specifically identified or alluded to during each instance of a category item at study, but rather expressly mentioned only at retrieval, and, as stated earlier, was based on general knowledge. Category as a possible source is a different type of “intrinsic” source since it is semantically related to the word, a part of general knowledge, and unlike traditional “intrinsic” sources, is not arbitrarily paired with the word.

#### *Age-Related Memory Differences*

Although memory deficits in older adults are well known, losses differ as a function of the type of memory task. Age differences in explicit (conscious) memory have been extensively documented ( Craik & Jennings, 1992; Light, 1996; Moscovitch & Winocur, 1995). It also has been found that implicit (unconscious) memory in older adults is minimally if at all impaired (Balota, Dolan, & Duchek, 2000; Craik & Jennings, 1992; Hasher & Zacks, 1979; Graf, 1990; Light, 1996; Schacter, 1987). Therefore, findings suggest that explicit memory is more impaired than implicit memory in older adults. Within explicit memory there are differences in age-related memory decrement as well. For example, there are greater declines in episodic memory (memory for events in one’s life) than semantic (general knowledge and facts) memory. Age-related deficits

have been found in the common ways in which memory is tested, such as list memory, story memory, visual design memory, and facial memory. Age-related declines have been documented in performance on more ecologically valid tasks, such as memory for, activities performed, buildings located on familiar streets, appearance of common objects, medicine labels, and names of people ( Craik & Jennings, 1992). In addition, memory deficits for the context (or source) of situations such as whether information was seen or heard have been found ( Craik & Jennings, 1992). However, there are circumstances, such as elaborative encoding with generative processing, that bring about attenuation of age-related memory deficits (e.g. Grix, 1998; Heth, 2000; Vollaro, 2000).

Therefore, it is of interest to review theories of explicit (item and source) age-related memory loss. These include the reduced attentional resources theory and reduced processing resources theory. Each theory will be described briefly.

One explanation for age-related memory decline is the notion of reduced attentional resources in older adults. Much of the evidence for reduced attentional resources comes from research using divided attention tasks. The rationale is that the more attentional resources consumed by encoding and retrieval processes the more the divided attention task performance will suffer. Craik (1984, 1986) discusses attentional resource allocation in his environmental support hypothesis. The environmental support hypothesis “refers to the notion that a supportive task environment that facilitates encoding or guides retrieval can offset the effects of reduced attentional resources” (Anderson & Craik, 2000, p. 414). Evidence has suggested that attentional resources are involved in both encoding and retrieval processes; however, if these resources are taxed at encoding, they produce greater detrimental effects than when attentional resources are

taxed at retrieval (Anderson, Craik, & Naveh-Benjamin, 1998; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Naveh-Benjamin, Craik, Perretta, & Tonev, 2000). In addition, Naveh-Benjamin et al. found that as the retrieval task becomes more challenging, the performance on the divided attention task suffers. However, even with more challenging retrieval tasks, evidence suggests that the attentional resources employed are still greater at the encoding stage. Therefore, if attentional resources are reduced with aging, and intact attentional resources are necessary for encoding, it follows that there would be an age-related decrement in memory performance. If attentional resources are engaged at encoding, as with generation, older adult's memory performance may improve. If more environmental support is available at retrieval, less attentional resources may be necessary.

The theory of reduced processing resources, also called the production deficiency hypothesis, states that reduced processing resources in older adults impair their ability to engage in more elaborative or effortful encoding (Anderson & Craik, 2000; Craik, 1984; Craik & Jennings, 1992). This theory is closely tied to the reduced attentional resource theory and recently has been incorporated into the environmental support theory (Anderson & Craik, 2000). Although older adults' memory decrements may be due to an inability to spontaneously perform effortful or elaborative encoding, these decrements may be reduced by inducements to carry out more elaborative processing. Recent neuroimaging evidence has supported this possibility (Anderson et al., 2000; Logan, Sanders, Snyder, Morris, & Buckner, 2002), indicating that reduced processing resources may be the key to age-related memory decline.

Neither of these theories alone necessarily accounts for age-related memory declines. In addition, many of the tenets of these theories overlap. For instance, attentional resources and processing resources are not mutually exclusive. The search for an acceptable theoretical framework still continues today.

### *The Present Study*

The two experiments of this study investigated the effects of three encoding tasks on item and source memory in young and old participants and included two different types of source memory: one memory for encoding instruction accompanying each word, the other memory for category affiliation of each word, which is the proposed source. Special interest was in age differences in the effects of both kinds of source memory.

In Experiment 1 encoding source responses were required to identify the kind of encoding applied to each word recalled. Therefore, for every word correctly recalled in free recall, participants were asked to identify the encoding condition in which they originally encountered the word. Experiment 2 used a cued recall format to measure source responses and free recall was eliminated. Thus, for each encoding condition (e.g. words used to generate a sentence) participants were asked to list all the target words they recalled that had been encoded in each way. For category affiliation as a proposed source, cued recall was used in both experiments since category affiliation could not be measured as an identification task (e.g. asking if the word 'giraffe' belonged to the category of animals would not assess source memory).

In Experiment 1, encoding requirements were varied in order to examine effects on free recall of items and identification of encoding source after free recall. It is important to note that free recall was the measure of item memory in the present

experiment. In the encoding source identification task, participants were requested to identify the source (target word was read as part of sentence; target word was supplied to complete the sentence; or target word was cue for generation of a sentence) for each item correct on the free recall task. Encoding source identification was chosen, because this is the standard source measure used in many experiments (e.g. Heth, 2000; Mitchell et al., 1986; Rabinowitz, 1989).

The second proposed source task was based on category affiliation of the words presented at study, half categorized and half not categorized. Following free recall and encoding source identification, category-cued recall presented the category labels (foods, animals, and physical structures) and the participant was asked to list, for each category label, the target words in that category that had been studied, and also to list target words seen that did not have any category association. The proposed category-based source recall was considered a knowledge-based type of source.

Three retrieval tests were administered in Experiment 1: free recall of items, encoding source identification, and category cued-recall. Many studies with generation as the main paradigm have used recognition as the item retrieval task. However, the present study used free recall as the item memory measure with interest in how these different encoding processes would affect item recall scores of younger and older adults.

In sum, Experiment 1 investigated item (free recall), encoding source memory, and category affiliation of the target words as item and source memory. Predictions for Experiment 1 were: 1) Older participants would be better on category-cued recall than encoding source identification since the former is based in general knowledge; 2) In free recall younger adults would show higher semantic clustering than older adults, as

has occurred in the literature (e.g. Denney, 1974; Hultsch, 1969; Mueller et al., 1979; Sanders et al., 1980; Wegesin et al., 2000; Witte et al., 1993; Witte et al., 1990); 3) The increases in elaboration were expected to increase memory scores, with sentence generation producing the highest scores, which would be higher than word generation, which in turn would be higher than the read only condition.

### Experiment 1

The first experiment examined young-old memory scores from three retrieval tasks: free recall, encoding source identification, category-cued recall. The first retrieval task was item memory, then identification of encoding condition for each recalled word. A third retrieval test searched for the potential source influence of category affiliation by presenting category names and asking for the words studied that belonged to these categories. These are quite different from the standard method of measuring source memory by identification, which is identification of source for each correct item. The administration of three retrieval tasks applied to the same materials was unusual, but was dictated by the important comparisons in the present study, which were the effects on item memory scores and the two kinds of source memory scores. They were also necessary for comparisons with results of the retrieval tasks of Experiment 2.

#### *Method*

*Participants.* Serving in this study were 27 young ( $M = 21.24$  years,  $SD = 5.09$ ) and 27 older adults ( $M = 73.56$  years,  $SD = 5.85$ ). Demographic information for the groups is shown in Table 1. The young participants were from a pool of Introductory Psychology students serving in the study in partial fulfillment of course requirements. The older adults were recruited from senior centers and senior independent

Table 1

*Demographic Information of Younger and Older Groups in Experiment 1*

	<u>Young</u>		<u>Old</u>		<i>r</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Education in years	13.17	1.86	13.44	2.44	0.54	0.58
MMSE scores	29.35	0.78	29.41	0.74	0.52	0.61
WAIS-III Vocabulary Scores	45.56	7.74	45.33	7.71	-0.21	0.84
Percent Female	81.48%		74.07%		.43**	0.51

\*\* Note: this is a Chi<sup>2</sup> statistic.

living facilities throughout Queens, Nassau, and Suffolk counties. Inclusionary criteria for the participants were: English as a primary language (i.e., the first language learned); age range 18 to 35 years old for younger adults, and 65 to 89 years old for the older adults; and a criterion score of 27 or above on the Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) with corrections for age and education (see Monsch et al., 1995). An additional provision was that only one error point could be from the recall portion of this test. Exclusionary criteria (see Appendix A) for both groups were: a history of a 1) primary Axis I psychiatric disorder; 2) neurological disorders, such as head trauma, epilepsy, stroke, Multiple Sclerosis, Parkinson's disease, or signs of possible neurological decline such as diagnosed memory problems, balance problems or dizziness, and double vision; 3) diseases with possible neurological effects such as hypertension, cardiac conditions, thyroid problems, Lyme disease, or kidney disease; 4) uncorrected vision or hearing problems; and 5) hormone replacement therapy.

As shown in Table 1, there were no significant differences in the two groups' educational level, scores on the MMSE, or raw scores on the Vocabulary Subtest of the Wechsler Adult Intelligence Scale - Third Edition (WAIS-III; Wechsler, 1997).

*Apparatus and Materials.* A standard portable computer with 14" screen was used to present the study materials that consisted of 36 concrete nouns (either as target words within a sentence, target words for sentence generation, or as target words to complete incomplete sentences) chosen from normative lists (Battig & Montague, 1969). The words and sentences are presented in Appendix B. The target words were 5-12 letters long, and of low frequency to high frequency of usage (Kucera & Francis, 1967). Half of the words chosen belonged to one of three different categories (i.e. food, animals,

and physical structures) and half were not members of those categories (i.e. “noncategorized”) words. Of note, the “noncategorized” words belonged to categories other than the three categories mentioned, lengths were taken to choose words did not form common category groupings.

There were three processing instructions presented in blocks: 1) to read a complete sentence out loud, 2) to generate a word to complete an incomplete sentence, and 3) to generate a sentence for a given (target) word. Words presented for each individual encoding task included two animals, two foods, two physical structures, and six “noncategorized words”. There was a unique sentence for each word to a) either be completed by the participant or b) read as the control condition. The blocks of materials for each instructional condition were counterbalanced across participants. For each condition the words used were presented in a different random order for each participant.

The three blocked encoding lists did not differ on word frequency,  $F(2,17) = .52$ ,  $p = .60$ , or number of letters,  $F(2,17) = .89$ ,  $p = .45$ , for the target words. The words belonging to the three categories (i.e., animals, foods, and physical structures) and the target words that did not belong to those three categories (i.e., “noncategorized” words) did not significantly differ in word frequency,  $t(34) = .22$ ,  $p = .83$ , or number of letters,  $t(34) = .32$ ,  $p = .75$ . The sentences varied in length from 8 to 16 words.

*Procedure.* Approval of the Institutional Review Board (IRB) and the requirements for dissertation studies with Human Subjects were obtained. Participants read and signed the IRB approved Informed Consent shown in Appendix C. The investigator then administered a short background and health questionnaire to participants. After the health questions were completed, the MMSE was administered.

Based on these findings the individual was either included or excluded from the study. If included, the participant began the study portion of the experiment described below. No mention was made of the pending memory test.

The experiment began with general information that the participants would be reading materials from the computer screen and would perform different tasks as requested. Then the study task on the computer began, which presented blocks of words, complete sentences or incomplete sentences in a self-paced fashion. Accompanying each of the three blocks of study materials were instructions to read the material (for the complete sentence), to add a word (for the incomplete sentence), or to generate a sentence (when a single words appeared). Of note, the first letter of the target word was provided in the incomplete sentence condition. If a participant completed an incomplete sentence with a word other than the target word, he/she was given the correct word by the experimenter. If the participant was unable to complete the sentence, guessing was suggested after 20 seconds and if the response was incorrect, the experimenter provided the target word.

After completion of the study phase, three retrieval tasks were administered. The order of these tasks was the same for all participants. First was free recall task in which participants were asked to write down all the target words they could remember in any order. This free recall test measured item memory in the present experiment.

Instructions are given in Appendix D.

Encoding source identification for each word recalled and written on the sheet was next; this is the standard method for measuring source memory. Participants were instructed to place a letter that corresponded to one of the three encoding conditions next

to each word recalled (i.e., B was used to indicate that the participant saw Both a sentence and word; W was used to indicate that that the participant saw an incomplete sentence and was asked to provide the target Word to complete the sentence; and S was used to indicate that the participant saw the target word and was requested to create a full sentence). The full instructions are also shown in Appendix D.

Third, category-cued recall, used a format different from the identification task used for encoding source. For this test participants were presented category labels individually on the response sheets and asked for a listing of the studied exemplars for each category provided, as well as the target words they remembered that did not belong to those categories. A prepared response form was given to the participants for this task. Instructions for this part of the experiment are shown in Appendix E.

With the completion of the experiment proper, the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) Vocabulary subtest was administered to each participant. The total duration of participation was approximately one hour. All results were coded by an ID number to ensure confidentiality.

### *Results*

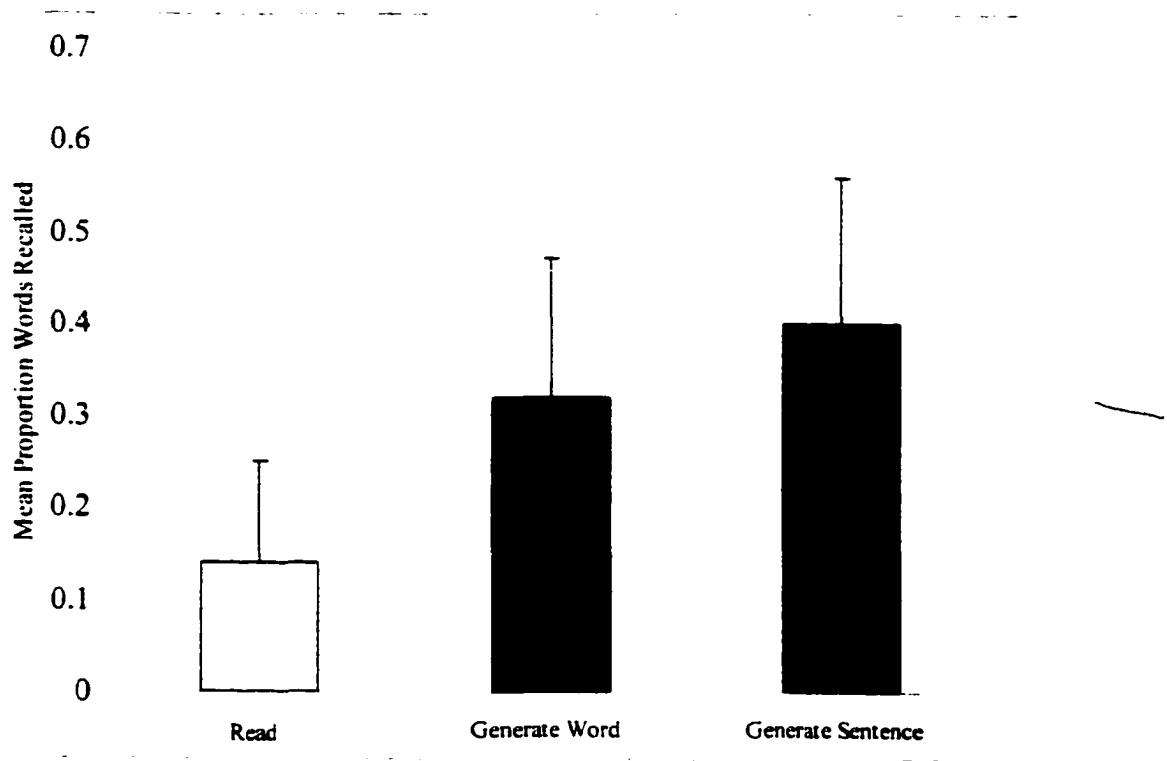
Two main analyses were conducted using the mean proportion of words correctly recalled, for free recall and category-cued recall, and the mean proportions of encoding sources correctly identified, as the dependent measures. Unlike many previous experiments, the present study did not conditionalize encoding source scores based on number of correctly recalled items, yet, the encoding source scores were still dependent on the number and specific items recalled by the participant in free recall. The non-conditionalized scores permitted direct comparison and so that the encoding source

measures could be compared to the other retrieval measures in this experiment and encoding source identification could be directly compared to the encoding source measure in Experiment 2 (see Comparison of Experiments 1 and 2). First was the 2 (Age) X 3 (Encoding tasks) X 3 (Retrieval tasks) mixed factorial Analysis of Variance (ANOVA). The within subjects factors were encoding type and retrieval task and the between subject factor was age group. A separate 2 (Age) X 2 (Word type) X 2 (Retrieval task) mixed factorial ANOVA examined categorized and “noncategorized” words in these two groups as a function of retrieval task. In addition, an independent samples *t*-test for free recall was performed to compare the amount of category clustering in the two groups. Finally, the groups were compared on the number of errors that occurred during the retrieval tasks. The level of rejection was set at  $p = .05$  for all statistical analyses.

*The number of errors on the encoding task at study.* There were 11 older participants and nine younger participants who provided either no answer or the wrong answer to one of the items in the incomplete sentence condition.

*Effects of age.* Younger adults ( $M = .35$ ) achieved significantly higher memory scores than older adults ( $M = .23$ ) collapsed across all other conditions,  $F(1, 52) = 43.30$ ,  $MSE = 425.30$ .

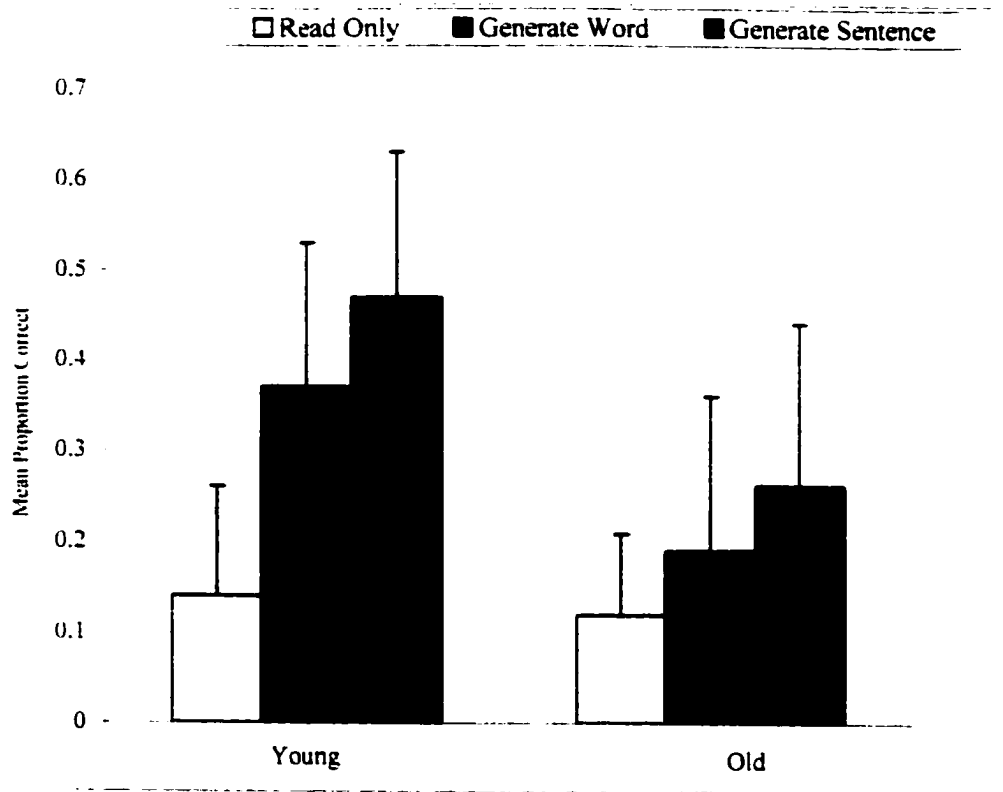
*Effects of encoding tasks.* Figure 1 shows recall scores totaled across the three retrieval task where the scores for the sentence generation condition were higher than the scores for the word generation condition, which were higher than the scores for the read only condition, yielding a significant main effect of encoding type,  $F(2, 104) = 52.96$ ,  $MSE = 529.3$ . Fisher’s least significant difference procedure (LSD) or the unprotected *t*-



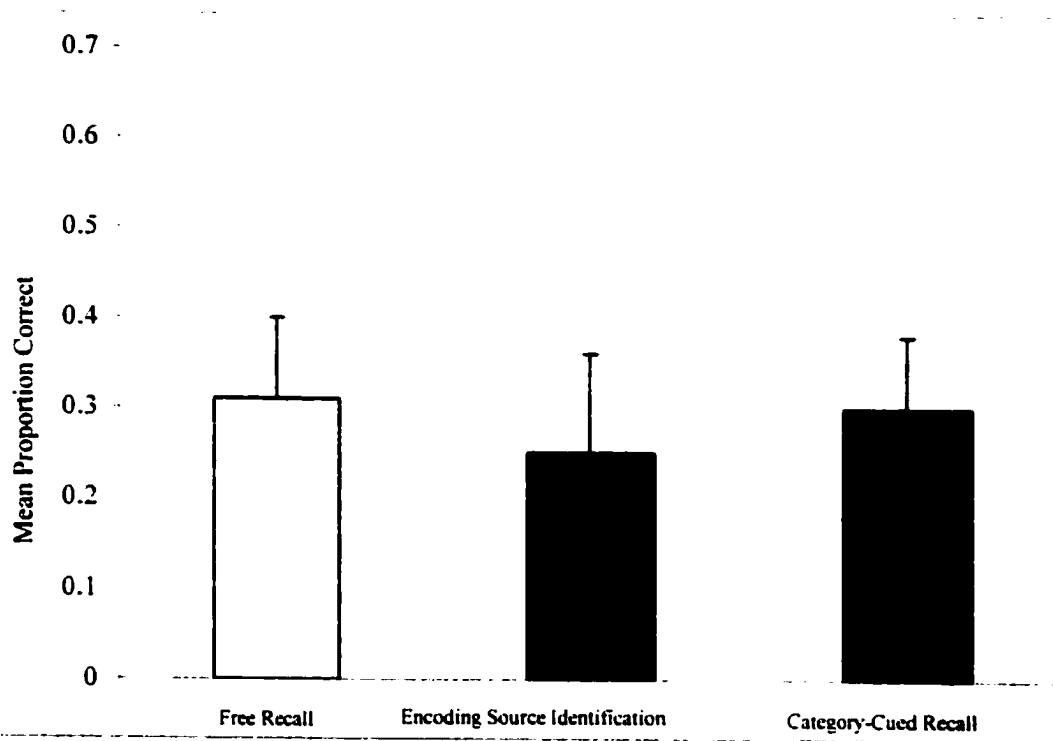
**Figure 1:** Mean proportion of total words recalled (+ *SD*) for the three encoding tasks combining old and young groups in Experiment 1.

test was used to test for significant differences among the means. This test is known to limit the Type I error rate to the alpha level used for the analysis when comparing three means (Ramsey, 1995). The Fisher's LSD indicated that the read only condition ( $M = .14$ ) produced significantly lower scores than the generate word condition ( $M = .32$ ),  $t(53) = 7.10, p < .001$ , which produced significantly lower scores than the generate sentence condition ( $M = .40$ ),  $t(53) = 2.20, p = .032$ . The Age by Encoding interaction failed to find significance,  $F(2, 104) = 1.33, MSE = 529.31$ . As shown in Figure 2, older and younger adults' memory scores for the encoding conditions produced similar step-like statistical effects. Of note, the significant differences across groups remained even when the participants who made errors at study were eliminated ( $F(2, 64) = 23.66, MSE = 40.89$ , using Fisher's LSD read only scores ( $M = .16$ ) were significantly lower than the generate word scores ( $M = .32$ ),  $t(33) = 4.61, p < .001$ , which were significantly lower than the generate sentence scores ( $M = .40$ ),  $t(33) = 2.93, p < .001$ ).

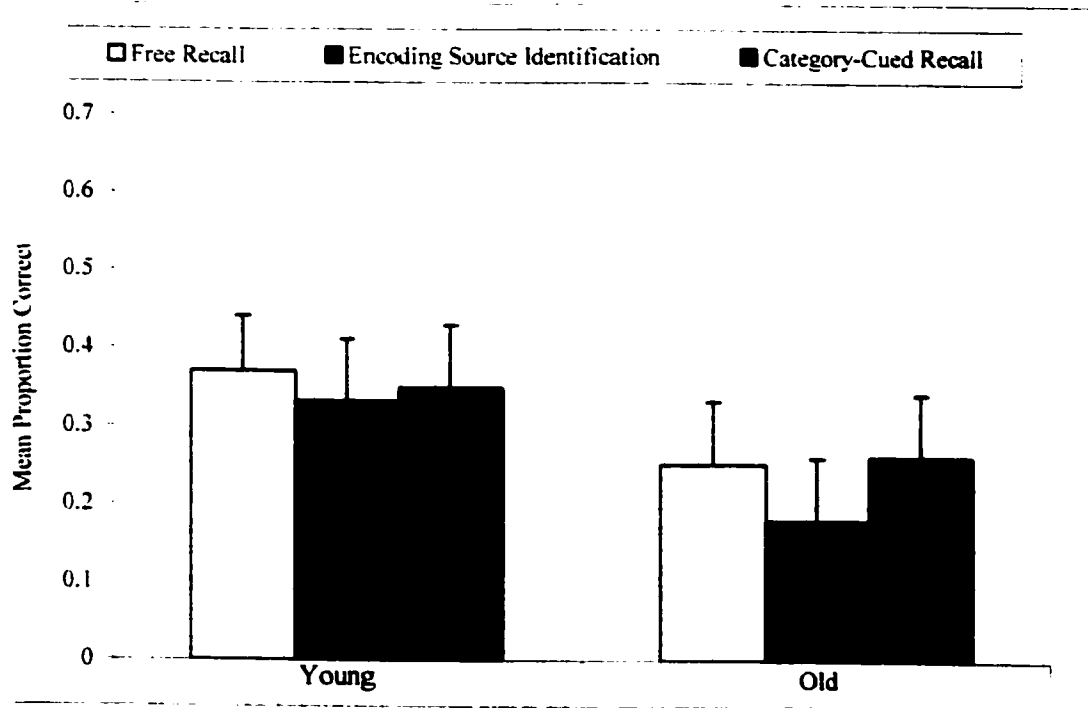
*Retrieval tasks.* The three retrieval tests, item recall, encoding source identification and category-cued recall, produced the mean scores shown in Figure 3. Free recall and category-cued recall scores were higher than encoding source identification scores as confirmed by a significant main effect for retrieval test scores,  $F(2, 104) = 40.49, MSE = 44.98$ . In this case, free recall ( $M = .31$ ) and category-cued recall ( $M = .30$ ) did not significantly differ,  $t(53) = .77, p = .43$ . However, both free recall and category-cued recall were significantly higher than encoding source identification scores ( $M = .25$ ),  $t(53) = 4.83, p < .001$ ,  $t(53) = 6.70, p < .001$  respectively. Of particular interest, Figure 4 shows higher free recall and category-cued



**Figure 2:** Mean proportion of words correctly recalled (+ *SD*) for each encoding condition totaled across all retrieval conditions for old and young in Experiment 1.



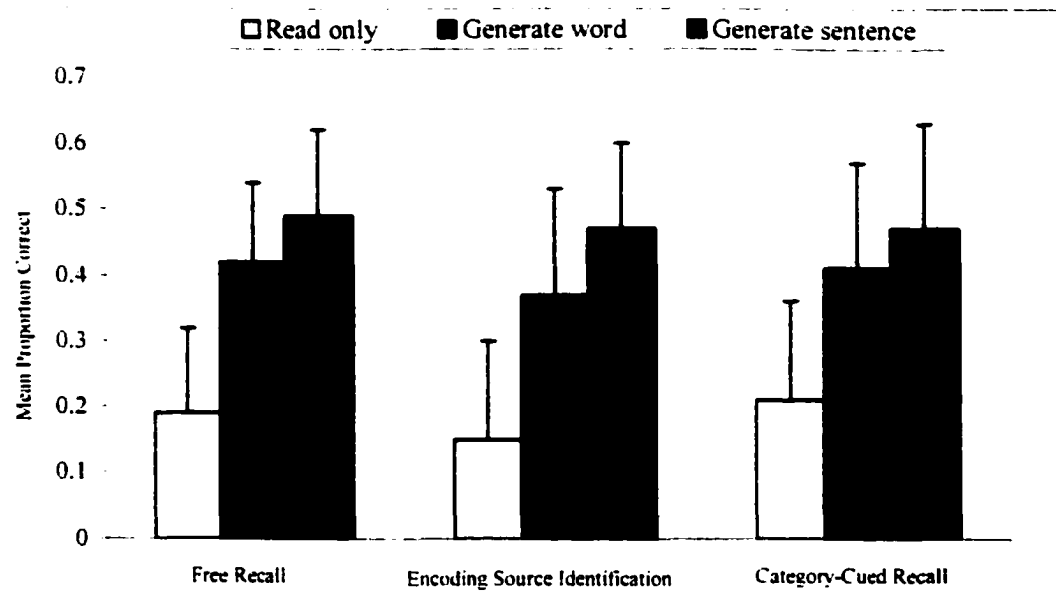
**Figure 3:** Mean proportions of total words recalled (+ *SD*) for the three retrieval tasks in Experiment 1 for all participants.



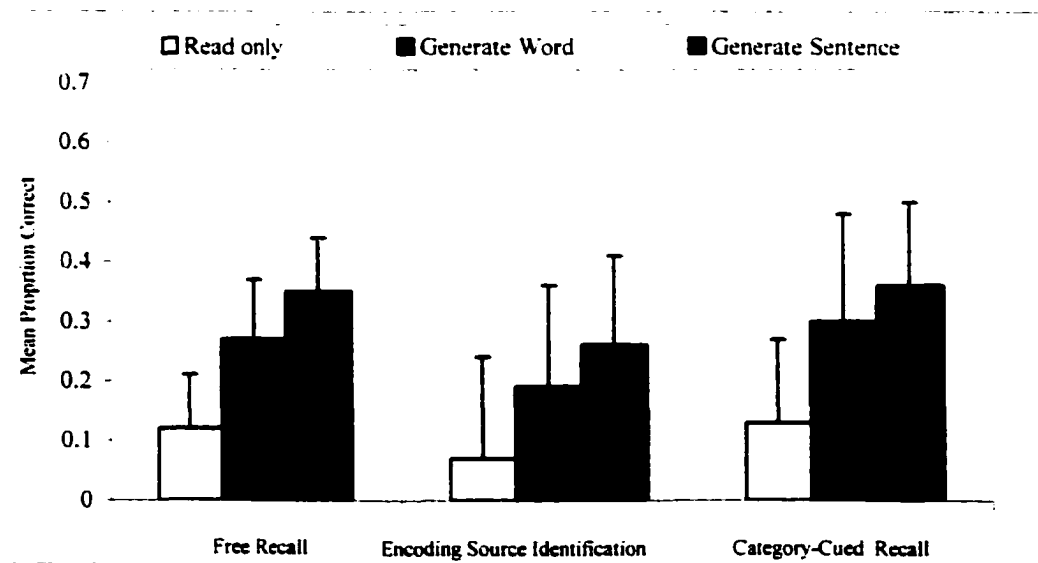
**Figure 4:** Mean proportion of memory scores (+ *SD*) for free recall (item memory), encoding source identification, and category-cued recall for old and young in Experiment 1.

recall scores than encoding source identification scores for older adults. In contrast, for younger adults, free recall scores, category-cued recall scores, and encoding source identification scores were similar. This age difference for the three retrieval tests was confirmed by a significant Age by Retrieval test interaction,  $F(2, 104) = 7.0$ ,  $MSE = 44.98$ . The Fisher's LSD unprotected  $t$ -test revealed that the free recall ( $M = .25$ ) and category-cued recall scores ( $M = .26$ ) did not differ from each other  $t(26) = 1.70$ ,  $p = .10$ ; but the encoding source identification scores ( $M = .18$ ) were significantly lower than both the free recall scores,  $t(26) = 7.83$ ,  $p < .001$ , and category-cued recall scores,  $t(26) = 6.70$ ,  $p < .001$ , in the older adults. However, in the younger adults, these three scores did not significantly differ; free recall ( $M = .37$ ) and category-cued recall scores ( $M = .35$ ),  $t(26) = .61$ ,  $p = .55$ ; source identification ( $M = .33$ ) and free recall scores,  $t(26) = 1.37$ ,  $p = .10$ ; source identification and category-cued recall scores,  $t(26) = .77$ ,  $p = .63$ . As in many previous studies, source memory for older adults was significantly lower than item memory. However, the measure of encoding source did not conditionalize source scores with item scores (e.g. the number of sources correctly identified divided by number of items correctly recalled); therefore, there was a greater likelihood that the encoding source identification scores would be lower than item memory scores. Nonetheless, it is noteworthy that there were age-related differences and that encoding source identification scores were lower than category-cued recall scores, which measured category as source.

*Encoding and retrieval effects.* As shown in Figures 5 and 6, the pattern of scores for each encoding condition did not differ as a function of retrieval task for younger and older adults and the Encoding by Retrieval tests interaction failed to reach significance,  $F(4, 208) = .261$ ,  $MSE = 64.82$ . This finding indicates that both groups had



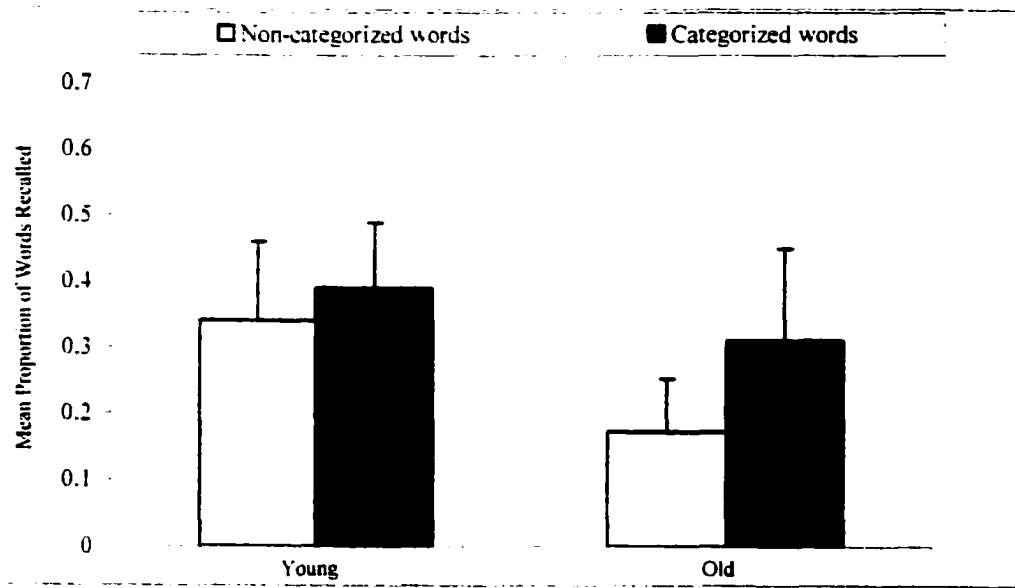
**Figure 5:** Mean proportion correct for younger adults (+ *SD*) on free recall (item memory), encoding source identification, and category-cued recall as a function of the encoding tasks in Experiment 1.



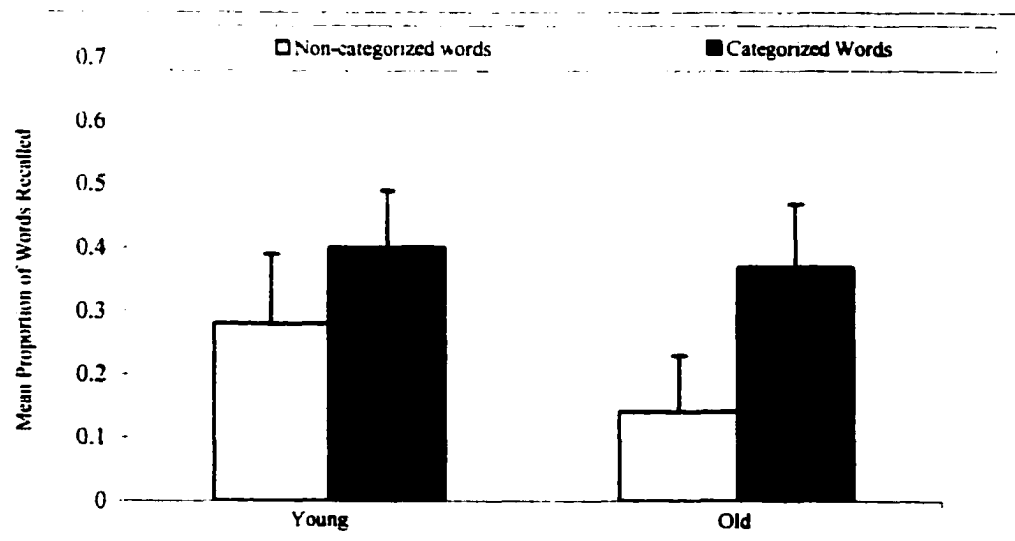
**Figure 6:** Mean proportion correct for older adults (+ *SD*) on free recall (item memory), encoding source identification, and category-cued recall as a function of the encoding tasks in Experiment 1.

a significant stepwise pattern of scores that was similar for the three retrieval tasks (i.e., exercised parallel influence on the two source measures).

*Comparison of categorized and "noncategorized" words.* Proportions of categorized words and "noncategorized" words correctly recalled in free recall and category-cued recall in both groups were examined for any word characteristic or age effects. There was a significant main effect for age,  $F(1,52) = 45.24$ ,  $MSE = 178.16$ , where younger ( $M = .34$ ) outperformed older ( $M = .24$ ) participants on recall scores collapsed across conditions. Figure 7 shows that memory scores for categorized words in free recall were close in value for younger and older adults. As shown in Figure 8, memory scores for categorized words in category cued-recall were also similar in young and old groups. A significant main effect for category affiliation indicated that words belonging to the three categories ( $M = .36$ ; animals, foods, and physical structures) were better remembered in both groups than those that did not belong to any of the three categories ( $M = .24$ ),  $F(1,52) = 34.69$ ,  $MSE = 125.44$ . Also, older adults' memory scores for categorized words ( $M = .35$ ) were higher than their memory scores for "noncategorized" words ( $M = .15$ ); whereas memory scores for younger adults for categorized ( $M = .38$ ) and "noncategorized" words ( $M = .31$ ) were fairly similar. Indeed, there was a significant Age by Word type interaction,  $F(1,52) = 5.34$ ,  $MSE = 125.44$ , indicating that the older and younger participants' recall scores did not differ when remembering category affiliated items (e.g. animals, foods, and physical structures), whereas older participants recall scores were significantly lower than those of younger participants when recalling target words that did not belong to the three categories.



**Figure 7:** Mean proportion of categorized and “noncategorized” words (+ *SD*) recalled on free recall for old and young in Experiment 1.



**Figure 8:** Mean proportion of categorized and “noncategorized” words (+ *SD*) recalled in category-cued recall for old and young in Experiment 1.

In addition, there was a significant main effect for retrieval task,  $F(1,52) = 24.69$ ,  $MSE = 50.59$ , where scores were higher in the free recall condition ( $M = .31$ ) compared to the category-cued recall condition ( $M = .27$ ). An Age by Retrieval task interaction failed to find significance,  $F(1,52) = .20$ ,  $MSE = 50.59$ .

All other two-way and three-way interactions were tested, but none reached significance.

*Category (or semantic) clustering scores in free recall.* In addition to these measures, semantic clustering scores for free recall were also obtained for both groups. It was of interest to examine the amount of category clustering in the free recall task because if category clustering was high in free recall then it could be assumed that at retrieval participants had spontaneously organized the items. An independent samples  $t$ -test compared the amount of category clustering, as measured by the adjusted ratio of clustering score (ARC), between the two groups (Roener, Thompson, & Brown, 1969). The equation for the calculation of ARC scores is shown in Appendix H. ARC scores range from 1.00 to  $-1.00$ . A score of 1.00 signifies perfect category clustering for material to be recalled; a score of 0 indicates categorization by chance, and a score of  $-1.00$  means complete absence of categorization. In addition, ARC clustering scores are independent of the number of items recalled. Older participants'  $M$  ARC was 0.32 with a  $SD$  of .81, while younger participants'  $M$  ARC was 0.24 with a  $SD$  of .48. The clustering scores for the groups show limited category clustering. In addition, the  $t$ -test did not reach significance,  $t(53) = .19$ ,  $p > .87$ , indicating the groups did not differ in the degree of category clustering in free recall.

*Error scores for retrieval tasks as a function of group.* Errors included extra-list intrusions or perseverations for free recall, incorrect encoding source identification for the two source measures, incorrect category assignment, and extra list intrusions or perseverations for category-cued recall and are shown in Table 1. Errors for free recall, encoding source identification, and category-cued recall were compared for group differences. In addition, total intrusion errors were compared. Older and younger adults did not significantly differ in the number of errors produced in the free recall task,  $t(52) = .62, p > .51$ , or in the number of intrusion errors shown,  $t(52) = 1.62, p = .113$ . However, the error scores for the encoding source identification task following free recall,  $t(52) = 2.33, p = .02$ , and for category-cued recall,  $t(52) = 2.04, p = .049$ , significantly differed between the groups, for the latter two source retrieval tasks older adults had significantly more errors than younger adults.

*Summary of the results of Experiment 1.* In summary, Experiment 1 found that both the total recall and source identification scores for younger adults were higher than older adults' scores when collapsed over all three conditions (free recall, encoding source identification, and category-cued recall). As for the encoding conditions, the act of generating a sentence produced higher memory scores than did generating a word, which produced higher memory scores than the reading condition for both groups. On the three retrieval tests, free recall (item) and category-cued recall (source) scores were significantly higher than the encoding source identification scores. The findings also suggested that participants' performance on the three tasks differed in the two age groups.

Table 2

*Error Rates of Younger and Older Groups in Experiment 1*

Retrieval Test	<u>Mean Error Rate</u>		<u>Standard Deviation</u>	
	Young	Old	Young	Old
Free Recall	0.41	0.59	1.04	1.15
Source Identification	1.37	2.41	1.62	1.65
Category-cued recall	0.30	0.96	0.54	1.61

For the younger adults the scores of these three retrieval measures did not significantly differ while, for the older adults the encoding source identification scores were significantly lower than for the other two tasks (free recall and category-cued recall). Category clustering scores in item memory revealed little clustering in free recall with the amount of clustering approximately equal across groups. Another finding was that older adults' memory scores were higher for categorized words, while younger adults recalled both categorized and "noncategorized" words equally well. It is important to note that older and younger adults' memory scores for categorized words did not differ, thus, with category cueing, older adults performed as well as younger adults.

### *Discussion*

The finding of higher memory scores for younger than for older adults is consistent with the literature on memory and aging (Anderson & Craik, 2000; Craik & Jennings, 1992). This finding was expected since free recall provides no cues at retrieval, and without such support at study, age-related decline in memory scores is usual. Also, free recall is considered a more challenging task than recognition and it would be unlikely for the scores of the older adults to be close to the scores of the younger adults, as had occurred in previous generation experiments where recognition was used (e.g. Grix, 1998; Heth, 2000; Vollaro, 2000).

In free recall, younger adults were expected to use category-clustering more than older adults based on findings that older adults' semantic clustering scores are usually lower than younger adults' scores (e.g. Denney, 1974; Hultsch, 1969; Mueller, et al. 1979; Sanders, et al., 1980; Wegesin, et al. 2000; Witte, et al., 1993; Witte, et al., 1990). However, as in the present study, some investigators have found equal amounts of

clustering in these groups (Bäckman, & Wahlin, 1995; Basden, Basden, & Bartlett, 1993). Unlike many previous studies the category items were not simply listed, but were equally distributed among the three different encoding tasks. Only half of the words were available for category clustering, whereas in other experiments many if not all the words at study could potentially be grouped semantically. Overall, there was little spontaneous organization of words into semantically related groups at free recall. Therefore, the grouping that occurred at cued recall was a retrieval event.

An important finding was a generation effect found for item recall and for the two source measures. Generating a sentence compared to generating a word substantially increased item and source memory scores in both groups. When adults were induced by encoding instructions to engage in more elaborative or effortful encoding they showed improvement compared to the passive task of reading with the greatest degree of elaboration (e.g. generating a sentence) producing the highest memory scores. This finding supported the original hypothesis of a stepwise increment in scores with increases in the degree of elaborative encoding.

Encoding source identification scores for both groups paralleled the stepwise increments found for scores in the free recall of words in the three encoding conditions of read, generate a word, and generate a sentence. The influence of generation on source (or context) performance has recently been examined for the generate-read dichotomy, and a generation effect was found for other contexts (e.g. location of the room the participant was in during the encoding condition; Marsh, Edelman, & Bower, 2001). The present introduction of the three-step encoding format extended their conclusion. With the generation effect obtained, it may be that generative processing solidifies the relationship

between the item and the relevant encoding source feature therefore allowing the encoding source feature to be more easily accessible for later identification.

For the three retrieval tasks, it was found that older adults' encoding source identification scores were lower than free recall scores and category-cued recall scores, while, for younger adults, the memory scores for these three tasks were similar. This is consistent with previous findings that traditional source memory is usually more impaired than item memory in older adults compared to younger (e.g. Heth, 2000; Johnson, Hashtroudi, & Lindsay, 1993; Mitchell, Hunt, and Schmitt, 1986; Rabinowitz, 1989; Spencer & Raz, 1995). However, with source scores not conditionalized, there was a greater likelihood of this occurring. Nonetheless, the measure was identical for older and younger adults, and a significant difference was found.

Unlike other studies, in the present experiment cued recall was used for category-cued retrieval, which was a proposed source measure. Therefore, the finding that older adults' performance on category-cued recall was similar to their performance on free recall or item memory is not consistent with the predominant findings on source memory and aging. One possible explanation is that for category-based source memory the item and the source were semantically related. This explanation is three-fold. First, other researchers have found that older persons tend to rely more than younger persons on their general knowledge to attribute items remembered to a source (Bayen et al., 2000, Mather et al., 1999; Spaniol & Bayen, 2002). Since the semantic relationship between the category and exemplars is a part of general knowledge, assigning target items to category labels in a category-cued recall task may have allowed participants to rely more on their knowledge base. For instance, participants may have used the category labels given to

generate items in that category, then deciding whether the item was one encountered at study; this strategy was originally called the generate-recognize strategy (Anderson & Bower, 1972). Second, source memory is dependent not only on intact memory for item and source, but also on the binding of item and source features (Chalfonte & Johnson, 1996). Therefore, if item and source features are more interrelated, as in this special “intrinsic” context where the item is semantically related to its proposed source, it follows item and source are easily bound and therefore more easily remembered. Empirical evidence has supported that traditional intrinsic sources (arbitrarily paired) are better remembered (Spencer & Raz, 1995; Troyer & Craik, 2000). Third, Hunt and Seta (1984) and Rabinowitz et al. (1982) both alluded to category context as an automatic type of memory, one that is coincidentally rather than consciously activated. Therefore, the findings are in line with research on memory and aging, where automatic operations have been found to be less affected than effortful (conscious) operations (e.g. Hasher & Zacks, 1979).

Another possible explanation for the differences in source scores is the disparity in retrieval task demands. One was category-cued recall while the other was encoding source *identification*. Therefore, one limitation of Experiment 1 was the difference in methods of measuring the two source retrieval tasks. In the encoding source identification task, the standard measure of source memory, participants identified the condition in which they encountered each word at study. For instance, for each word freely recalled, the participant was asked how the word was originally encountered (the standard method). Therefore, category could not be measured as an identification task (e.g. it is self-evident that raccoon is an animal). For category-cued recall, participants

were given category designations and asked to recall target words within those categories. According to the literature, recall tasks would be more challenging for participants because they provide fewer cues than an identification task. Therefore, the retrieval task demands may have affected the results. This issue will be addressed in Experiment 2.

The free recall test, which was given before the two source tasks, may have influenced these source measures as well. For the measurement of encoding source, only for the words correctly recalled could source be identified. It follows that source scores could only be equal to or less than item scores. Other researchers have tried to compensate for this source measurement dependency issue. For instance, Wegesin et al. (2000) choose to have their source measurement independent of item recall. Murnane and Bayen (1996) have analyzed various methods of measuring source memory. Their findings were that most methods of measuring source are not independent of item memory, therefore, source measures are not purely measuring source but are influenced by item measures, as was the case in Experiment 1. In contrast, the proposed source of category-cued recall, as measured here, was not restricted by the number of items recalled in free recall. If the encoding source task could bypass item recall, the memory scores for the two source measures may have been more comparable. In addition, category as source could not be measured in the identification format (e.g. it is self evident that a raccoon is an animal), therefore, one possibility is that cued recall might also serve as a measure of encoding source. Such an approach would mean that the free recall test could be eliminated, which was viewed as having interesting potential

consequences. The investigation of these two comparable measures was carried out in Experiment 2.

### Experiment 2

This experiment changed the method of measuring encoding source to match the method used to measure the proposed category as source (category-cued recall). Thus, for the cued encoding source test, the names of the three encoding tasks were presented with the instruction to list the words that had been encoded in each way. This is similar to the way category as source was measured in Experiment 1, with categories presented with the instruction to list target words belonging to those categories or having no category affiliation ("noncategorized" words). An important difference from Experiment 1 is that the free recall task was not included. In consequence source recall was independent of item recall. Since these two tests are recall tests they will be called encoding source cued recall and category-cued recall (as in Experiment 1). These differ from the standard source identification. It is maintained that source is being measured by cued recall in both instances, and such measurement is independent of item recall (since item recall was omitted). Therefore this experiment has measured source recall without item recall. In the present experiment, the order of the two source retrieval tasks could be counterbalanced so that the two retrieval tasks appeared equally often in the first and second recall positions.

#### *Method*

*Participants.* There were 27 young ( $M = 19.70$  years,  $SD = 3.10$ ) and 27 older adults ( $M = 74.00$  years,  $SD = 6.82$ ) participating in this study. Demographic information for the groups is shown in Table 3. Both young and older participants were recruited in

Table 3

*Demographic Information of Younger and Older Groups in Experiment 2*

	<u>Young</u>		<u>Old</u>		<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Education in years	12.77	.81	12.23	2.12	1.25	0.22
MMSE scores	29.40	0.79	29.15	0.86	1.15	0.26
WAIS-III Vocabulary Scores	40.56	6.99	40.37	7.10	0.22	0.83
Percent Female	59.26%		85.20%		.53**	0.52

\*\* Note: this is a Chi<sup>2</sup> statistic.

the same manner and with the same inclusionary and exclusionary criteria as in Experiment 1.

IRB approval and the requirements for dissertation studies with Human Subjects were obtained. Participants read and signed IRB approved Informed Consent, shown in Appendix C.

As shown in Table 3, there were no significant differences between young and old in level of education, scores on the MMSE, or raw scores on the Vocabulary Subtest of the Wechsler Adult Intelligence Scale - Third Edition (WAIS-III).

*Apparatus and Materials.* The words and processing tasks were the same as Experiment 1; all the materials are shown in Appendix B.

*Procedure.* The materials and procedures were the same as in Experiment 1, except that there was no free (item) recall, and the two source responses were measured by cued recall. The two cued recall tasks asked for either recall of the target words in terms of encoding source (e.g. read, generate a word, or generate a sentence) or recall of category exemplars (e.g. animals, foods, physical structures, and "noncategorized" or words that did not belong to one of those three categories). For instance, participants were asked to recall all the target words that they had read and then were asked to recall all the target words they had generated or used to complete a sentence, etc. These questions were asked separately (the participants were given a response sheet for each encoding task). The same procedure was used for category cued-recall, where participants were asked to recall all the animals that were target words and then separately asked to recall all of the foods that were target words, etc. Unlike Experiment 1 where the order of retrieval tasks did not vary (free recall followed by encoding source

identification followed by category cued –recall), in Experiment 2 the order of the two source retrieval tasks alternated. Order of encoding source cued recall and category-cued recall tests was counterbalanced for order and within the respective tests both of the three encoding conditions and the three category conditions were counterbalanced. However, for the latter test the other or “noncategorized” condition was always administered last. The response sheets for each of the three encoding source cued recall tasks were given to participants separately as shown in Appendices F & G. The instructions for the category-cued recall were similar to Experiment 1 except that the response sheets were given to participants one at a time.

As in Experiment 1, with the completion of the study portion of the experiment, the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III; Wechsler, 1997) Vocabulary subtest was administered to all participants.

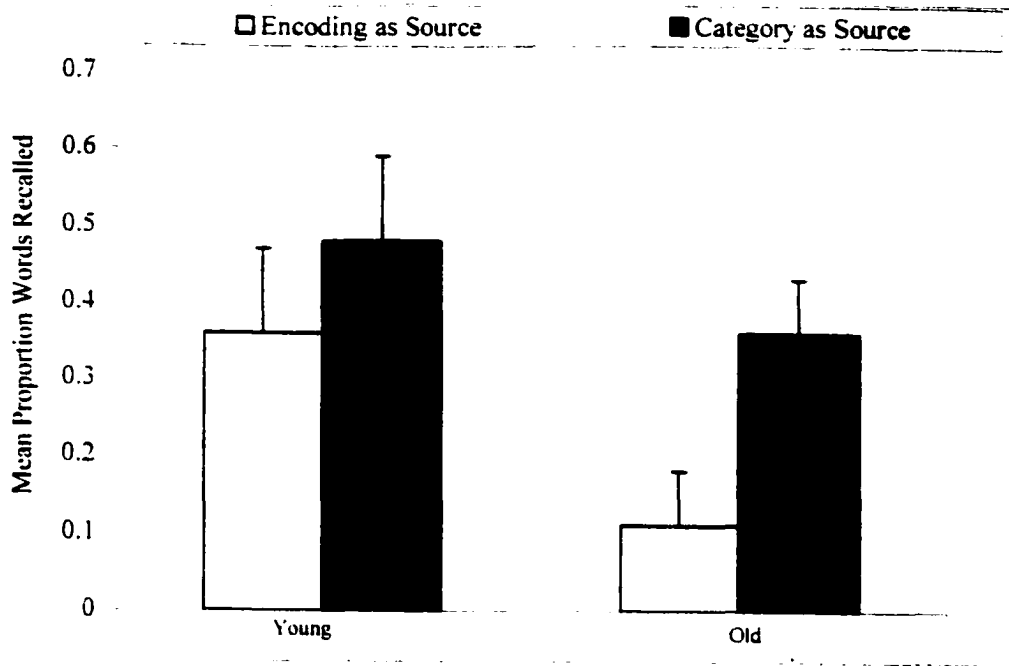
### *Results*

Cued recall scores for the two sources (mean proportion of words correctly recalled), were compared to each other directly by performing a 2 (Age) X 2 (Source type) mixed factorial ANOVA. To examine the effects of encoding processes a 2 (Age) X 3 (Encoding type) ANOVA was performed. In addition, in order to compare categorized words recalled to “noncategorized” words recalled a 2 (Age) X 2 (Word type) ANOVA was performed. The groups were also compared on the number of errors and intrusions that occurred during the retrieval tasks. Finally, a 2 (Order) X 2 (Source Type) ANOVA was performed to examine the effects of order of presentation for the retrieval tasks. The level of rejection was set at  $p = .05$  for all statistical analyses.

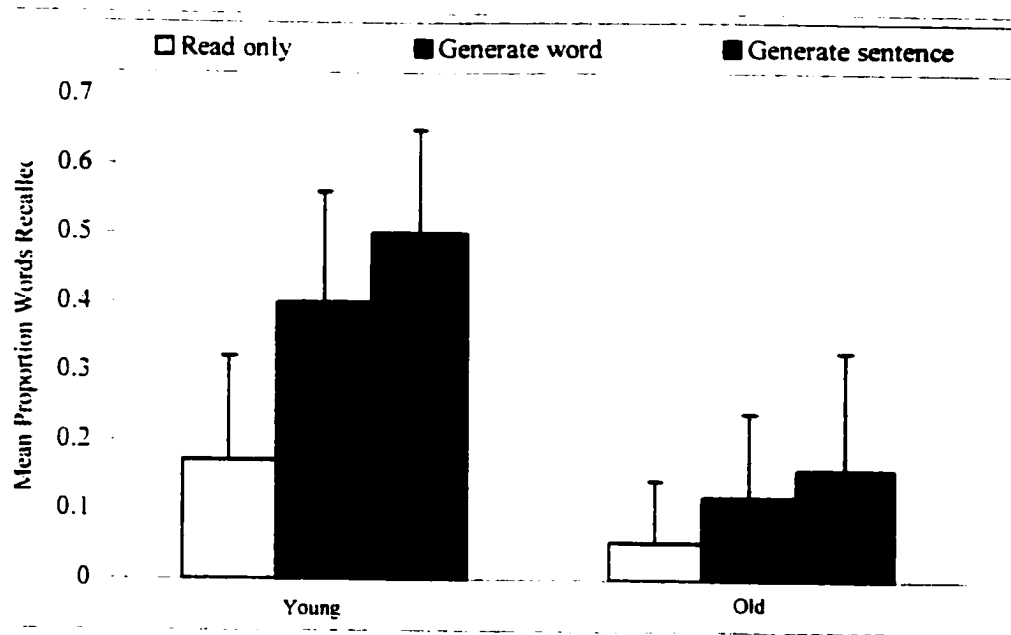
*The number of errors on the encoding task at study.* There were nine older participants and seven younger participants who provided either no answer or the wrong answer to one of the items in the incomplete sentence condition.

*Source recall measures compared.* As shown in Figure 9, total source memory scores of younger adults ( $M = .38$ ) were higher than total source memory scores of older adults ( $M = .16$ ). As predicted, there was a significant main effect for age,  $F(1,52) = 103.99$ ,  $MSE = 123.46$ , where young participants had higher source recall scores than older participants. Also, as seen in Figure 9, category-cued recall scores produced higher scores than encoding source cued recall and there was a significant main effect for source type,  $F(1,52) = 29.94$ ,  $MSE = 51.73$ , where category as source ( $M = .33$ ) produced significantly higher scores than encoding as source ( $M = .24$ ). In addition, there was a significant Age by Source interaction,  $F(1,52) = 17.92$ ,  $MSE = 51.73$ , where older adults' performance on the category source task ( $M = .36$ ) was significantly higher than on the encoding source task ( $M = .11$ ); in contrast, younger adults' performance on these source tasks did not significantly differ [category as source ( $M = .42$ ); encoding as source ( $M = .37$ )].

*Effects of encoding source cued recall.* As shown in Figure 10, younger adults achieved higher scores ( $M = .37$ ) than older adults ( $M = .11$ ) and indeed there was a significant main effect for age,  $F(1,52) = 99.30$ ,  $MSE = 263.37$ . Also shown in Figure 10, the lowest encoding source scores for the old and young were obtained in the read only condition followed by higher scores in the generate word condition with the highest scores in the generate sentence condition. There was a significant main effect of encoding source responses,  $F(1,52) = 34.03$ ,  $MSE = 196.69$ . In order to test for



**Figure 9:** Mean proportion correct (+ *SD*) in the two source measures for the two age groups in Experiment 2.



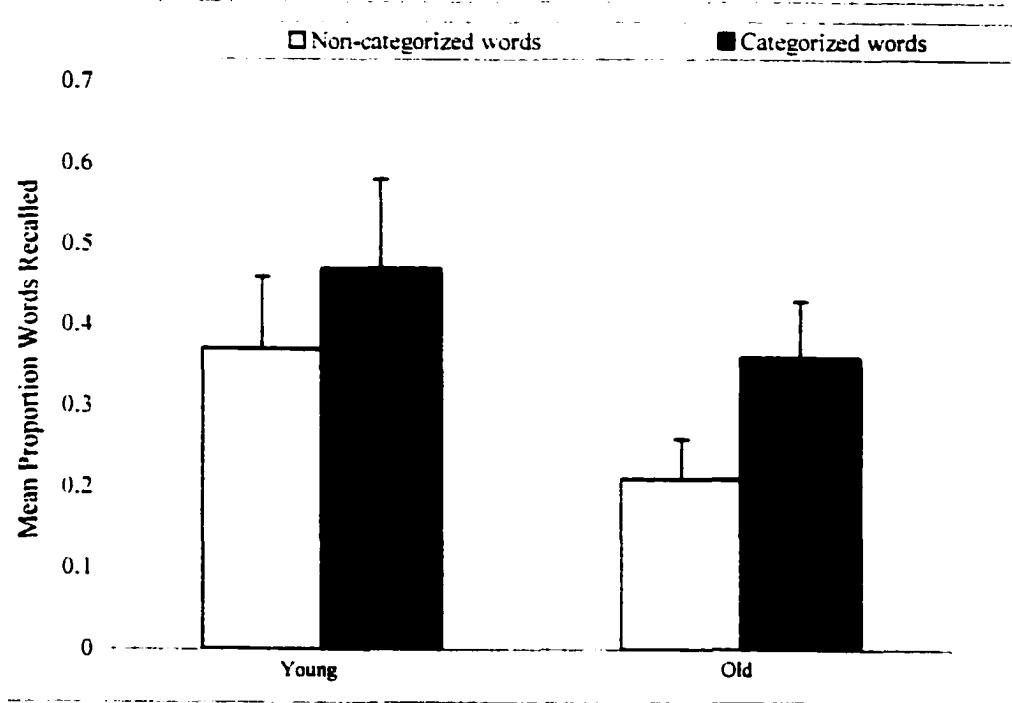
**Figure 10:** Mean proportion correct (+ *SD*) of encoding source cued recall as a function of three encoding tasks for the two age groups in Experiment 2.

significant differences among the means. Fisher's LSD unprotected  $t$ -tests were used. They revealed that the read only scores ( $M = .11$ ) were significantly lower than the generate word scores ( $M = .26$ ),  $t(53) = 5.25$ ,  $p < .001$ , which were significantly lower than the generate sentence scores ( $M = .33$ ) across groups,  $t(53) = 2.56$ ,  $p = .13$ . These significant differences remained even when the participants who made errors at study were eliminated ( $F(2, 72) = 25.30$ ,  $MSE = 206.78$ , using Fisher's LSD read only scores ( $M = .11$ ) were significantly lower than the generate word scores ( $M = .25$ ),  $t(37) = 4.31$ ,  $p < .001$ , which were significantly lower than the generate sentence scores ( $M = .35$ ),  $t(37) = 2.99$ ,  $p < .001$ ).

In addition, there was a significant Age by Encoding type interaction,  $F(1, 52) = 8.24$ ,  $MSE = 196.69$ , indicating that the encoding-based scores for these three conditions differed between the groups. Fisher's LSD unprotected  $t$ -tests revealed that the read only condition ( $M = .05$ ) produced significantly lower scores than the generate word ( $M = .12$ ),  $t(26) = 2.22$ ,  $p = .035$ , and generate sentence conditions ( $M = .16$ ),  $t(26) = 2.82$ ,  $p = .009$ , in the older group; but, the two generative conditions did not significantly differ from each other  $t(26) = .86$ ,  $p = .39$ . For the younger group the read only scores ( $M = .17$ ) were significantly lower than the generate word scores ( $M = .40$ ),  $t(26) = 5.38$ ,  $p < .001$ , which were significantly lower than the generate sentence scores ( $M = .50$ ),  $t(26) = 3.20$ ,  $p = .004$ . These significant differences remained even when the participants who made errors at study were eliminated,  $F(2, 72) = 4.53$ ,  $MSE = 206.78$ .

*Comparison of categorized and "noncategorized" words in category-cued recall.*

Recall scores for categorized and "noncategorized" words were compared between the groups. As shown in Figure 11, there was a significant main effect for age such that



**Figure 11:** Mean proportion of (+ *SD*) categorized and “noncategorized” words recalled in category-cued source recall for the two age groups in Experiment 2.

young participants ( $M = .42$ ) achieved higher recall scores than older participants ( $M = .29$ ),  $F(1,52) = 63.87$ ,  $MSE = 119.15$ . There was also a significant main effect for category affiliation,  $F(1,52) = 32.74$ ,  $MSE = 23.90$ . The highest scores were obtained for categorized words ( $M = .42$ ; "noncategorized" words,  $M = .29$ ). In addition, there was a significant Age by Category affiliation interaction,  $F(1,52) = 45.69$ ,  $MSE = 23.90$ , indicating that older participants benefited more from the category labels than younger participants; although scores for categorized and "noncategorized" words were significantly lower in older adults. Memory scores were higher for categorized than "noncategorized" words for older adults. In Experiment 2 older and younger adults' memory scores for categorized and "noncategorized" words significantly differed (unlike Experiment 1).

*Order of retrieval task.* The effect of order of encoding source cued recall and category-cued recall was examined. No significant differences were found for the main effect of order (encoding source cued recall 1<sup>st</sup>,  $M = .26$ ,  $SD = .15$ ; category-cued recall 1<sup>st</sup>,  $M = .27$ ,  $SD = .11$ ),  $F(1, 52) = .14$ ,  $MSE = 348.92$ , or for the interaction of Source Type by Order,  $F(1, 52) = .03$ ,  $MSE = 36.03$ . Thus, the order of presentation for the source retrieval tasks did not significantly affect the results, indicating no practice or fatigue effects.

*The number of errors on retrieval tasks in the two groups.* Errors were defined as incorrect category or encoding source assignment, perseverations, as well as extra list intrusions. Errors for encoding source cued recall (Young  $M = 1.33$ ,  $SD = 1.86$ ; Old  $M = .92$ ,  $SD = 1.24$ ), category-cued recall (Young  $M = 1.52$ ,  $SD = 1.70$ ; Old  $M = .77$ ,  $SD = 1.22$ ), and total intrusion errors were compared (Young  $M = .41$ ,  $SD = .70$ ; Old  $M = 1.88$ ,

$SD = 2.90$ ). Errors for older and younger adults did not differ significantly in either encoding source cued recall,  $t(52) = .94, p = .34$ , or category-cued recall errors,  $t(52) = 1.84, p = .07$ . However, older adults had significantly more intrusion errors than younger adults,  $t(52) = 2.58, p = .013$ .

*The number of no recall responses in the encoding source cued recall condition.*

There were 13 older adults and 2 younger adults who did not recall any words in the read only condition. In addition, there were 6 older adults and no younger adults who did not recall any words in the generate word condition and 6 older adults who did not recall any words in the generate sentence condition.

*Summary of the results of Experiment 2.* The methods of measuring encoding source memory and the presence or absence of the free recall test differed in Experiment 2. The encoding source memory task (of Experiment 1) was changed in Experiment 2 to a cued recall test and the measurement of category as source was unchanged. The results of Experiment 2 found younger participants' memory scores to be higher than the scores of older participants. Scores from the two source recall tasks, encoding source cued recall and category-cued recall, were compared and age-related differences in memory scores were found. For older participants, the category-cued recall test produced higher memory scores than the encoding source cued recall test. For the younger participants, the memory scores for these two source conditions did not differ significantly. In Experiment 2, within the encoding source cued recall condition and across groups, memory scores for the read only condition were significantly lower than the scores for the generate word condition which were significantly lower than the recall scores of the generate sentence condition. In addition, in Experiment 2, for older adults, both

generative conditions produced significantly higher encoding-based recall scores than the read only condition: but for younger adults the scores of the three conditions differed from each other.

In Experiment 2, both groups had higher memory scores for categorized words than for “noncategorized” words. Noteworthy is that although both groups benefited more from the category affiliation of the words, the category/noncategory difference in memory scores for older adults was significantly greater than this difference for younger adults (see Figure 11). In Experiment 2, older and younger adults’ memory scores for categorized words differed significantly. However, in Experiment 1, older and younger adults’ memory scores for categorized words were similar. In addition, in Experiment 2, older adults produced significantly more intrusion errors than younger adults.

### *Discussion*

Recognizing the differences in methods of measuring the two sources in Experiment 1, Experiment 2 used cued-recall to measure encoding source in the same way as used for category source measurement. Along with this change in method, the free recall test was omitted to permit source measurement uncontaminated by item recall. As predicted, category-cued recall scores (the proposed source) were higher than encoding source cued recall scores when these source retrieval tasks were used. A comparison of group scores for these sources found that older participants had higher scores on category-cued recall than on encoding source cued recall, whereas for younger adults the two kinds of source memory scores did not significantly differ. Categorized words might be expected to produce higher scores since categories and exemplars are automatically related and because category affiliation is a semantic attribute of a word

(Hunt & Seta, 1984; Rabinowitz, Craik, & Ackerman, 1982). This possibility may account for higher scores in category-cued recall compared to encoding source cued recall in older adults, whereas younger adults' source memory scores for these two tasks did not differ. In addition, for the category-cued recall test, it was found that both groups recalled more categorized target words than those not categorized. Unlike the suggested source of category-cued recall, encoding source cued recall performance could not be facilitated by general knowledge since participants could have only relied on their episodic memory of the previous pairing of words with the encoding instruction. Younger adults seem to be able to access and retrieve this information. However, older adults had difficulty explicitly recalling under which encoding condition they had encountered the words at study, providing additional evidence of age-related memory deficits in explicit source memory.

In encoding source cued recall, a generation effect occurred such that read only scores were lower than generate word scores, which were lower than generate sentence source scores when collapsed across groups. With encoding source cued recall: collapsed across groups, the same stepwise effect of generative processing occurred, duplicating the finding for encoding source identification in Experiment 1. However, older adults benefited from the two generative tasks (with no difference between the two), compared to the control condition in encoding-based source recall, whereas, younger adults' source memory scores for the generate sentence condition were higher than memory scores for the generate word condition, which were higher than scores for the control condition. This finding may have occurred because encoding source cued recall may have been more challenging for older adults compared to younger. As stated, some older adults

were unable to recall words for any of these conditions. Although generation produced higher memory scores than reading, apparently the degree of elaboration during encoding was not enough to substantially increase memory scores from generate word to generate sentence in older adults.

Another possible explanation for the difference on encoding source cued recall is the change in retrieval task from the encoding source identification task of Experiment 1 to the cued encoding source cued recall task of Experiment 2. In addition, in Experiment 1 free recall had to be completed prior to the source task while the second experiment omitted free recall. Free recall did not aid encoding source memory for younger adults, since in Experiment 2 scores were as high as those in Experiment 1. However, free recall appeared to facilitate older adults' encoding source memory scores because these scores were higher in Experiment 1 compared to Experiment 2. Most important was that free recall allowed both groups to state all the items that could be remembered and then the participant used the target word they provided for the encoding source identification task. Thus, participants had an accessible pool of items for the source task, suggesting that source memory may be confounded by item memory. This essential difference may account for the change in encoding source memory scores for older adults in Experiment 2.

In Experiment 2, it was noted that older adults had significantly more intrusion errors than younger adults. Hasher and Zacks' (1988) impaired inhibition theory may partially account for these findings as they state that irrelevant information may interfere with goal-oriented information. Older adults produced more intrusion errors, which

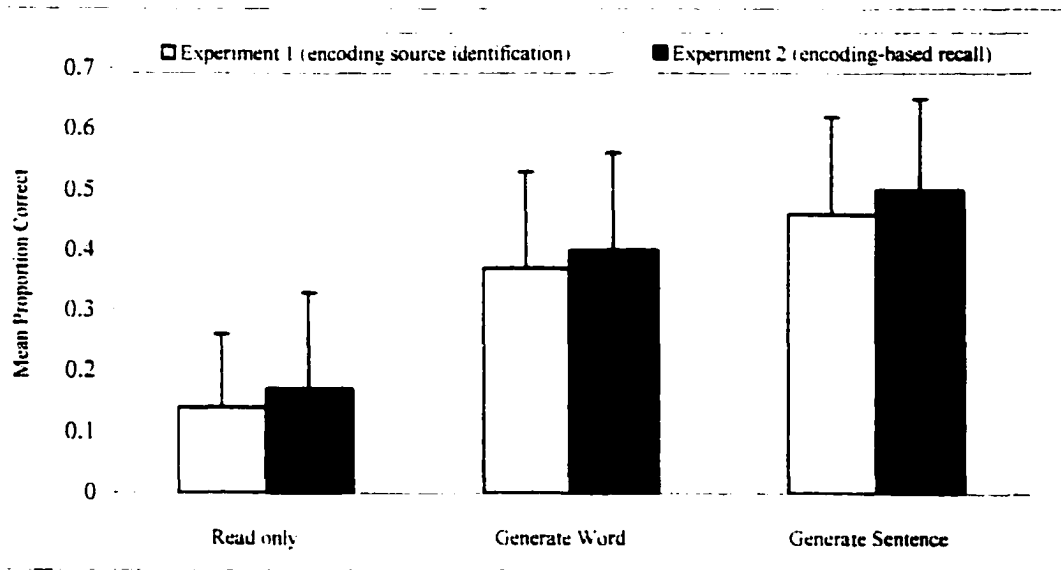
would be considered irrelevant information and therefore these data provide partial support for this theory.

### Comparison of Experiments 1 and 2

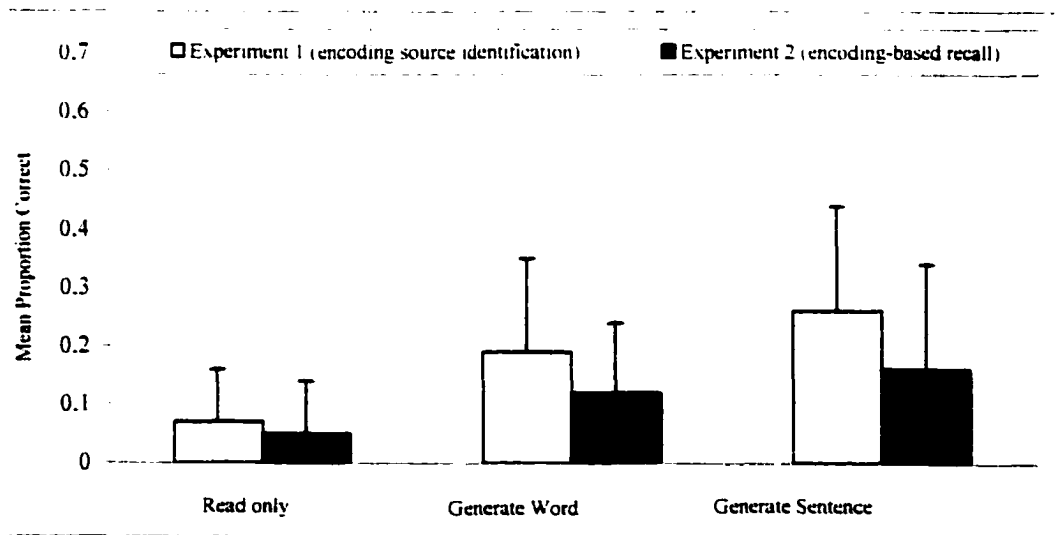
Statistical comparison of the findings from these two experiments was deemed acceptable since the participants of both experiments were selected in the same manner and all procedures at study were identical. Additionally, there were no significant differences between young and old groups, collapsed across experiments, in level of education,  $t(106) = .39, p = .69$ , scores on the MMSE,  $t(106) = .47, p = .64$ , raw scores on the Vocabulary Subtest of the Wechsler Adult Intelligence Scale - Third Edition (WAIS-III),  $t(106) = .29, p = .77$ . This comparison was made to investigate the influence of the retrieval task changes from Experiment 1 (free recall, encoding source identification, and category cued-recall) to Experiment 2 (encoding based-recall and category cued-recall). It seemed possible that there might be noteworthy age-related effects uncovered with these comparisons.

### *Results*

*Encoding source cued recall.* A 3 (Encoding instruction) X 2 (Age) X 2 (Experiment) mixed factorial ANOVA compared encoding source memory scores in source identification of Experiment 1 and cued source recall of Experiment 2. This comparison was done to examine whether there were significant differences between the memory scores from encoding source identification (Experiment 1) and encoding source cued recall (Experiment 2) in the two age groups. As shown in Figure 12, scores for younger adults in encoding source identification (Experiment 1) were lower than their scores for encoding based-recall (Experiment 2). Most important, as shown in Figure 13,



**Figure 12:** Mean proportion of words identified or recalled (+ *SD*) for younger adults as a function of encoding source tasks in Experiments 1 & 2.

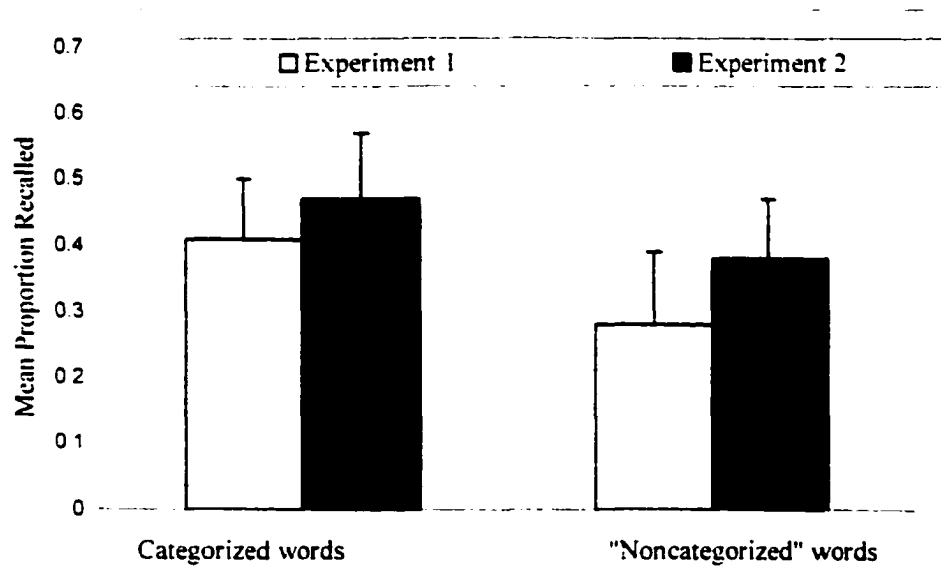


**Figure 13:** Mean proportion of words identified or recalled (*SD*) for older adults as a function of encoding source tasks in Experiments 1 & 2.

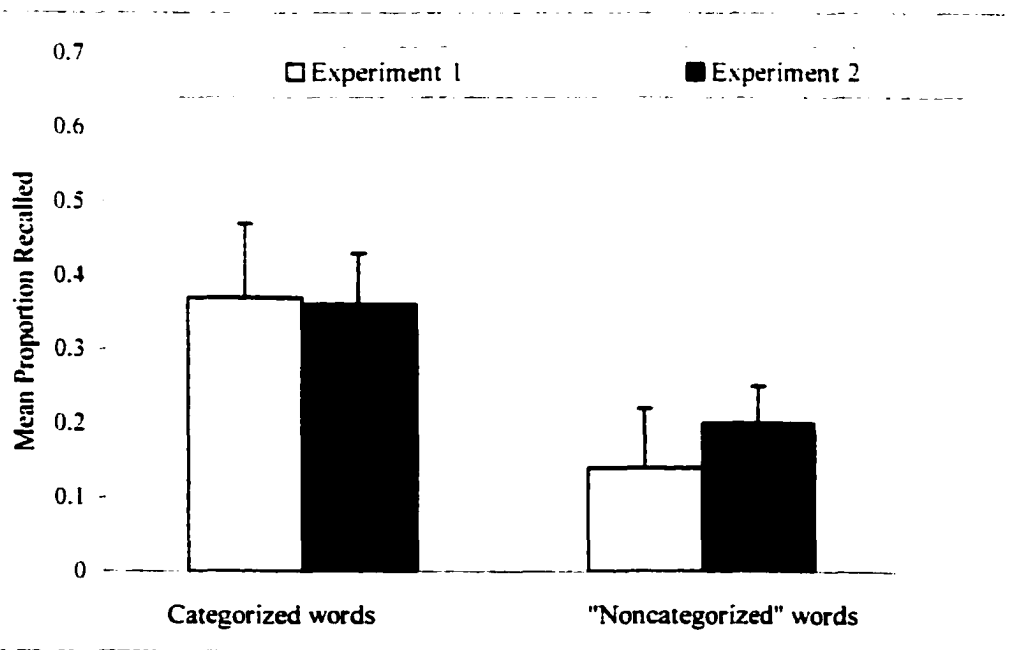
memory scores for older adults in encoding based-recall (Experiment 2) were lower than memory scores for encoding source identification (Experiment 1). Significance was found for the Age by Experiment interaction,  $F(1,104) = 9.04$ ,  $MSE = 223.45$ . Older adults' encoding source scores in Experiment 2 ( $M = .11$ ) were lower than their encoding source scores in Experiment 1 ( $M = .17$ ), whereas the scores were close to equal for younger adults (Experiment 1,  $M = .34$ ; Experiment 2,  $M = .36$ ). Therefore, conditions in Experiment 1 made for better performance for older adults but not for younger. In addition, requesting for each item its encoding source rather than asking for the item cued by the encoding instruction, was helpful for older adults, but not for younger adults.

*Category-cued recall.* In addition, a 2 (Age) X 2 (Word type) X 2 (Experiment) mixed factorial ANOVA compared category-based source memory scores in Experiment 1 and 2 for the two age groups. As shown in Figures 14 and 15, the category-based memory scores of younger adults were higher in the second experiment compared to the first, whereas the memory scores of older adults did not significantly differ across experiments. Indeed, there was a significant Age by Experiment interaction, where younger category-based memory scores were significantly higher on the second experiment ( $M = .43$ ) than the first experiment ( $M = .35$ ), however, older adults' category-based memory scores did not differ as a function of the experiment (Experiment 1,  $M = .26$ ; Experiment 2,  $M = .28$ ),  $F(1,104) = 13.77$ ,  $MSE = 111.11$ .

Noteworthy is that more "noncategorized" words were recalled in the second experiment compared to the first experiment, and this finding was confirmed by a significant Word type by Experiment interaction, where there were significantly more "noncategorized" words recalled in Experiment 2 ( $M = .28$ ) compared to Experiment 1 ( $M = .21$ )



**Figure 14:** Mean proportion of words recalled (+ *SD*) for younger adults in category-cued recall for Experiments 1 and 2.



**Figure 15:** Mean proportion of words recalled (+ *SD*) for older adults in category-cued recall for Experiments 1 and 2.

collapsed over age group where categorized words recalled were not significantly different in these two experiments (Experiment 1,  $M = .39$ , Experiment 2,  $M = .42$ ).  $F(1,104) = 4.98$ ,  $MSE = 59.35$ . The differences between the two experiments may be related to the change in retrieval tasks in Experiment 2, including eliminating free recall, and this will be addressed later.

### *Discussion*

Encoding source cued recall (Experiment 2) produced lower scores than did encoding source identification (Experiment 1) for older adults; however for younger adults encoding source cued recall (Experiment 2) scores did not significantly differ from encoding source identification (Experiment 1). Retrieval demands may have contributed to the altered performance of older adults. In Experiment 1 source memory was tested as an identification task after the participants remembered items that were presented at study and this appears to be a less challenging task for older adults than recalling words that belonged to one of the three encoding task instructions. In encoding source cued recall (Experiment 2) the participant must rely on the explicit memory of the target words for each encoding instruction task. This is not a traditional way to measure source, but was necessary for the comparison of encoding source memory to category-based memory. As mentioned in the literature, it is an arduous task to identify a source memory measure that is manageable for older adults yet challenging for younger adults (Wegesin et al., 2000). The age-related deficits seen on encoding source cued recall possibly reflected its reliance on explicit memory and its lack of cues and environmental support (i.e. requiring more attentional/processing resources) for the participant. Even if the participants

provided the item themselves (free recall) in encoding source identification it appears that it was helpful for older adults.

Category-cued recall scores of younger adults were higher in Experiment 2 than in Experiment 1, but were similar for older adults. Although younger adults recalled more categorized words they also recalled more "noncategorized" words. The 'other' or "noncategorized" section might have served as a kind of free recall task (in Experiment 2) since the alternative tasks asked specifically for targets belonging to some category or encoding instruction. This may indeed be the case since more "noncategorized" words were recalled in Experiment 2 than in Experiment 1.

### *General Discussion*

The two experiments of this study differed in ways that produced important outcomes. Both compared memory performance of young and old persons, but this comparison was carried out in Experiment 1 for both item and source materials, while Experiment 2 studied source memory alone. Included in the study phase of both experiments were three encoding instructions, two of them generative, applied to words and sentences containing categorized and "noncategorized" target words. There were significant effects for these variables in both experiments, but most revealing were the differences obtained. This discussion will begin with an examination of these obtained differences after a brief summary of the procedures in the two experiments.

Free recall (in Experiment 1 only) assessed effects of three encoding tasks and category/"noncategory" differences on item memory (memory for target words) for young and old groups. The encoding task for each word and the category-belongingness of the words also served as possible sources whose influence was assessed at the retrieval

stage. The memory for these quite different sources required testing by distinctive methods. For encoding as source, participants were asked to identify which encoding task had accompanied each correctly recalled word. Since categories were not mentioned at study, the retrieval test for the suggested category as source proceeded by presenting the names of the three categories and asking the participant to list exemplars seen before as well as “noncategorized” target words. This method was a form of cued recall, called here category-cued recall.

For Experiment 2, the retrieval procedures were altered. The free recall test was omitted, transforming this experiment into a study of source memory alone, with both forms of source memory measured by cued recall. To be more specific, instead of identification of the encoding task for each word (as in Experiment 1), the three encoding conditions were listed on the response sheet, with the instruction that words so encoded be listed for each encoding condition. This change led to nearly identical procedures for measuring the two sources, using variants of cued recall. Most important is that this method of measuring source memory resulted in the independence of source memory from influences of item memory.

Description of the procedures in the two experiments and their alteration from first to second has been given in detail because the changes in procedure affected quite dramatic age-related changes, comprising an important finding of this study, which will be described next.

Compared to scores on Experiment 1, Experiment 2 scores were consistently higher for the young, while for old participants, Experiment 2 scores were generally lower. Since there were two changed conditions in Experiment 2 both must be

considered as the basis for the differential effects on old and young. The change in method of measuring encoding as source is a likely candidate, since the old were poorer at encoding source cued recall in Experiment 2, while the younger were equal on the two. In addition, the second change, the omission of the free recall task in Experiment 2 might be at the root of this change. Standard in item/source memory studies is that the measurement of recognition or free recall of items is paired with requests for identification of the experienced sources. Omitting the free recall task removes the item measurement feature of Experiment 1, rendering it an examination of two word attributes as the basis for source responses, measured in parallel fashion. While this is true, the two experiments measured both, encoding and category-cued source responses, one following free recall, one in the absence of free recall. Clearly free recall has played an important role in the obtained interaction, involving influences on the scores of old persons and, possibly, confounding of source scores by item scores (in Experiment 1).

Of particular interest are the scores on the encoding cued source tests for the older persons; these scores are lower in the second experiment than in the first, and they are poorer for all three of the encoding instructions, with the smallest difference for read and the largest for the generate sentence condition. The change in method of measuring this kind of source memory does not seem to be responsible for this difference, since scores for the young persons are slightly higher under the conditions of Experiment 2. This change is an age-related effect, and what is suggested by this analysis is that old persons show a reliance on the free recall task to provide an extra “practice” trial, which is generative in nature (for free recall, at least) and possibly helps to achieve some degree of consolidation. Young persons, of course, have help from the free recall trial available

also, but apparently have other strategy options available to them, even under the conditions of Experiment 2.

The apparent differences in memory scores for the encoding source variable in Experiment 2 are age-related and hence of interest here. Older adults found encoding source cued recall (Experiment 2) particularly difficult compared to encoding source identification (Experiment 1), which followed free recall. It appeared that target words were both available (stored) and accessible (retrievable) on item recall (free recall) for older adults in encoding source identification (Experiment 1). In contrast, younger adults' encoding source memory scores were similar. The more target words recalled on free recall, the more words whose encoding source could potentially be identified. Although different participants served in Experiment 2, it could be assumed that the words belonging to each encoding condition were available or were stored for participants as they were for participants in Experiment 1. However, in Experiment 2 for encoding-based source recall, the words were not necessarily accessible (retrievable). Therefore, encoding retrieval task demands, also, may account for the difference between encoding source identification (Experiment 1) and encoding source cued recall (Experiment 2). In Experiment 2, participants had to rely on their memory not only of the item, but they also had to recall which of the three encoding conditions that item was presented in. Therefore, in Experiment 2, when older adults could not begin by writing down all the words they recalled and use those words for encoding source identification, their performance suffered.

Craik's attentional resource (or environmental support hypothesis) and processing resource theories of age-related memory decline may partially account for this finding

( Craik 1986; Craik & Jennings, 1992; Anderson & Craik, 2000). As demonstrated, increased elaboration (which engages more attentional/processing resources) at encoding facilitated memory performance in older and younger adults. However, when the retrieval task required more attentional/processing resources and less environmental support (i.e. recalling words from one of the three encoding conditions rather than having them already written) older participants performed significantly more poorly. Although researchers (e.g. Troyer & Craik, 2000) have found evidence that greater attentional/processing resources are engaged at encoding than retrieval, they also found evidence to support that as the retrieval task becomes more challenging, more attentional/processing resources are engaged. If more attentional/processing resources are necessary, then age-related declines are more likely to be demonstrated. Encoding source cued recall probably required more attentional and more processing resources and less environmental support (e.g. keeping a word or words in mind while recalling and holding other target words in mind), than encoding source identification (Experiment 1). For encoding source identification participants had the "environmental support" of the item. Therefore, for older adults the finding that encoding source cued recall (Experiment 2) performance was poorer than encoding source identification (Experiment 1) adds support to Craik's attentional theory and Craik's processing resource theory of age-related memory impairment.

#### *Category as Item and Source*

Age-related memory deficits were not demonstrated for the recall of categorized words in Experiment 1. Prior knowledge has been shown to affect source attributions and this probably guided category-cued recall (Bayen et al. 2000; Mather et al., 1999,

Sherman & Bessenoff, 1999; Spaniol & Bayen, 2002). According to Mather et al. (1999) information that can be used to make source memory attributions “includes...schemas, stereotypes, and category information” (p. 438). Therefore, decisions based on knowledge of categories and category exemplars facilitated memory performance for all participants, especially older adults. Much of this literature is based on stereotypical information of group belongingness (e.g. democrat or republican groups). In addition, research has been done where items belonging to certain categories are used and the decision of which list the items originally appeared (e.g. kitchen items or bathroom items) has been used as the source measure (Bayen et al., 2000). This type of prototypical group membership and typical item and source (list membership) is different from category affiliation of a category exemplar being a source because this category affiliation appears to be embedded in the word and is an unspoken context. The perspective proposed here is that category affiliation, serving as the source for category words, is an extension of the existing literature in this area. Both Rabinowitz et al. (1982) and Hunt and Seta (1984) refer to category affiliation as a context of a word. Repeatedly, authors speak of semantic context as one aspect of source, suggesting that category affiliation of category exemplars is by definition a source.

Rabinowitz et al. (1982) and Hunt and Seta (1984) also suggest that the general semantic features of items occur automatically without conscious awareness.

Conceptually, then, category labeling can be a type of implicit (instantaneous) perception that occurs automatically for the participant with experience of the word but without awareness. It occurs so instantaneously that we are not aware of it. There is evidence that category affiliation may be an implicit type of memory (e.g. Banaji, Hardin, &

Rothman, 1993; Sherman, Castelli, Hamilton. 2002; Smith & Branscombe, 1988). As Wickens (1970) stated. "...when a person hears the word "horse," it is encoded into the broader categories of beasts of burden, four-legged creatures, mammals, warm-blooded animals, and finally of animals in general" (p. 1).

In an early account of such theory and research, Luria (1973) fashioned his view of categorization as the final stage in the coding of variegated memory traces; describing the process as occurring instantaneously and culminating in a "network" of categories. Luria described such networks as, "...systems of connections into which traces of information are coded with respect to different signs, and consequently they form multidimensional matrices from which the subject must choose each time the system which, at that particular moment, will form the basis for coding" (p. 284). Luria described a process of such (category) memory where information is automatically (or unconsciously) coded into an elaborative network.

Even earlier, Wickens (1970) had raised the question of awareness as applied to categories. As he stated, "My interpretation of the encoding process...has been one which assumes that categorizations are achieved with very little awareness on the part of the subject of what he is doing" (p. 12). Wickens uses an analogy of a professional baseball player catching a ball automatically, and possibly without looking at the ball being able to catch it with ease. In the same way a participant encodes the category label coincidentally with each experience of a category exemplar.

#### *Comparison of Source Measures*

One reason differences may have emerged between these two sources as a function of age is that the item/source relationships for these two types of source are very

different. As Spencer and Raz (1995) concluded from their meta-analysis "...the greatest magnitude of age differences in context memory was observed for those contextual features that were more likely to have been encoded independently from the content" (p. 527). Consistent with previous findings, older adults performed more poorly when the source of a word was extrinsic to the item, rather than when the source was more "intrinsically" related. However, the intrinsic/extrinsic distinction does not fully account for this finding. For instance, a person's voice, or the color a word is printed in, are traditional examples of "intrinsic" sources. Although these examples of source (voice, color) are intrinsic to the item, they are not related to the item before presentation, but rather are arbitrarily paired with the item to be a source. This is unlike the notion of "intrinsic" source of category affiliation because category affiliation is related to the word itself and is a semantic attribute of the word. Therefore, it appears that the difference in sources may be an automatic or implicit (category as source), effortful or explicit (encoding instruction as source) distinction. It is most likely that words that belong to categories carry with them cues to an automatic labeling. As Rabinowitz et al. (1982) stated

...age deficits in memory are attributable to a reduction in attentional resource. It is postulated that such a reduction is associated with poor integration of the encoded item with its context, so that the context is a poor cue for the target item in the subsequent retention test. This decrement in integration may be modified by the strength of the prior relatedness between the item and its context; however, in that highly compatible relations may be formed and encoded even when

processing resources are substantially reduced, the general semantic features of an item are still encoded under such circumstances (pp.341-342).

As previously stated Rabinowitz et al. (1982) found an age-related decline in cued recall when cuing with specific cues, but not when cuing with general cues. They suggest that general semantic features of items appear to be encoded automatically. As stated, other researchers have supported this basic tenet (Hunt & Seta, 1984; Wickens, 1970).

#### *Generation as Item and Source*

Another important finding in the present study was that item and source memory for encoding benefited from the generative task. How does generation facilitate memory performance? Slamecka and Graf (1978) speculated that "generation requires more cognitive effort than does reading, and effort increases memorability" (p.603). Since their speculations, others have hypothesized that generation induces elaboration and more active encoding than merely reading and therefore provides a memorial benefit (Hashtroudi, Parker, Luis, & Reisen 1989; Grix, 1998; Heth, 2000; Rankin & Collins, 1986; Vollaro, 2000). In the present study, item memory scores were incrementally higher as the degree of elaboration increased. In addition, increased elaboration also produced an incremental increase in encoding source memory scores.

Generation or elaboration seems to have increased the integration of the item and its encoding source since both groups consistently showed a generation effect in these source scores. Indeed research has shown that if the item and source are "bound" they are more likely to be recalled. Engaging in more effortful encoding processes may facilitate memory performance by creating a connection or by 'binding' the item and

source, especially for older adults. Glisky, Rubin, and Davidson (2001) investigated source memory in older adults and according to these researchers, the frontal lobes may be involved in the 'strategic processing' or binding of the item and source. Previous research investigating source memory and encoding processes have pointed to frontal lobe dysfunction as a reason for source memory declines in adults (e.g. Craik, Morris, Morris, & Loewen, 1990; Glisky, Polster, & Routhieaux, 1995; Glisky et al., 2001; Henkel, Johnson, & De Leonardis, 1998; Johnson et al., 1993; Mitchell, Johnson, Raye, Mather & D'Esposito, 2000; Spencer & Raz, 1994; Spencer & Raz, 1995). as it is also known that the frontal lobes deteriorate more rapidly in normal aging than the temporal lobes (e.g. Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998; Raz, 2000, West, 1996). Glisky et al. provided additional evidence of the importance of frontal lobe functioning in the encoding of source and stated that decreased frontal lobe functioning may lead to failure to bind the source and item information, rendering this information partially available or unavailable at retrieval. In Glisky's investigation, when older participants were told to attend to the relationship between item and source (i.e., given this strategy) they performed as well as younger adults on source memory. Arguably, generation forces the participant to become aware of the relationship between the encoding source and the item, with the participant actively completing the incomplete sentence or creating a sentence with a target word. Therefore, it was expected that the encoding source scores would benefit from generation and this occurred in both experiments to varying degrees.

### *Limitations*

One limitation in this study was the words and sentences used. Although great lengths were taken to insure that word length and frequency were similar on all three lists

other issues were de-emphasized. Designing the sentences so that all of them did not include the category label would have been beneficial, since it would have allowed the possibility of drawing more certain conclusions with respect to category affiliation being an unconscious perception. However, it would have been impossible to control the sentences participants created, any of which could have included a category label.

### *Overall Conclusions*

Source is not a unitary concept, and the definition of source is expanding. As Anderson and Craik (2000) stated, "Given that aging impairs source memory, the question is whether the age-related deficit in conscious recollection is in fact an impairment in source memory" (p. 421). Possibly, explicit source memory is in large part conscious memory. In line with this perspective, memory for source information is important in real life situations. For instance, it is important to know whether your doctor or your hairdresser gave you information regarding a medical condition (Glisky et al., 2001). If engaging in elaboration during encoding allows one to better integrate an item and source, then this would be useful as a tool for compensatory strategies for individuals with memory problems.

It has also been found that people use such prior knowledge as category affiliation to guide source memory. Most likely the decision of whether your doctor or hairdresser gave you medical information is guided by prior knowledge of the stereotype of 'doctor' and 'hairdresser', along with specific knowledge of your hairdresser and doctor. For instance, if your hairdresser is attending medical school this source decision may be more difficult. The use of general knowledge regarding categories and stereotypes appears to

be a likely scenario of how one would attempt to recall a source; therefore, this is also an important aspect to source memory.

In line with the present study, the definition of source has expanded to include aspects of context or source within words themselves, such as the unspoken emotional valence of a word, or as just presented the unspoken category affiliation of a word. This conceptualization of source extends its current definition and may lead to the development of new and exciting research.

Source memory has been deemed an essential type of memory, and, proposing category affiliation as a source was an innovative way to add to the expanding definition of source. Measuring source memory as cued recall and independent of item memory was distinctive as well. Examining these measures in old and young adults produced a number of interesting findings. In sum, the present study found evidence that source memory performance differed, depending on age, and on the type of source. Overall, free recall facilitated encoding source memory performance for older adults. Thus, when older adults were asked to write all the target items that they could recall and subsequently identified which encoding condition those items were presented in increasing the environmental support and reducing the attentional/processing resources needed, their performance was much better than when they were asked to list the items that belonged to each encoding condition without free recall. Additionally, older adults consistently demonstrated higher category–cued recall scores than encoding source memory scores most likely because they used their prior knowledge of categories. Category items facilitated participants' performance because the proposed source of category is semantically related to the category exemplar. Also noteworthy, generation

helped participants 'bind' the item to its respective encoding source increasing encoding source memory scores with generative encoding. These findings separately or in combination raise further questions for future research.

Appendix A

**BACKGROUND QUESTIONNAIRE**

**Subject I.D. Number** \_\_\_\_\_

1. Age \_\_\_\_\_

2. Sex: M      F

3. How far did you go in school (# of Years Education/Degree): \_\_\_\_\_

4. Current Medical Conditions: \_\_\_\_\_  
(Please note what they  
are for) \_\_\_\_\_  
\_\_\_\_\_

*Vision/hearing*

*Cardiac/heart conditions*

*Hypertension/ HTN*

*Thyroid*

*Infectious disease (e.g. Lyme)*

*Kidney*

5. Current Medications: \_\_\_\_\_  
\_\_\_\_\_

6. Are you currently receiving hormone therapy? Y      N (if yes, please name):

7. Do you have a history of head injury, loss of consciousness (e.g. fainting or blacking out)?      Y      N

If yes, please explain: \_\_\_\_\_  
\_\_\_\_\_

8. Do you have/had epilepsy (seizures)?      Y      N

If yes, please explain: \_\_\_\_\_

9. Do you have/had any significant Neurological Diseases? (e.g. Stroke, Multiple Sclerosis, Parkinson's Disease)?                      Y                      N

If yes, please explain: \_\_\_\_\_

*Stroke*

*Balance problems/ dizziness*

*Tremor*

*Double vision*

*Memory problems*

10. History of psychiatric disorders? Y                      N

If yes, please explain: \_\_\_\_\_

\_\_\_\_\_

## Appendix B

## Sentences and Words

## List 1

1. The animal who has large black circles around his eyes is called a **RACCOON**.
2. Before the automobile much traveling was done on the back of a **HORSE**.
3. The woman made a delicious turkey and cheese **SANDWICH**.
4. Dole is probably the best-known manufacturer of canned **PINEAPPLES**.
5. In New York City, Broadway is the area where one is most likely to go to the **THEATER**.
6. Calvin Klein posts large advertisements in Times Square on **BILLBOARDS**.
7. Traditionally the center stone in an engagement ring is a **DIAMOND**.
8. To make neat edges and sharp corners in cutting paper, it is necessary to use **SCISSORS**.
9. Gene Kelly sang "Singing in the Rain" carrying an **UMBRELLA**.
10. Several Americans in the 2000 Olympics won gold **MEDALS**.
11. When one wants water one can merely turn on the **FAUCET**.
12. There has been much research studying the relationship between lung cancer and smoking **CIGARETTES**.

## List 2

1. The only animal tall enough to eat leaves from the top of the tree is a **GIRAFFE**.
2. Crocodile Dundee happens to wrestle **ALLIGATORS**.
3. A popular appetizer on the menu at many restaurants are cooked portabella **MUSHROOMS**.
4. Popeye was supposed to get strength from eating **SPINACH**.
5. Even in the winter a wide variety of tropical plants can be grown in an enclosed glass **GREENHOUSE**.
6. In San Francisco, a great tourist attraction is the Golden Gate **BRIDGE**.
7. Charles A. Lindbergh was the first person to cross the Atlantic, in an **AIRPLANE**.
8. It is important to put bills or a letter into an **ENVELOPE**.
9. A piece of jewelry worn around the wrist is called a **BRACELET**.
10. Fighter pilots should be trained on jumping from a plane with a **PARACHUTE**.
11. When you are very busy it is a good idea to mark engagements on a **CALENDAR**.
12. A great way to take quick pictures and mail them to friends is to use an instant **CAMERA**.

## List 3

1. The animal that wears a shell on its back is called a **TURTLE**.
2. The animal who is reputed to never forget is the **ELEPHANT**.
3. A favorite food that is red and put in salads is called a **TOMATO**.
4. The food that has a yellow peel that darkens when it is too ripe is called a **BANANA**.
5. An alternative source of power that uses a breeze is called a **WINDMILL**.
6. The tennis games of the U.S. Open are held at the Arthur Ashe **STADIUM**.
7. More than one person has tried to travel the world in a hot air **BALLOON**.

8. Big Ben in London is probably the worlds biggest CLOCK.
9. To wake the soldier's the Corporal blew his shiny brass TRUMPET.
10. The typewriter and word processor were precursors to the COMPUTER.
11. An experienced traveler packs clothing and other items neatly in a SUITCASE.
12. Perishable foods, once kept in an icebox are now kept in a REFRIGERATOR.

Appendix C

**Queens College/CUNY**  
**65-30 Kissena Blvd.**  
**Flushing, NY 11367**

**CONSENT TO SERVE AS A RESEARCH PARTICIPANT IN A RESEARCH PROJECT**

**Title of Project:** Generation in Item and Source Performance: Young/ Old Differences

**Program Director Investigator:** Dr. Wilma Winnick

**Research/Study Investigator:** Susan Farella-Busch

**Departmental Affiliation with Queens College:** Psychology

**Date of Approval from Queens College Institutional Committee for the Protection of Human Subjects:**

You are being asked to participate in a research project conducted through Queens College CUNY. Queens College requires that you give your signed authorization to participate in this research project.

A basic explanation of the project is written below. Please read this explanation and discuss it with the Research Investigator. If you then decide to participate in the project, please sign the last page of this form.

**Nature and Purpose of Study:**

The purpose of this study is to determine whether or not there are differences in the learning and processing of words in healthy young adults (18-35 year-olds) versus healthy older adults (65-89 year-olds). Questions will be asked regarding learning various words.

**Explanation of Procedures:**

As a subject, you will be asked to fill out a short background and health questionnaire. Your name will **NOT** appear on this form. All responses will be coded, insuring confidentiality of all responses. In addition, you will be asked a number of questions, which will take approximately 5-10 minutes to answer. These questions will be about basic cognitive functioning. You will be asked to perform a number of simple computer tasks involving looking at words presented on a computer screen and given two different verbal tasks in response to the words. The computer will record some of your responses and the only person to look at this data will be the Research Investigator. Once the data are obtained from the computer, your name will no longer appear with it, only your I.D. #. You will also be asked to write verbal responses on paper. At the end of the

experiment, you will be asked some vocabulary questions. Again only your ID# will appear on the response forms. One list will have both the names of participants and their I.D. #. This will be kept in a securely locked cabinet that only the Program Director Investigator and the Research Investigator have access to. The length of participation will be between 1.0 and 1.5 hours. All results will be kept in the Research Investigator's locked file.

**Potential Discomfort and Risks:**

There are no risks associated with participation in this research.

**Potential Benefits:**

The benefit that you will derive from participation is that you are helping to advance knowledge in this area of Neuropsychology.

**Cost/ Reimbursements:**

There are no costs associated with participating in this research.

**Alternatives to participation:**

All Queens College Psychology 101 students may participate in other IRB approved experiments offered. These same students have the option of writing reports instead of participating in any experiment and can speak with their Psychology 101 Instructor or contact Dr. Ehrlichman for details.

**Termination of Participation:**

Students may be terminated by the Research Investigator if they are disruptive to others participating in this research project and /or if they are deceitful in obtaining an opportunity to participate in the research. If participants knowingly do not follow the instructions of the research project they may also be terminated (the resulting data would be tarnished).

**Confidentiality:**

The results of your participation will be kept confidential to the fullest extent permitted by law. This means that only the Research Investigator will know about your specific results. Only the information that cannot be traced to you will be used in reports or manuscripts published by the Project Director and Research Investigator.

**Withdrawal from the Project:**

I understand that at any point if I wish to withdraw from the experiment I may do so without explanation and without penalty. If I choose to withdraw from this

experiment, I understand that I will not receive credit toward the Psychology 101 research requirement, but that I may participate in other studies or write a research report to fulfill the requirement.

**Who to Call if you have any Questions:**

The approval stamp on this consent form indicates that this project has been reviewed and approved for the period indicated by the Queens College (CUNY) Institutional Review Board for the Protection of Human Subjects in Research and Research Related Activities.

If you have any questions about your rights as a participant in this study, or to report a research related injury, you may contact:

Office of Research and Sponsored Programs, Queens College (CUNY) at 718-997-5400.

If I have any concerns or questions about the conduct of this research project you may call:

Dr. Wilma Winnick and/or Susan Farella-Busch  
Queens College Psychology Department  
(718) 997-3201 (Dr. Winnick's Office)  
(718) 997-3251 (Cognitive Neuropsychology Lab)  
(516) 568-0166 (Susan Farella-Busch)

**What signing this form Means:**

By signing this consent form, you agree to participate in this research project. The purpose, procedures to be used, as well as the potential risks and benefits of your participation have been explained to you in detail. You can refuse to participate from this research project at anytime without penalty. Refusal to participate in this study or withdrawal from this study will have no effect on any services you may otherwise be entitled to from Queens College (CUNY). You will be given a copy of this consent form.

\_\_\_\_\_  
Printed Name of Participant

\_\_\_\_\_  
Participant's Signature

\_\_\_\_\_  
Today's Date

Susan Farella-Busch  
Printed Name of Research Investigator

\_\_\_\_\_  
Signature of Research Investigator

\_\_\_\_\_  
Today's Date

**Institutional Review Board Approval Stamp:**



Part IV - Source Instructions

Next to each word write down the conditions under which you saw the word.

For example:

- 1) If you saw the word in a sentence, write a 'B' next to that word to indicate that you saw both a sentence and word.
- 2) If you saw the word and made up a sentence, write an 'S' next to that word.
- 3) If you saw a sentence and provided a word to complete the sentence, write a 'W' next to that word.

Appendix E

Category Recall

You may have noticed many of the words you saw belonged to the same category. Below are shown the three categories involved. You are to list the words that you saw that belong to those categories and also any words that you remember that did not belong to those categories. The ones that I would like you to try to remember are the words that you saw in capital letters either at the end of a sentence, or for you to make up a sentence, and also the word you supplied to complete the sentence.

Animals

_____	_____
_____	_____
_____	_____
_____	_____

Foods

_____	_____
_____	_____
_____	_____
_____	_____

Physical Structures

_____	_____
_____	_____
_____	_____
_____	_____

Not categorized

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Part VI - Source Instructions

Next to each word write down the conditions under which you saw the word.

For example:

- 1) If you saw the word in a sentence, write a 'B' next to that word to indicate that you saw both a sentence and word.
- 2) If you saw the word and made up a sentence, write an 'S' next to that word.
- 3) If you saw a sentence and provided a word to complete the sentence, write a 'W' next to that word.

Appendix F

Category Recall

You may have noticed many of the words you saw belonged to the same category. Below are shown one of three categories involved. You are to list the words that you saw that belong to that category. The ones that I would like you to try to remember are the words that you saw in capital letters either at the end of a sentence, or for you to make up a sentence, and also the word you supplied to complete the sentence.

**Animals**

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**Foods**

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**Physical Structures**

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Now list any of the target words that you remember that did not belong to those categories.

Not categorized words

<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

Appendix G

Source Recall

You have seen many words in the previous experiment, the ones that I would like you to try to remember are the words that you –

1) Saw on the computer screen alone that you used to create a sentence:

<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

2) The words you provided to complete incomplete sentences

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

3) The words that were at the end of the complete sentences you read

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

## Appendix H

$$ARC = \frac{R - E(R)}{\max R - E(R)}$$

where

$R$  = total number of observed category repetitions  
 $\max R$  = maximum possible number of category repetitions  
 $E(R)$  = expected (chance) number of category repetitions

It should be noted that

$$\max R = N - k$$

where  $N$  = total number of items recalled, and  $k$  = number of categories represented in the recall protocol.  
 And ...

$$E(R) = \frac{\sum_i n_i^2 - 1}{N}$$

where  $n_i$  = number of items recalled from Category  $i$ , and  $N$  is as before (Roemaker, Thompson, & Brown, 1971, p. 46)

## References

- Allan, K., Wildling, E.L., & Rugg, M.D. (1998). Electrophysiological evidence for dissociable processes contributing to recollection. *Acta Psychologica*, *98*, 231-252.
- Anderson, J.R. & Bower, G.H. (1972). Recognition and retrieval processes in free recall. *Psychological Review*, *79*, 97-123
- Anderson, N.D. & Craik, F.I.M. (2000). Memory and the aging brain. In E. Tulving and F. I.M. Craik (Eds.), *The Oxford handbook of memory* (pp. 411-425). New York: Oxford University Press.
- Anderson, N.D., Craik, F.I.M., & Naveh-Benjamin, M. (1998). The attentional demands of encoding and retrieval in younger and older adults: 1. Evidence from divided attention costs. *Psychology and Aging*, *13*, 405-423.
- Anderson, N.D., Lidaka, T., Cabeza, R., Kapur, S., MacIntosh, A.R., & Craik, F.I.M. (2000). The effects of divided attention on encoding and retrieval-related brain activity: A PET study of younger and older adults. *Journal of Cognitive Neuroscience*, *12*, 775-792.
- Bäckman, L., & Wahlin, A. (1995). Influences of item organizability and semantic retrieval cues on word recall in the very old. *Aging, Neuropsychology and Cognition*, *2*, 312-325.
- Baddeley, A. D. (1982). Domains of recollection. *Psychological Review*, *89*, 708-729.
- Balota, D.A., Dolan, P.O. & Dunchek, J.M. (2000). Memory changes in healthy older adults. In E. Tulving and F. I.M. Craik (Eds.), *The Oxford handbook of memory* (pp. 395-409). New York: Oxford University Press.
- Banaji, M.R., Hardin, C., & Rothman, A.J. (1993) Implicit stereotyping in person judgment. *Journal of Personality and Social Psychology*, *65*, 272-281.
- Basden, B.H., Basden, D.R., & Bartlett, K. (1993). Memory and organization in elderly subjects. *Experimental Aging Research*, *19*, 29-38.

- Battig, W.F., & Montague, W.E. (1969). Category norms of verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology*, 80, 1-46.
- Bayen, U.J., & Murnane, K. (1996). Aging and the use of perceptual and temporal information in memory tasks. *Psychology and Aging*, 11, 293-303.
- Bayen, U.J., Nakamura, G.V., Dupuis, S.E., & Yang, C.L. (2000). The use of schematic knowledge about sources in source monitoring. *Memory and Cognition*, 28, 480-500.
- Bornstein, M.H., Kessen, W., & Weiskopf, S. (1976). Color vision and hue categorization in young human infants. *Journal of Experimental Psychology*, 2, 115-129.
- Bousfield, W.A. (1953). The occurrence of clustering in the recall of randomly arranged associates. *Journal of General Psychology*, 39, 229-240.
- Bower, G.H., Clark, M.C., Lesgold, A.M., & Winzenz, D. (1969). Hierarchical retrieval schemes in recall of categorized word lists. *Journal of Verbal Learning and Verbal Behavior*, 8, 323-343.
- Chalfonte, B.L., & Johnson, M.K. (1996). Feature memory and binding in young and older adults. *Memory and Cognition*, 24, 403-416.
- Cohen, G., & Faulkner, D. (1989). Age differences in source forgetting: Effects on reality monitoring and on eyewitness testimony. *Psychological Bulletin*, 90, 513-546.
- Collins, A.M. & Quillian, M.R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, 8, 240-247.
- Craik, F.I.M. (1984). Age differences in remembering. In L. A. Squire & N. Butters (Eds.), *Neuropsychology of Memory*. (pp. 3-12). New York: Guilford Press.
- Craik, F.I.M. (1986). A functional account of age differences in memory. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities, mechanisms, and performances* (pp. 409-422). North-Holland: Elsevier Science Publishers B.V.

- Craik, F.I.M., Byrd, M., & Swanson, J.M. (1987). Patterns of memory loss in three elderly samples. *Psychology and Aging, 2*, 79-86.
- Craik, F.I.M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General, 125*, 152-180.
- Craik, F.I.M., & Jennings, J.M. (1992). Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *The Handbook of Aging and Cognition*. (pp. 51-110). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Craik, F.I.M. & McDowd, J.M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 474-479.
- Craik, F.I.M., Morris, L.W., Morris, R.G., & Loewen, E.R. (1990). Relations between source amnesia and frontal lobe functioning in older adults. *Psychology and Aging, 5*, 148-151.
- Delbecq-Derouesné, J., Beauvois, M.F., & Shallice, T. (1990). Preserved recall versus impaired recognition. *Brain, 113*, 1045-1074.
- Damasio, A.R. (1990). Category-related recognition defects as a clue to the neural substrates of knowledge. *Trends in Neuroscience, 13*, 95-98.
- Damasio, H., Grabowski, T.J., Tranel, D., Hichwa, R.D., & Damasio, A.R. (1996). A neural basis for lexical retrieval. *Nature, 380*, 499-505.
- Denney, N.W. (1974). Clustering in middle and old age. *Developmental Psychology, 10*, 471-475.
- Epstein, M.L., & Dupree, D.A. (1977). Category headings as recall cues: A test of the principle of encoding specificity. *The Journal of General Psychology, 97*, 101-108.
- Epstein, M.L., Dupree, D.A., & Gronikowski, L.A. (1979). Encoding specificity and contextual similarity. *Bulletin of the Psychonomic Society, 14*, 177-180.

- Estes, W.K. (1994). *Classification and Cognition*. New York: Oxford University Press.
- Ferguson, S.A., Hashtroudi, S., & Johnson, M.K. (1992). Age differences in using source-relevant cues. *Psychology and Aging, 7*, 443-452.
- Folstein, M.F., Folstein, E., & McHugh, P.R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*, 189-198.
- Gainotti, G. (2000). What the locus of brain lesion tells us about the nature of the cognitive defect underlying category-specific disorders: A review. *Cortex, 36*, 539-559.
- Glisky, E.L., Polster, M.R., & Routhieaux, B.C. (1995). Double dissociation between item and source memory. *Neuropsychology, 9*, 229-235.
- Glisky, E.L., Rubin, S.R., & Davidson, P.S.R. (2001). Source memory in older adults: an encoding or retrieval problem. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*, 1131-1146.
- Geiselman, R.E., & Bjork, R.A. (1980). Primary versus secondary rehearsal in imagined voices: Differential effects on recognition. *Cognitive Psychology, 12*, 188-205.
- Graf, P. (1990) Lifespan changes in implicit and explicit memory. *Bulletin of the Psychonomic Society, 28*, 353-358.
- Grix, M. (1998). *Processing and Generation Effects on Explicit and Implicit memory performance in younger and older adults*. Unpublished Dissertation, Queens College of the City University of New York, New York.
- Guttentag, R.E., & Hunt, R.R. (1988). Adult age differences in memory for imagined and performed actions. *Journal of Gerontology, 43*, 107-108.
- Haberlandt, K. (1999). Memory from infancy to old age: Developmental changes. *Human Memory*. (pp. 189-218). Needham Heights, MA: Allyn and Bacon.

- Hasher, L. & Zacks, R.T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology:General*, 108, 356-388.
- Hasher, L. & Zacks, R.T. (1988). Working memory, comprehension, and aging: A review and a new view. In G.H. Bower (Ed.), *The psychology of learning and motivation* (pp.193-225). New York: Academic Press.
- Hashtroudi, S., Johnson, M.K., & Chrosniak, L.D. (1989b). Aging and source monitoring. *Psychology and Aging*, 4, 106-112.
- Hashtroudi, S., Johnson, M.K., & Chrosniak, L.D. (1990). Aging and qualitative characteristics of memories for perceived and imagined complex events. *Psychology and Aging*, 5, 119-126.
- Hashtroudi, S., Parker, E.S., Luis, L.D., & Reisen, C.A. (1989a). Generation and elaboration in older adults. *Experimental Aging Research*, 15, 73-78.
- Henkel, L.A., Johnson, M.K., & De Leonardis, D.M. (1998). Aging and source monitoring: Cognitive processes and neuropsychological correlates. *Journal of Experimental Psychology: General*, 127, 251-268.
- Heth, I.A. (2000). *Two generative tasks: Age related differences in item and source memory*. Unpublished Dissertation, Queens College of the City University of New York, New York.
- Hultsch, D.F. (1969). Adult age differences in the organization of free recall. *Developmental Psychology*, 1, 673-678.
- Hunt, R.R., & Seta, C.E. (1984). Category size effects in Recall: The roles of relational and individual item information. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 10, 454-464.
- Janowsky, J., Shimamura, A.P., & Squire, L.R. (1989). Source memory impairment in patients with frontal lesions. *Neuropsychologia*, 27, 1043-1056.
- Johnson, M.K., Hashtroudi, S., & Lindsay, D.S. (1993). Source monitoring. *Psychological Bulletin*, 114, 3-28.

- Kausler, D.H., & Puckett, J.M. (1980). Adult age differences in recognition memory for a nonsemantic attribute. *Experimental Aging Research*, 6, 349-355.
- Kausler, D.H. & Puckett, J.M. (1981a). Adult age differences in memory for modality attributes. *Journal of Gerontology*, 36, 44-50.
- Kausler, D.H. & Puckett, J.M. (1981b). Adult age differences in recognition memory for a nonsemantic attribute. *Experimental Aging Research*, 6, 349-355.
- Kucera, H. & Francis, W.N. (1967). *Computational Analysis of Present-Day American English Providence*. Electronic reference, RI: Brown University Press.
- Light, L.L. (1996). Memory and aging. In E.L. Bjork & R.A. Bjork (Eds.), *Memory* (pp.443-490). San Diego, California: Academic Press.
- Light, L.L. & Carter-Sorbell, Linda (1970). Effects of changed semantic context on recognition memory. *Journal of verbal learning and verbal behavior*, 9, 1-11.
- Logan, J.M., Sanders, A.L., Snyder, A.Z., Morris, J.C., & Buckner, R.L. (2002). Under-recruitment and nonselective recruitment: dissociable neural mechanisms with aging. *Neuron*, 33, 827-840. Retrieved April 9, 2002, from <http://www.neuron.org>.
- Luria, A.R. (1973). *The Working Brain An Introduction to Neuropsychology*. New York: Basic Books Inc.
- MacFarland, C.E., Warren, L.R., & Crockard, J. (1985). Memory for self-generated stimuli in young and old adults. *Journal of Gerontology*, 40, 205-207.
- Marsh, E.J., Edelman, G., & Bower, G.H. Demonstrations of a generation effect in context memory. *Memory and Cognition*, 29, 798-805.
- Martin, A., Wiggs, C.L., Ungerleider, L.G., & Haxby, J.V. (1996). Neural correlates of category-specific knowledge. *Nature*, 379, 649-652.
- Mather, M., Johnson, M.K., & De Leonardis, D.M. (1999). Stereotype reliance in source monitoring: Age differences and neuropsychological test correlates. *Cognitive Neuropsychology*, 16, 437-458.

- McIntyre, J.S., & Craik, F.I.M. (1987). Age differences in memory for item and source information. *Canadian Journal of Psychology*, *41*, 175-192.
- Medin, D.L. & Shaffer, M.M. (1978). Context theory of classification learning. *Psychological Review*, *85*, 207-238.
- Mitchell, D.B., Hunt, R.R., & Schmitt, F.A. (1986). The generation effect and reality monitoring: Evidence from dementia and normal aging. *Journal of Gerontology*, *41*, 79-84.
- Mitchell, K.J., Johnson, M.K., Raye, C.L., & D'Esposito, M.D. (2000). fMRI evidence of age-related hippocampal dysfunction in feature binding in working memory. *Cognitive Brain Research*, *10*, 197-206.
- Mitchell, K.J., Johnson, M.K., Raye, C.L., Mather, M., & D'Esposito, M.D. (2000). Aging and reflective processes of working memory: Binding and test load deficits. *Psychology and Aging*, *15*, 527-541.
- Monsch, A.U., Foldi, N.S., Ermini-Funfschilling, D.E., Berres, M., Taylor, K.I., Seifritz, E., Stahelin, H.B., & Spiegel, R. (1995). Improving the diagnostic accuracy of the Mini-Mental State Examination. *Acta Neurologica Scandinavica*, *92*, 145-150.
- Moscovitch, M., & Winocur, G. (1995). Frontal lobes, memory, and aging. In J. Grafman, K.J. Holyoak, & F. Boller (Eds.), *Structure and functions of the human prefrontal cortex*. *Annals of the New York Academy of Sciences* (Vol. 769; pp. 119-150). New York: New York Academy of Science.
- Mueller, J.H., Rankin, J.L., & Carlomusto, M. (1979). Adult age differences in free recall as a function of basis of organization and method of presentation. *Journal of Gerontology*, *34*, 375-380.
- Multhaup, K.S., & Balota, D.A. (1997). Generation effects and source memory in healthy older adults and in adults with dementia of the Alzheimer's type. *Neuropsychology*, *11*, 382-391.
- Murnane, K. & Bayen, U.J., (1996). An evaluation of empirical measures of source identification. *Memory and Cognition*, *24*, 417-428.

- Naveh-Benjamin, M., Craik, F.I.M., Perretta, J.G., & Tonev, S.T. (2000). The effects of divided attention on encoding and retrieval processes: The resiliency of retrieval processes. *The Quarterly Journal of Experimental Psychology*, 53A, 609-625.
- Newman, M.C., Allen, J.B.J., & Kasniak, A.W. Tasks for assessing memory for temporal order versus memory for items in aging. *Aging, Neuropsychology and Cognition*, 8, 72-78.
- Park, D.C., Puglisi, J.T., & Lutz, R. (1982). Spatial memory in older adults: Effects of intentionality. *Journal of Gerontology*, 37, 330-335.
- Park, D.C., & Puglisi, J.T. (1985). Older adults' memory for the color of pictures and words. *Journal of Gerontology*, 40, 330-335.
- Posner, M.I. (1969). Abstraction and the process of recognition. In G.H. Bower & J.T. Spencer (Eds.), *The psychology of learning and motivation* (Vol. 3, pp.44-96). New York: Academic Press.
- Quinn, P.C. (2002). Category representation in young infants. *Current Directions in Psychological Science*, 11, 66-70.
- Rabinowitz, J.C. (1986). Priming in episodic memory. *Journal of Gerontology*, 41, 204-213.
- Rabinowitz, J.C. (1989). Judgments of origins and generation effects; Comparisons between young and elderly adults. *Psychology and Aging*, 4, 259-268.
- Rabinowitz, J.C., Craik, F.I.M., & Ackerman. (1982). A processing account of age differences in recall. *Canadian Journal of Psychology*, 36, 325-344.
- Ramsey, P.H. (1995). *Intermediate Statistical Methods*. Queens, New York: Author.
- Rankin, J.L. & Collins, M. (1986). The effects of memory elaboration on adult age differences in incidental recall. *Experimental Aging Research*, 12, 231-234.

- Raz, N. (2000). Aging of the brain and its impact on cognitive performance: Integration of structural and functional findings. *In Handbook of Aging and Cognition II*, F.I.M. & T.A. Salthouse, eds. Mahah, NJ: Erlbaum.
- Raz, N., Gunning-Dixon, F.M., Head, D., Dupuis, J.H., & Acker, J.D. (1998) Neuroanatomical correlates of cognitive aging: evidence from structural magnetic resonance imaging. *Neuropsychology*, 12, 95-114.
- Roenker, D.L., Thompson, C.P., & Brown, S.C. (1971). Comparison of Measures for the estimation of the clustering in free recall. *Psychological Bulletin*, 76, 45-48.
- Sanders, R.E., Murphy, M.D., Schmitt, F.A., & Walsh, K.K. (1980). Age differences in free recall rehearsal strategies. *Journal of Gerontology*, 35, 550-558.
- Schacter, D.L. (1987). Implicit Memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 13, 501-518.
- Schacter, D.L., Kaszniak, A.W., Kihlstrom, J.F., & Valdiserri, M. (1991). Relation between source memory and aging. *Psychology and Aging*, 6, 559-568.
- Schonfield, D. & Robertson, B. (1966). Memory storage and aging. *Canadian Journal of Psychology*, 20, 228-236.
- Shaw, R.J. & Craik, F. I. (1989). Age differences in the prediction and performance on cued a recall task. *Psychology and Aging*, 4, 131-135.
- Sherman, J.W. & Bessenoff, G.R. (1999). Stereotypes as source-monitoring cues: On the interaction between episodic and semantic memory. *Psychological Science*, 10, 106-110.
- Sherman, S.J., Castelli, L., & Hamilton, D.L. (2002). The spontaneous use of a group typology as an organizing principle in memory. *Journal of Personality and Social Psychology*, 82, 328-342.
- Slamecka, N.J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Human Learning and Memory*, 4, 592-604.

- Smith, E.R., & Branscombe, N.R. (1988). Category accessibility as implicit memory. *Journal of Experimental Social Psychology, 24*, 490-504.
- Spaniol, J., & Bayen, U.J. (2002). When is schematic knowledge used in source monitoring? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 631-651.
- Spencer, W.D., & Raz, N. (1994). Memory for facts, source, and context: Can frontal lobe dysfunction explain age related differences. *Psychology and Aging, 9*, 149-159.
- Spencer, W.D., & Raz, N. (1995). Differential age effects on memory for content and context: A meta-analysis. *Psychology and Aging, 10*, 527-539.
- Trott, C., Freidman, D., Ritter, W., & Fabiani, M. (1997). Item and source memory: Differential age effects revealed by event-related potentials. *Neuroreport, 8*, 3373-3378.
- Troyer, A.K. & Craik, F.I.M. (2000). The effect of divided attention on memory for items and their context. *Canadian Journal of Experimental Psychology, 54*, 161-171.
- Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior, 5*, 381-391.
- Vollaro, J. (2000), *Memory performance of young and old healthy adults in two processing paradigms: Sentence production and sentence construction*. Unpublished Dissertation, Queens College of the City University of New York, New York.
- Warrington E.K. & McCarthy , R.A. (1983). Category specific access dysphasia. *Brain, 106*, 1273-1296.
- Warrington, E.K. & Shallice, T. (1984) Category specific semantic impairments. *Brain, 107*, 829-853.
- Wechsler, D. (1997). *Wechsler Adult Intelligence Scale-Third Edition*. San Antonio, Texas: The Psychological Corporation.

Wegesin, D.J., Jacobs, D.M., Zubin, N.R., Ventura, P.R., & Stern, Y. (2000). Source memory and encoding strategy in normal aging. *Journal of Clinical and Experimental Neuropsychology*, 22, 455-464.

West, R.L. (1996). An application of the prefrontal cortex function theory to cognitive aging. *Psychological Bulletin*, 120, 272-292.

Wickens, D.D. (1970). Encoding categories of words: An empirical approach to meaning. *Psychological Review*, 77, 1-15.

Witte, K.L., Freund, J.S., & Brown-Whisler, S. (1993). Adult age differences in free recall and category clustering. *Experimental Aging Research*, 19, 15-28.

Witte, K.L., Freund, J.S., & Seiby, R.A. (1990). Age differences in free recall and subjective organization. *Psychology and Aging*, 5, 307-309.