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Context effects of false remember responses in older and younger adults

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Context Effects of False Remember Responses in Older and Younger Adults

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Dedication

To Kethera, thank you for taking a chance on me and for encouraging my love of cognitive psychology. Without you, I would not be where I am today. And to Chris, thank you for always supporting me and for listening to my musings at all hours of the day.

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Abstract

Although different theories attempt to explain the underlying mechanism of false remembers, none have been able to adequately describe this process. The current study aims to determine if a specific contextual detail (i.e., font color) can be tied to false remembers (i.e., false memory that contains contextual or perceptual details), and if there are age differences in this ability. Using the Deese, Roediger, McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) and the contextual detail of font color, this study investigated if older and younger adults can tie a specific color to studied items and critical lures (non-presented semantic associates). No differences in the ability to tie the color back to studied items and critical lures were found between older and younger adults; however, both groups had performances that were at or near chance. It was found that older adults used *remember* responses (i.e., a specific detailed memory) more frequently than *know* responses (i.e., a feeling of familiarity). This indicates that older adults are able to associate specific details, although their performance was as poor as younger adults in incorporating the specific detail of font color that was supplied.

Context Effects of False Remember Responses in Older and Younger Adults

It is easy to believe that memory is a reproductive process, recording events verbatim, much like a video camera does, however research has shown that this notion is not accurate and that memory is prone to many different types of errors (Bartlett, 1932; Roediger, 1996; Schacter, 1999). Memory has been shown to be a reconstructive process, meaning that it can be changed, distorted, or interfered with, depending on one's current interpretation of the event (Bartlett; Reyna & Lloyd, 1997). These memory errors also have been shown to increase with age, as some cognitive processes decline. In particular, episodic memory seems to be affected by age related cognitive decline (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Mitchell, Brown, & Murphy, 1990). In recent years, a particular type of memory error, termed *false memory*, has been a focus of research, especially in the context of eyewitness testimony (Loftus, 1979). Research has extended to older adults, who have been shown to have an increased rate of false memory in some contexts (Schacter, Koustaal, & Norman, 1997; Tun, Rosen, & Blanchard, 1998). A false memory is the remembrance of an event that never happened, or the remembrance of details for an event that are inaccurate (Roediger & McDermott, 1995). People who experience false memory often believe them to be true with the utmost confidence, and can sometimes recall specific contextual details surrounding the memory. These detailed, episodic false memories are referred to as phantom recollections (PRs), or more recently, false remembers, and are different from other types of false memory in that they are more than just feelings of familiarity (Brainerd, Wright, Reyna, & Mojardin, 2001).

The existence of false memory, and even more specifically false remembers, has sparked much controversy, especially in regards to eyewitness testimony (Loftus, 1979).

The nature of false remembers makes them apparently indistinguishable from true memory, given that both are accompanied by specific, contextual details. This could have serious implications for the validity of eyewitness testimony, especially from older adults (Bernstein & Loftus, 2009). There also have been mixed results in attempting to describe the underlying mechanism of false remembers, as no theory can fully explain why contextual details could be incorporated into an event that never occurred. The current study aims to determine not only if the occurrence of false remembers for contextual details is possible, but also if there are age-related differences in rates of these highly detailed false memories.

Episodic Versus Semantic Memory

Memory can be defined in many different ways, but perhaps the most simplistic is as a storage place for facts, knowledge, and life events. Although memory for factual knowledge has been shown to be fairly stable over time, memory for autobiographic events is often subject to forgetting or distortion and is not very stable over time (Tulving, 1985). These unstable and stable types of memory can be broken down into two different types, episodic and semantic memory. Tulving theorized that there are different types of memory systems that can be defined by functions (i.e., what they do) and properties (i.e., how they do it). Episodic memory is a unique process in that it allows us to remember events from our past (Tulving, 2002). There are differences between episodic and semantic memory and it is important to distinguish between the two.

Episodic memory is memory for personal experiences, events, or situations, and is autonoetic, or self-knowing (Tulving, 1985). The memories within this system are unstable and are often prone to intrusions, distortions, and forgetting. Episodic memory

allows us to remember past events in our lives through a mental time travel, and is heavily dependent on the contextual details of each event. For example, remembering the location of the White House is a semantic memory; remembering that your elementary school teacher who had blue hair showed you a video about the White House is an episodic memory. Specific details, such as your teacher's blue hair, are brought to mind as you retrieve this autobiographical memory. Episodic memory is unlike any other memory system in that it is accompanied by a feeling of mental time travel to the past (Tulving, 2002). Even though episodic and semantic systems are similar in the ability to retrieve previously experienced information, a major difference between these types of memories is the reliance on contextual details (Tulving, 2002).

Semantic memory is categorized as memory for factual information, and is a relatively stable type of memory system. This type of memory has been called "noetic", meaning that it is knowing, and that we do not experience semantic memory, we learn it (Tulving, 1985). An example of a semantic memory is the knowledge that the White House is in Washington, D.C. A person does not necessarily have to take a vacation to D.C. in order to know the fact that the White House is in D.C., instead, this can be learned from many different sources. Unlike episodic memory, contextual details are irrelevant to semantic memory (Tulving). This means that forgetting that your elementary school teacher with blue hair taught you that the White House is in D.C. will not interfere with your semantic memory of this information.

Tulving (1985) designed the *remember* versus *know* (RK) paradigm to differentiate between semantic and episodic memory systems. During his research, Tulving noticed that people often use the phrase 'I know…' when relaying a semantic

memory (e.g., ‘I know the White House is in D.C.’) and ‘I remember…’ (e.g., ‘I remember when my teacher with blue haired showed me a video about the White House) when describing an episodic memory. Although it is not universally accepted that these responses are proxy for the two memory systems, it is widely used in the field of cognitive psychology and in the study of memory. Under this paradigm, it is believed that a remember (R) response would include specific contextual details for an event (i.e., episodic memory); in contrast, a know (K) response would lack contextual details, relying more on a feeling of familiarity akin to a semantic memory (Tulving, 1985). The RK paradigm has been used in many different areas of psychology to identify recollection and familiarity (Lampinen, Meier, Arnal, & Leding, 2005; McDermott & Roediger, 1998). The RK paradigm has also been used to study older adults, as they have been shown to have age-related decreases in episodic memory (LaVoie & Fogler, 2014; Naveh-Benjamin, Brav, & Levy, 2007), while semantic memory seems to be protected (Levin et al., 2002).

Some research in the field of aging shows that, although memories that are familiarity based do not decline with age, recollection memory does (Yonelinas, 2002). As previously stated, episodic memory has been shown to decrease with age related cognitive decline (LaVoie & Fogler, 2014; Naveh-Benjamin, Brav, & Levy, 2007). Both of these findings directly relate to the study of R versus K responses, and would suggest that older adults would display an increase of both true and false K responses, but a decrease in true and false R responses. The idea behind this is that older adults would not be able to recollect verbatim items that were previously presented, and instead would rely

on feelings of familiarity based on the gist or semantic relatedness of the items they were being presented (Yonelinas).

False Memory

False memory has been predominantly studied using the RK paradigm (Roediger & McDermott, 1995), and also yields differing results in older versus younger adults (LaVoie & Fogler, 2014; Schacter et al., 1997; Tun et al., 1998). False memory is described as remembering something that has never happened, or remembering details of an event differently from what actually occurred (Roediger & McDermott). The false memory phenomenon has received much attention in the last 10 to 20 years, and has many implications for real life, such as the reliability of eyewitness testimony. This robust phenomenon is often seen in real life, and also can be induced in a laboratory setting (Gallo, Roberts, & Seamon, 1997).

False memory has frequently been studied using the Deese, Roediger, and McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) Paradigm and RK responses. The DRM paradigm is a list-learning task consisting of semantically related word lists and associated critical lures that are never presented. Deese (1959) originally created this list-learning paradigm in attempts to examine extra-list intrusions, and Roediger and McDermott (1995) adapted the paradigm to induce false recall and recognition in participants. The creations of these lists have allowed researchers to induce false memory in laboratory settings and garner robust findings. An R response for a critical lure is defined as having specific contextual details for an event (Gallo et al.). This specific type of false memory, false remembers, incorporates the application of contextual details to some type of memory trace; however, where and how these details

become incorporated in the memory is contested among false memory researchers (see Brainerd & Reyna, 2001; Johnson & Hastroudi, 1993; Yonelinas, 2002). Interestingly enough, researchers have been unable to find a definitive way to distinguish true from false memory, especially false remembers (Bernstein & Loftus, 2009). Previously, it was believed that the crucial difference between these two memory types was that veridical memory contained rich, contextual details and high confidence ratings; however, false remembers are accompanied by rich, contextual details and high confidence ratings, despite the memory being false (Bernstein & Loftus; LaVoie & Fogler, 2014; Roediger & McDermott).

The ability to create false remembers (i.e., phantom recollections) was found in a study conducted by Gallo and Roediger (2003). In this study, both older and younger adults heard or saw DRM lists of varying lengths, in attempts increase associative activation. The idea of associative activation is that presenting associated words internally activates a critical lure. It was hypothesized that by increasing the list lengths and therefore the level of associative activation would increase false remembers rates in both older and younger adults. It was found that both older and younger adults had increased levels of false remembers with longer lists, though older adults' source judgments for both studied items and critical lures were less likely to match the actual modality of the related list (Gallo & Roediger). These findings show that false remembers are possible and occur for both older and younger adults.

Although some theories can explain the occurrence of false K responses (see Brainerd & Reyna, 2002; Johnson, Hashtroudi, & Lindsay, 1993), or feelings of familiarity, not many can sufficiently explain how or why false remembers occur. Three

influential theories that are applied to the false memory phenomenon are fuzzy trace theory, source monitoring theory, and content borrowing theory. Each of these theories takes a different approach to explaining false memory, but none can adequately explain the indistinguishable nature of true and false recollection.

Theories Explaining False Memory

Fuzzy trace theory (FTT). Although fuzzy trace theory was not originally applied to false memory, it has been shown to explain some features of this phenomenon. Different aspects of FTT can be explained using the RK paradigm. FTT states that there are two different type of memory traces, gist and verbatim, that are stored together, and through dissociated retrieval, can lead to memory errors such as false memory (Brainerd & Reyna, 2002). The first type of memory trace, gist-based, deals with the overall meaning or theme of an event and is relatively stable over time. A gist-based memory trace would lead a person to a K response, as specific details are not incorporated into the gist of a memory. For example, you may remember the overall idea of a presentation but you will not remember word for word what was said. This leads us to the other type of memory trace, verbatim traces. A verbatim trace includes the episodic, contextual details of an event. A verbatim trace would lead to a true R response and decreased occurrence of false memory, due to the specific remembrance of the words presented on the list and the ability to *recollect to reject* a critical lure.

FTT holds that if verbatim trace is strong enough, then it will be retrieved over the gist trace, causing a decrease in false memory. In this case, participants will *recollect to reject*, which is the ability to recollect the previously studied items, and recognize that the critical lure actually was not presented. In contrast, if the verbatim trace is weak, then the

gist trace will be favored and familiarity will take over, allowing for false memory to occur (Reyna & Mills, 2007). This implies that there cannot be specific, contextual details for false memory, and that the only true response to a critical lure is a K response. This is not the case though, as it has been shown that people often have false remembers for items that were never shown (Gallo et al., 1997; Roediger & McDermott, 1995). Fuzzy trace theorists have accepted that both verbatim and gist traces can have specific contextual details and that there can be false remembers, though the theory cannot exhaustively explain why (Brainerd & Reyna, 2002). Instead, they believe that when a false memory is constructed during testing, there is a possibility that specific details are simultaneously confabulated (Brainerd & Reyna, 2001).

Source monitoring theory. Source monitoring theory has been applied to false memory in attempts to understand the underlying mechanism of this phenomenon. This theory focuses on the judgments about the source, or origin, of information, which can refer to the context in which the memory is created (Johnson, Hashtroudi, & Lindsay, 1993). The occurrence of a false memory is described as a source monitoring error, or, the inability to connect a memory to a direct source. This error may play on feelings of familiarity, in which it is believed that something familiar was actually previously presented. Due to the familiarity of the new item, perhaps through semantic relatedness, the correct source from which it was derived cannot be determined, and it is judged as being old. An example of this is the judgment that the word sleep was presented because of its similarities with the words bed and nap, which were shown before. The familiarity of the word leads to an inability to correctly determine the source of sleep was internally generated, not externally presented on the word list (Johnson et al.).

In this theory, it is believed that memories are stored in such a way that episodic and semantic information overlap, allowing misattributions of sources and perceptual information to occur (Johnson et al., 1993). Based on this theory, it would make sense to believe that all false memory are derived from feelings of familiarity, and should be categorized using a K response. This, however, is not the case; as previously stated, critical lures are often given R responses. Though Johnson et al. do not deny the existence of false remembers, their theory cannot adequately explain why or how false remembers occur, and why they are accompanied by such high confidence ratings. Another theory, content borrowing, can explain the occurrence of false remembers, but not all aspects of false memory (Lampinen et al., 2005).

Content borrowing. Content borrowing has often been used to explain why a false memory can be so vivid and indistinguishable from a true memory. The idea behind content borrowing is that when something that has never been presented before seems familiar, people will unknowingly search their episodic memory for details from a related true memory and errantly borrow these details in attempts to corroborate the false memory (Lampinen et al., 2005). The process of mentally searching and borrowing details is thought to be a long process, which would lead one to believe that it takes longer to form a false memory compared to a true memory. Studies using reaction times show that this is actually not the case, as sometimes, R responses for a false memory are just as fast, if not faster, as those for a true memory (Stretch & Wixted, 1998; Tun et al., 1998; Williamson et al., 2015). Unfortunately, along with reaction time data, content borrowing also cannot explain why not all false memory are given R responses. It would seem that if the details of a true memory are so readily borrowed and bound to a false

memory, that the result would always be R responses. Although many false memory do contain episodic details, some are based on feelings of familiarity, and are, in fact, given K responses.

Despite the inability to fully explain the mechanism behind false memory creation, researchers still apply the aforementioned theories to study false memory. Though these theories can explain some aspects of false remembers, they cannot explain all of the results regarding false remembers. As noted above, reaction times in responding "old" to critical lures have been shown to be as fast as studied items (Stretch & Wixted, 1998; Tun et al., 1998; Williamson et al., 2014). A novel approach (Fogler, 2011; Williamson et al.) to explaining false remembers shifts the error to one of encoding versus retrieval. This approach posits that critical lures are being internally generated at encoding (as do the aforementioned theories) and are concurrently being bound to contextual details during that encoding episode (none of the aforementioned theories posit this process). Due to the nature of this approach, it is assumed that people can encode and associate contextual details implicitly. Evidence, through reaction time data and the role of sleep consolidation in false remember rates (Fogler; Williamson et al.), has supported that this is happening for younger adults, though this has yet to be examined in older adults. In order to examine the potential role of encoding in false remembers, one must first establish whether or not older adults can encode and associate contextual details to semantic information (e.g., gist). Surprisingly perhaps, the answer to this question is disputed.

False Memory in Older Adults

Much, though not all, of false memory research has shown that older adults are more susceptible to false memory than younger adults, though the exact cause of this is unknown (LaVoie & Fogler, 2014). Age-related declines in cognition and memory could explain why older adults make more false R and K responses, but the source of this occurrence has yet to be found. Gutchess et al. (2007) found that older adults have a tendency to rely on contextual details, and because of this, have trouble rejecting stimuli that are new, regardless of whether or not they are semantically related to old information. This would account for increased false memory rates in older adults, and would also lead one to believe that they would have increased false remembers, compared to younger adults, but other theorists disagree. As described by Naveh-Benjamin et al. (2007) and the Associative Deficit Hypothesis, older adults also have difficulty forming associations and correctly binding associations to the appropriate content.

Associative Deficit Hypothesis. In the Associative Deficit Hypothesis (ADH), it is believed that older adults have declines in the ability to create and use associations between contextual details and contents, meaning that they have difficulty binding together details or components into solidified units (Naveh-Benjamin et al., 2007). The ADH is theorized to be the underlying mechanism of age-related episodic memory impairments. The theory states that older adults have issues with associative memory, that is, tying together details of an item to the specific item. An example of this would be the inability to bind together the font color of a list of words with the actual words on the list. This could explain increased false K responses in older adults, as contextual

information is not bound directly to an item, causing these details to be applied to similar items such as a critical lure.

A study using the ADH framework presented both older and younger adults 40 word-nonword pairs on index cards (Naveh-Benjamin, 2000). Participants were presented with the words in groups of two to three, and were informed that they would need to study the words for an item and associative recognition test (word recognition, nonword recognition, and associative recognition). The word recognition test consisted of 20 words, 10 targets and 10 distractors, with the target words being randomly selected from the previously studied pairs. Participants were asked to circle the word that appeared during the study phase. The nonword recognition test was structured in the same manner, but with nonword targets. Finally, the associative recognition test consisted of 20 word-nonword pairs, 10 of which were original pairs from the study phase. The other 10 pairs were new combinations of previous pairs from the study list. Participants were told that all words were on the study list, but that only 10 of the pairs were in the correct order, and were asked to circle these 10 correct pairs. The results showed that younger adults performed better than older adults overall, and that across participants, performance on the word test was significantly better than performance on the nonword test. Finally, older adults were shown to perform significantly worse than younger adults on the associative recognition and nonword tests, but not differing on the words test. The results of this experiment show that although older adults were able to encode word information, as shown by performance on the word test, they had difficulties encoding associative information, as shown by age differences on the associative recognition test (Naveh-Benjamin). These results support the idea that episodic memory decline could be

mediated by the inability to associate the correct context to a particular content. This research is of particular importance, as it could explain the increased rates of false memory, specifically false K judgments, displayed by older adults. An opposing theory, hyper-binding, also attempts to explain age-related differences in RK responses, but states that older adults are actually over-binding, or over-associating information.

Hyper-binding. In hyper-binding theory, it is believed that a decrease in inhibitory regulation leads older adults to errantly bind too much information from the environment, and therefore form excessive associations between irrelevant and relevant stimuli (Campbell, Hasher, & Thomas, 2010). This decrease in inhibitory regulation is believed to cause older adults to encode important information, but also to encode distracting information that has no relevance to the task. In attempts to test this theory, Campbell and colleagues conducted a study to determine if older adults would form not only meaningful associations, but also associations between distractors and co-occurring targets.

In a series of two experiments, Campbell et al. (2010) tested both older and younger adults on a 1-back task containing pictures superimposed with irrelevant words. During the 1-back task, participants were told to ignore the words, and press the spacebar if the current picture was the same as the previous picture. Participants were give a paired associates memory task, containing preserved and disrupted pairs of the irrelevant words featured on the 1-back task. The participants were not told that the words shown on the 1-back task would be important or featured later on in the experiment. This task consisted of a study list containing 12 picture-word pairs, and a recall test. During recall, participants were shown the pictures and asked to remember the words that were

previously paired with each picture. Though there were no differences in overall recall rate between older and younger adults, there was a significant interaction between age and pair-type, such that older adults showed an advantage for preserved pairs and a disadvantage for remembering disrupted, and younger adults performed similarly across pair types. The researchers believe that the results of this study support the idea that older adults are errantly binding too much information, including that of target and distracting information (Campbell et al.).

The Current Study

Both ADH and hyper-binding could be applied to the age-related differences in false memory rates, though each theory would predict a different outcome. If the ADH is correct, older adults should have more K responses, as they cannot accurately bind contextual information to the correct content, but would still have feelings of familiarity for the item. If hyper-binding theory is correct, then an increase in R responses, both true and false, would be expected. In this case, older adults would be errantly binding too much information, and would be unable to recollect to reject the critical lures, increasing the amount of R responses for this word type.

The current study aims to test the aforementioned theories of false memory by investigating 1) the role of a specific contextual detail in the rate false remembers and 2) any age-related differences in R and K responses. As to the first hypothesis, Lavoie and Fogler (2014) suggest that by giving older adults a salient context, they will use that context and have more true and false R responses. Using a method similar to LaVoie and Fogler, and the encoding hypothesis (Fogler, 2011), it is hypothesized that when participants give an R response (i.e., a specific, detailed memory of the item) they will be

more likely to get the font color correct (i.e., the font color of the presented word list) than when they give a K response, suggesting that this added contextual detail at encoding bolsters their ability to specifically recollect items. As to the second hypothesis, if ADH is correct, any specific details would not be associated with the word lists or corresponding critical lure, and more K versus R responses should be observed for older adults in comparison to younger adults. If hyper-binding is correct, older adults should have higher true and false R responses, as compared to younger adults, due to contextual details being bound to studied items and critical lures. Results will also be interpreted in light of the general theories of false memory previously described (e.g., fuzzy-trace theory, source monitoring theory, and content borrowing).

Method

Participants

The study originally consisted of 27 older adults, and 37 younger adults, but four older and five younger adults' data was excluded from the study. Out of the four older adults that were excluded, one was due to failure of the participant to follow instructions, and three were due high rates of response bias during testing, as shown through a high proportion of old responses to filler items (i.e., above 45%). The participant who failed to follow direction did so by flipping through the pages in attempts to match semantically related items on response type and color. All older adults participants obtained a score of 27 or higher on the MMSE. Out of the five younger adults excluded, one was due to failure to follow instructions, and four were due to high rates of response bias. In total, data from 23 older adults, ages 63-85 years (M = 76.61, SD = 5.16), and 32 younger adults, ages 18-23 years (M = 18.71, SD = 1.16) was utilized. All participants completed

the Nelson Denny Vocabulary test, and older adults (M = 18.43, SD = 2.35) obtained higher scores than younger adults (M = 12.41, SD = 2.86). The younger adult participants attended James Madison University, and the older adults were enlisted through the University of Colorado, Colorado Springs (UCCS) older adult participant pool, and from Rockingham County in Virginia. Older adults were compensated monetarily ($10.00 cash) for participating and younger adults received class credit. In order to ensure that the older adults were eligible to participate, they were given the Mini-Mental Status Examination (MMSE). Only adults who showed no cognitive impairment, as indicated by a score of 27 out of 30 or higher, were included in the experiment.

Materials

Cognitive assessments. The Mini Mental State Examination (MMSE) is a short questionnaire used to determine levels of cognitive impairment in older adults. This test has been used as a preliminary tool to detect cognitive deficits and is also used to track impairment in patients diagnosed with disorders associated with cognitive deficits. Patients obtaining a score of 27 out of 30 or higher are categorized as showing little to no cognitive impairment. The MMSE contains 11 questions and only takes about 5 to 10 minutes to administer (see Appendix A). High reliability and validity have been found for the MMSE as a test of cognitive functioning (Folstein, Folstein, & McHugh, 1975).

The Brief Test of Adult Cognition (BTACT) is a battery of cognitive tests used to assess levels of executive functioning in adults, and measures episodic verbal memory, working memory span, verbal fluency, inductive reasoning, speed of processing, and task switching (Tun & Lachman, 2005). The BTACT takes approximately 20 min to administer, and can be given by telephone or in person. The BTACT is typically used

with older adults and has been shown to be very reliable and to have high construct validity (Tun & Lachman). This battery includes a word recall test, digits backward test, category fluency test, stop and go task, number series test, and the 30 seconds and counting task. Due to the possible relationship with false memory rates, the category fluency test and number series test are the two tests of interest (see Appendix B). The category fluency test is hypothesized to have a relationship with false memory rates because it requires participants to generate related items for a given category; presumably, larger semantic networks would create more associative priming for the category label or the critical lure in the DRM. The number series test is also though to be related to false memory rates because it requires participants to be able to recognize patterns in order to correctly identify the next number in a list, which may indicate greater ability in making connections between concepts.

The Nelson-Denny vocabulary test assesses verbal abilities. This test gives participants a word and requires them to pick the closest meaning of the word from a short list of multiple-choice answers (see Appendix C). There are 25 words on this list and it takes about 5 min to administer.

Deese, Roediger, and McDermott (DRM) paradigm. The DRM Paradigm is a list learning task used to induce and measure false memory rates, as shown through RK responses. The task consists of a study phase, distractor task, and test phase. During the study phase, participants are presented with lists containing semantically related words. The items on each individual list converge on the “critical lure”, which is semantically related to each word on its respective list (Deese, 1959; Roediger & McDermott, 1995). Participants are never presented with the critical lure during the study phase. After

studying the words on the lists, participants are given a recognition task that includes not only the previously studied items, but also the critical lures and unrelated filler items. For each word on the recognition task participants are asked to judge if the word was old or new. Old judgments for critical lures are categorized as a false memory. In the current study 12 lists, each containing 12 words, were used for the study phase (See Appendix D). To make the context, in this case font color, of the lists salient, three of the lists were presented in red, three were presented in blue, three were presented in green, and three were presented in yellow. Four counterbalanced versions of the lists were created, so that each list was presented in a different color in each version. This was done to ensure that correct color identification of items was not due to participants guessing a specific color because of its possible relatedness to list items. The study phase was presented via PowerPoint, while all responses were recorded on paper.

Procedure

After obtaining informed consent, older adult participants were screened for cognitive impairment via the MMSE. Subjects that obtain scores below 27 out of 30 were excluded from participating in the study, and instead, were given the Nelson Denny Vocabulary test and then allowed to leave. Next, participants who obtained a score of 27 or higher received the BTACT, which lasted for approximately 20 min. Standard procedure was followed for administering the BTACT. All younger adult participants started the experiment with the BTACT. Next, the DRM paradigm was administered to all participants.

For the DRM Paradigm, 144 words were shown on a PowerPoint presentation, for about 10 min in duration. Each word appeared on the screen separately for 1 s, with a 500

ms white screen between each word. The delay between each word list was approximately 5 s. Each list was shown in either blue, green, red, or yellow font color (i.e., three lists in blue font, three lists in green font, three lists in red font, and three lists in yellow font) and all lists were presented in Times New Roman Font. Through counterbalancing, 4 list versions were created, one of which was randomly assigned to each participant. Participants were then given a colorblind test, which served as a filler task, and confirmed that they were able to see the colors. After the filler task was completed, participants received the recognition test packet, which consisted of 96 words; 48 of the words were previously studied items, 12 were critical lures, and 36 were unrelated filler items, all presented in black, Times New Roman font. Participants were instructed to judge if each word was old, meaning it was on the lists previously presented, or new. If old was selected, participants were then asked if they were remembering, knowing, or guessing that the word was old (see Appendix A). Finally, the subjects were asked if the word was previously presented in blue, green, red, or yellow font. Participants were also instructed not to flip back and forth between pages, and to answer the questions for each word in order, without skipping any words or questions. Finally, the participants were asked to complete the Nelson-Denny Vocabulary test, followed by a demographic questionnaire. After completing all tasks, participants were debriefed about the purpose of the study.

Results

After analyzing the data, it was realized that two of the lists, *anger* and *cold*, may have been associated with certain colors, red and blue respectively. Despite the studied items for these lists being presented in different colors (e.g., yellow, red, blue, and green)

depending on the counterbalanced version, participants across versions were consistently choosing the associated color for both studied items and critical lures (see Table 1). Due to the association between the color and the item types, all studied items and critical lures related to these lists were removed from the data set. The researcher believed that it was necessary to use the corrected data because the original hypothesis aimed to see if the specific contextual detail of color would increase R responses. In the case of the *cold* and *anger* lists, a prior association may have been causing participants to recall these words at a higher rate. By excluding the data for these lists, the researcher will be able to more accurately report the results in conjunction with the hypotheses (i.e., that the association between items and font color was happening at encoding). It is important to note that the patterns of results for this study did not significantly change by removing these items. All alpha levels are set at .05 unless otherwise noted. All effect sizes have been interpreted using Cohen's (1988) benchmarks.

Overall False Memory Effect. In order to see if there was an overall false memory effect, a mixed 2 (between groups, age: younger, older) x 3 (repeated measures, item type: studied, critical lure, filler) ANOVA was conducted on proportion of old responses. Filler items were included to test for response bias. A main effect of item type was found, $F(2, 106) = 528.42$, $p < 0.01$, such that both older and younger adults categorized studied items ($M = 0.68$, $SD = 0.14$) and critical lures ($M = 0.72$, $SD = 0.18$) as being old more frequently than filler items ($M = 0.12$, $SD = 0.11$; see Figure 1). Follow up pairwise comparisons using LSD showed that critical lures were categorized as old significantly more than fillers, $p < .001$, and that studied items were also categorized as old significantly more than fillers, $p < .001$. Note that these effects were still

significant even when applying the Bonferroni corrected alpha level of 0.017. The effect size was calculated, $\eta^2 = 0.91$, and showed that 91% of the variance of an old categorization was explained by item type. There was, however, no effect of age, $F(1, 53) = .01$, $p = .93$, showing that older and younger adults treated items the same. There also was no interaction between item type and age, $F(2, 106) = 1.84$, $p = .17$, meaning that regardless of item type, older and younger adults were responding similarly.

Item Type by Response Type. Next, the performance of older and younger adults was compared using a 2 (between groups, age: younger, older) X 2 (repeated measures, item type: studied, critical lure) X 2 (repeated measures, response type: R, K) mixed ANOVA. There was a main effect of response type, $F(1, 53) = 7.94$, $p < 0.01$, $\eta^2 = 0.11$, with R responses ($M = 0.36$, $SD = 0.24$) being utilized significantly more than K responses ($M = 0.22$, $SD = 0.21$) across item type (studied and critical lure; see Figure 2). There also was a significant interaction between response type and age, $F(1, 53) = 8.49$, $p < 0.01$, $\eta^2 = 0.14$, such that older adults used the R response ($M = 0.42$, $SD = 0.24$) significantly more than younger adults ($M = 0.30$, $SD = 0.22$), and younger adults used the K response ($M = 0.30$, $SD = 0.23$) significantly more than older adults ($M = 0.14$, $SD = 0.15$; see Figure 3).

No main effects for item type ($F(1, 53) = 1.95$, $p = .17$) or age ($F(1, 53) = .39$, $p = .54$) were found. There were no significant interactions between item type and age, $F(1, 53) < 1$, or between item type and response type, $F(1, 53) < 1$. Finally, there was no interaction found between item type, judgment, type, and age, $F(1, 53) = 2.66$, $p = 0.11$, showing that regardless of age, participants were responding similarly to the different item types.

Color Analyses. A 2 (between groups, age: younger, older) X 2 (repeated measures, item type: studied, critical lure) X 3 (repeated measures, response type: R, K, G) mixed ANOVA was conducted, comparing older and younger adults on the proportion of correctly identified color responses. For critical lures, font color was deemed correct if it was the color of the corresponding studied list. For this analysis, no significant results were found, and performance for both age group was at or near floor (< 25%; see Table 2). No significant main effect of item type was found, $F(1, 53) = 2.68$, $p > 0.05$, such that participants were getting the color correct for studied items ($M = .27$, $SD = .24$) at the same rates as critical lures ($M = .22$, $SD = .32$). There also was no significant main effect of age $F(1, 53) = 2.13$, $p > 0.05$, showing that older and younger adults did not differ in the frequency of correctly identifying the color, regardless of item type. No interaction between item type and age was found, $F(1, 53) = 1.80$, $p > 0.05$, such that older adults got the color correct more frequently for critical lures than studied items, and younger adults got the color correct more frequently for studied items than critical lures. There was no main effect of response type, $F(2, 106) = 1.07$, $p > 0.05$, meaning that participants did not get the color correct more for R, K, or G responses. Lastly, all other interactions were not found to be significant, $F(2, 106) < 1$.

Correlation Analyses between False Memory Rates and BTACT. Finally, older and younger adults' rates of old responses for both studied items and critical lures were examined via correlational analyses to determine their relationship with scores on two BTACT tasks, the number series task (measures the ability to infer relationships among items) and the category fluency (measures the ability to generate items in a category). It was believed that both of these categories would have been correlated,

though no directionality was assumed, with rates of false memory, as shown by old responses to critical lures, because both may indicate more intricate semantic networks. No significant correlations were found between these variables for older adults, though most relationships were trending in a positive direction (see Table 3). Younger adults, in comparison, were found to have a significant positive relationship between proportion of K responses for critical lures and the number series task ($R = .37$, $p < .05$), indicating that as participants K responses for critical lures increased, so did their scores on the number series task (see Table 4).

Discussion

The current study aimed to explore 1) the role of a specific contextual detail (e.g., font color) in false memory and 2) any age-related difference in the encoding and binding of this contextual detail. As seen by the aforementioned results, an overall false memory effect did occur, meaning that participants did indeed have false memory (R or K responses) for critical lures. These results are not surprising, as they are consistent with many previously conducted experiments (Lampinen et al., 2005; McDermott & Roediger, 1998; Roediger & McDermott, 1995). Although there were no significant differences between studied items and critical lures, mathematically the means for proportion of critical lures classified as old was higher than that of studied items. This indicates that across age groups, participants were recognizing critical lures as old more frequently than presented studied items. This result could be due to the participants internally generating the critical lure repeatedly during the presentation of the lists. Seeing as how Deese (1959), and Roediger and McDermott (1995) designed the words on each list to have a backwards association with the critical lure, meaning that the words are ordered from

most related to least related to the critical lure, it would make sense that the presentation of the studied items would internally generate the critical lure, through spreading activation, several times throughout the list presentation. This result is also consistent with previous studies, in which critical lures not only had higher percentages of being classified as old compared to studied items, but participants were also faster at identifying them as old, as compared to studied items (Tun et al., 1998; Williamson et al., 2014). It is interesting to note that Gutchess et al. (2007) reveal a tendency in older adults to rely on contextual details, which results in an inability to reject stimuli, whether it is semantically related or not. If this were true, then older adults should not be able to reject filler items, and should have similar proportions of old responses for all item types. This, however, was not the case, as seen by the fact that older adults categorized filler items as old significantly less than critical lures and studied items.

Another noteworthy finding was the significant interaction between response type and age, such that older adults were using "R" responses significantly more than younger adults. Older adults also used "R" responses more than "K" responses. In contrast, younger adults seemed to use these response types at a similar rate (see Figure 3). These results are unexpected because many aging theories (e.g., ADH) would predict a higher proportion of "K" responses in older adults, or the inability to make "R" responses and incorporate contextual details. The fact that older adults used "R" responses so frequently indicates an ability to encode contextual details and utilize them.

Despite results indicating that participants actually can have false memory for a specific contextual detail, as indicated by high R responses, the hypothesis that R responses would result in significantly more correct color identifications (i.e., identifying

the critical lure as having been seen in the font color of the corresponding studied list) was not supported, and both groups performed at or near floor for correctly identifying colors. Many of the aforementioned results did shed light on the predictions of opposing false memory theories, which will be explained in the context of the corresponding research question.

The Role of Contextual Details in False Memory

Overall, the results show that it is possible for people, regardless of age, to bind contextual details to items, though what exactly these details are has yet to be determined. Due to older adults having significantly more R responses than younger adults, it can be gleaned that in this case, they did have more false memory for contextual details, though not for the specific detail of font color that was provided. FTT's premises would suggest that participants would have more K responses for critical lures, as opposed to R responses, because the gist trace that was retrieved when viewing the word at test would cause participants to feel as sense of familiarity with the word, but that gist trace would not include contextual details (Brainerd, et al., 2001). It would also be expected that participants would have classified critical lures as old significantly less than studied items due to the ability to *recollect to reject* the lures; that is, relying on the verbatim memory trace would lead them to correctly accept *bed* as a word they previously saw, but reject *sleep* as being a word they previously saw. However, the current results contradict both of these principles, as critical lures and studied items were classified as old at the same rates and were both given more R responses in comparison with K responses, as seen from the significant main effect of response type. Although FTT can explain the

existence of false K responses, it is unable to adequately explain false remembers, and the ability to have false memory for contextual details.

In contrast to FFT (Brainerd et al., 2001), both source monitoring theory (Johnson et al., 1993) and content borrowing (Lampinen et al., 2005) were not supported or refuted from the results of this study. Both of these theories suggest that participants experience a feeling of familiarity towards the critical lure during retrieval that can either result in an R or K response. Due to the poor performance of both older and younger adults in tying the given contextual detail of font color back to the studied items and critical lures, it cannot be definitively determined if false remember formation is a product of encoding or retrieval. If participants were able to tie the font color back to a specific list, then the most reasonable explanation would be that they were encoding this specific detail and binding it to both the studied items and critical lures at the time of study, as this is a very difficult task. If this were the case, then it would provide strong support for the encoding hypothesis. The current results do not rule out the possibility of false remember formation at retrieval, but they also do not conclusively oppose the encoding hypothesis. The task may have simply been too difficult, as is evidenced by the floor effect for correct color identification. More research is needed in order to tease apart whether this is an issue of encoding or retrieval.

Age Related Differences in Encoding and Binding of a Specific Contextual Detail

Overall, it was found that older and younger adults were not able to bind the contextual detail of font color to any item type, as both groups performed at near chance. One age-related difference that was found, however, was an interaction between age and response type, such that older adults more frequently used R responses compared to

younger adults. This finding is interesting, because perhaps the contextual details actually are helping older adults to remember information. These findings will now be discussed in terms of the aforementioned aging theories.

As previously stated, ADH predicts that older adults have an inability to bind contextual details to relevant contexts (Naveh-Benjamin et al., 2000; 2007). If this theory were correct, then it could be predicted that older adults will have increased K responses caused by an overwhelming sense of familiarity. However, all items would seem familiar in this case, because of the inability to tie the contextual details to the content. Older adults were shown to have more false remembers than younger adults, indicating that they can have false memory for contextual details, though which details are still unknown. The results of this study do not support the prediction of ADH, showing that this theory cannot adequately explain the occurrence of false memory for contextual details in older adults.

In contrast to ADH, hyper-binding suggests that older adults cannot filter out irrelevant information, and instead will over-bind information together (Campbell et al., 2010). If this theory is correct, then older adults would have increased R responses for critical lures compared to younger adults. This was found in the current study, supporting hyper-binding. The theory would also predict that older adults would be worse than younger adults at tying the correct color to items due to the increased interference from irrelevant information; however, due to the floor effect of color responses, the current study can not shed light on any age-related differences regarding the accuracy of contextual binding.

The encoding hypothesis (Fogler, 2011) also cannot be ruled out, seeing as how both age groups are displaying false memory for contextual details. This hypothesis cannot be fully supported because participants were not able to tie the font color back to the studied items or critical lure, though this may have been because of the task difficulty. Though the results of this study did show that older adults can have false memory for contextual details as shown through false remember responses, it is still unclear if false remembers are a product of an encoding or retrieval error.

Limitations and Future Directions

One major limitation of this study was the semantic association between two of the lists (*anger* and *cold*), with font colors used. This limitation, however, was remedied, and the data was reported appropriately. Another limitation was that many participants did not realize that the words were being presented in color. It could be that this specific type of contextual detail was not made salient enough, causing the floor effect that was observed. In order to create a stronger manipulation, brightness and salience of the font color could be manipulated, or other types of contextual details could be utilized. Finally, the currently study was unable to determine if the contextual details increased false R responses for participants, specifically older adults. A follow up study will incorporate another condition, in which participants view the studied lists in black font, as opposed to colored font. This condition will be used as a control group. Then, researchers will be able to compare the false remember rates of participants in the contextually salient condition with those in the control condition. If participants in the salient condition do experience increased false remembers, compared to participants in the control condition, then it would be probable that this is due to the salience of the contextual details. By

adding this condition, researchers will be able to further test the possibility that the contextual detail is increasing false remember responses and that this may have a differential impact on older adult rates, as potentially seen by the significantly higher R responses rates for older versus younger adults

Conclusion

Overall, it was found that older adults can have false remember responses for contextual details, though their accuracy in applying a specific contextual detail was poor. Older adults were shown to make more false remember responses compared to younger adults, which indicates that they are able to encode and associate contextual details to studied items and critical lures. The results of this study do tell us that both older and younger adults are using contextual information, however because there was a floor effect for font color, we still cannot say if this is happening at encoding or retrieval. The results of this study do not rule out any previous theories, and still support the further exploration of the encoding hypothesis in attempts to tease apart whether this is an issue of encoding or retrieval.

Table 1

Proportion of Associated Color Judgment by Test Versions (i.e., anger reported in red; cold reported in blue)

Item	Version 1	Version 2	Version 3	Version 4
Anger	0.60	0.20	0.43	0.33
Cold	0.40	0.53	0.50	0.75

Note. In version 1, anger was actually presented in red. It was presented in green, yellow, or blue in the other versions, respectively. In version 2, cold was actually presented in blue, and was presented in red, green, or yellow in the other versions.

Table 2

Mean Proportions for Color Correct by Age, Item Type, and Response Type

Age Category	Studied "R"	Studied "K"	Studied "G"	CL "R"	CL "K"	CL "G"
Older Adults	0.24 (.17)	0.20 (.19)	0.24 (.27)	0.24 (.22)	0.20 (.36)	0.20 (.31)
Younger Adults	0.40 (.26)	0.32 (.17)	0.25 (.31)	0.25 (.33)	0.22 (.26)	0.23 (.40)

Table 3

Correlations between Item types, Response Types, and BTACT Subscales for Older Adults

Item Type by Response	1.	2.	3.	4.	5.	6.
1. Studied "R"	____					
2. CL "R"	.90**	____				
3. Studied "K"	-.21	-.15	____			
4. CL "K"	-.31	-.32	.62**	____		
5. Category Fluency	.22	.23	.18	.32	____	
6. Number Series	.41	.33	-.08	.04	.25	____

**Significant at p < .05.*
***Significant at p < .01.*

Table 4

Correlations between Item types, Response Types, and BTACT Subscales for Younger Adults

Item Type by Response	1.	2.	3.	4.	5.	6.
1. Studied "R"	____					
2. CL "R"	.83**	____				
3. Studied "K"	-.75**	-.60**	____			
4. CL "K"	-.63**	-.71**	.73**	____		
5. Category Fluency	-.18	-.16	.22	.22	____	
6. Number Series	-.14	-.12	.30	.37*	.06	____

**Significant at p < .05.*
***Significant at p < .01.*

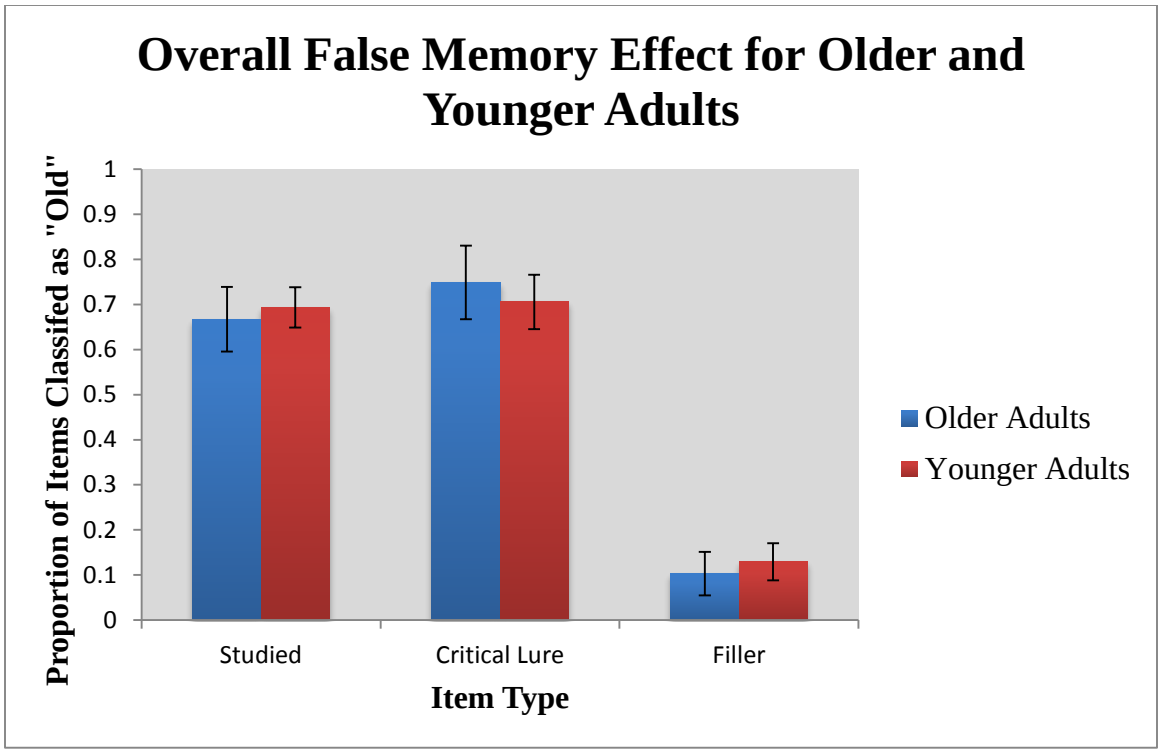


Figure 1. Proportions of items classified as "Old" by age. The error bars represent 95% confidence intervals.

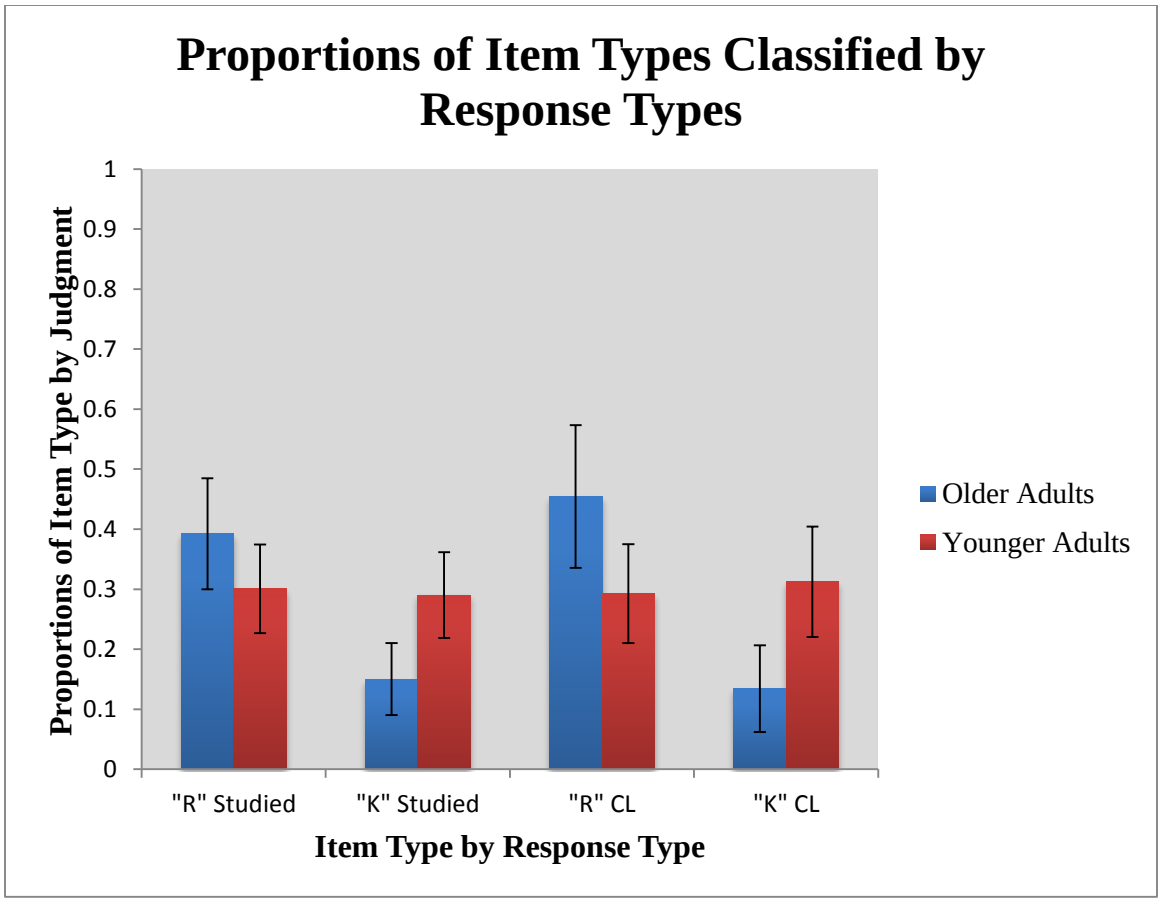


Figure 2. The proportions of items by response types made by old older and younger adults. The error bars represent 95% confidence intervals.

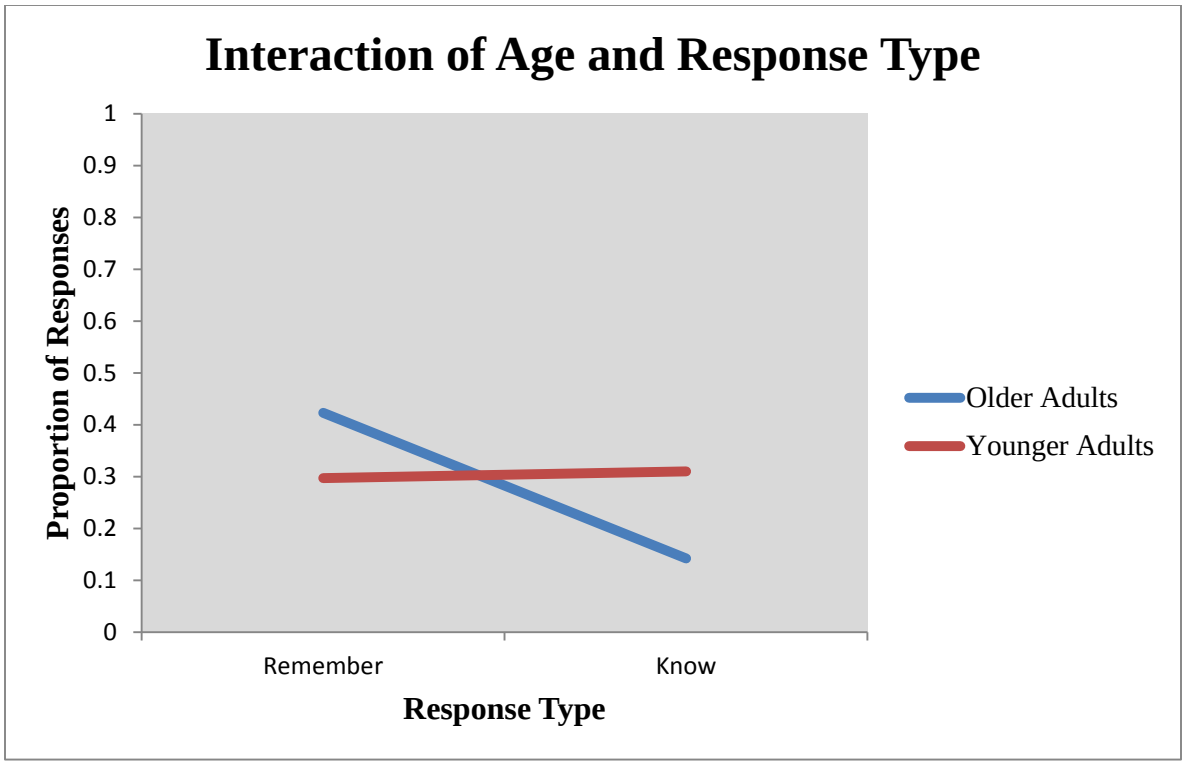
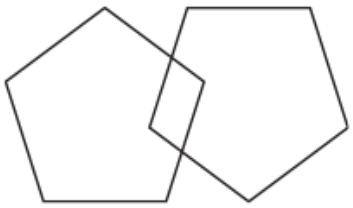


Figure 3. The interaction of age category and response type as shown through the proportions of items categorized as remember versus know for older and younger adults.

Appendix A

The Mini-Mental State Exam

Maximum	Score	
		Orientation
5	( )	What is the (year) (season) (date) (day) (month)?
5	( )	Where are we (state) (country) (town) (hospital) (floor)?
		Registration
3	( )	Name 3 objects: 1 second to say each. Then ask the patient all 3 after you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. Count trials and record. Trials _____
		Attention and Calculation
5	( )	Serial 7's. 1 point for each correct answer. Stop after 5 answers. Alternatively spell "world" backward.
		Recall
3	( )	Ask for the 3 objects repeated above. Give 1 point for each correct answer.
		Language
2	( )	Name a pencil and watch.
1	( )	Repeat the following "No ifs, ands, or buts"
3	( )	Follow a 3-stage command: "Take a paper in your hand, fold it in half, and put it on the floor."
1	( )	Read and obey the following: CLOSE YOUR EYES
1	( )	Write a sentence.
1	( )	Copy the design shown.



_____ Total Score

ASSESS level of consciousness along a continuum _____

Alert Drowsy Stupor Coma

"MINI-MENTAL STATE." A PRACTICAL METHOD FOR GRADING THE COGNITIVE STATE OF PATIENTS FOR THE CLINICIAN. *Journal of Psychiatric Research*, 12(3): 189-198, 1975. Used by permission.

Appendix B

Subsections of the MIDUS II Cognitive Test Battery Brief Test of Adult Cognition

CATEGORY FLUENCY (1.5 minutes) Drachman & Leavitt (1972)

Now I am going to name a category and you will name things that belong in that category. Let's practice with the category "fruit". You could say peach, or pear. Can you think of any other fruits? (*wait for 2 correct items*). In a moment I will give you another category. When I say begin, you will name all the things from this **new** category you can think of, as fast as you can. You will have one minute to do this. I will let you know when your time is up. The new category is not included here. Do you have any questions? Ready?

Begin. ***(Time for one minute)***. If person stops before 1 minute is up, say "There's still more time, can you think of any more?"

Good, now let's go on.

NUMBER SERIES (2.5 minutes) Salthouse & Prill (1987)

In the next exercise I will read you a series of numbers that may get larger or smaller in value. At the end you will try to figure out what the next number would be. So if the numbers were 2,4,6,8,10, the next number would be 12. After I say each number I will pause for as long as you need, and then you should say "okay" when you are ready for me to go on to the next number in the group. So if I said 2, you should say "okay" when you are ready for me to go on to the next number, then I say 4, you say okay, 6, okay, 8, okay, 10, and at the end I will ask you what you think the next number would be. In this case the next number would be 12, as each number has increased by 2.

Let's try one for practice: 35 (okay), 30 (okay), 25 (okay), 20 (okay), 15 (okay) **AND** the next number would be....???? (The answer should be 10 as each number has decreased by 5). There will be different patterns, and some of these will be harder than others, so just do the best you can. If you are not sure of the answer, it is okay to guess. Do you have any questions? *(Pause after each of the first 4 items for okay response; after the last item, say **AND** the next number is...?).*

Appendix C

Nelson Denny Vocabulary Test

We are interested in your knowledge of the meanings of words. Please complete each of the following items with the alternative that best fits the sentence. For example, consider the following:

A linguist is trained in

a. art b. law c. language d. writing e. history

You should have chosen "c" above. There are 25 more items for you to work on. Begin when you are ready.

1. Fundamental reasons are:
    a. Logical
    b. Basic
    c. Acceptable
    d. Convenient
    e. Hidden

2. A cluster is a
    a. Clue
    b. Mess
    c. Badge
    d. Group
    e. Team

3. A valid reason is
    a. New
    b. Critical
    c. False
    d. Hopeful
    e. Sound

4. To insinuate is to
    a. Devise
    b. Err
    c. Convict
    d. Hint
    e. Officiate

5. An arrogant person is
    a. Haughty
    b. Wealthy
    c. Subdued
    d. Unsuccessful
    e. Arrested

6. A medieval crusade was a
    a. Campaign
    b. Battalion
    c. Parade
    d. Trip
    e. Cruise

7. An indictment is a
    a. Charge
    b. Statute
    c. Commission
    d. Warning
    e. Proclamation

8. A prudent move is
    a. Wise
    b. Kind
    c. Rash
    d. Costly
    e. Successful

9. A spontaneous reply is
    a. Erroneous
    b. Unconsidered
    c. Fierce
    d. Provoking
    e. Embarrassing

10. Current fashions are
    a. Prevalent
    b. Changing
    c. Anticipated
    d. Unpopular
    e. Outdated

11. Inveterate hatred is
    a. Unmerited
    b. Deep-rooted
    c. Inherited
    d. Nationalistic
    e. Legalistic

12. A sham battle is
    a. Bloody
    b. Make-believe
    c. Short
    d. Indecisive
    e. Poorly planned

13. Infinitesimal objects are
    a. Awkward
    b. Ponderous
    c. Disagreeable
    d. Everlasting
    e. Very small

14. One who is amenable is
    a. Irresponsible
    b. Submissive
    c. Unruly
    d. Saucy
    e. Envious

15. An ominous cloud is
    a. High
    b. Fleecy
    c. Black
    d. Threatening
    e. Stationary

16. To revile is to
    a. Gloat
    b. Frolic
    c. Infect
    d. Beweep
    e. Slander

17. An insolent person is
    a. Scheming
    b. Bankrupt
    c. Haughty
    d. Dishonest
    e. Heedless

18. To enhance is to
    a. Protect
    b. Enter
    c. Capture
    d. Enlarge
    e. Pursue

19. An igneous appearance is
    a. Ugly
    b. Beautiful
    c. Hopeful
    d. Unworthy
    e. Firelike

20. A prelate is high in the
    a. Navy
    b. Church
    c. Drama
    d. Government
    e. Lodge

21. To decoy is to
    a. Estrange
    b. Tease
    c. Entice
    d. Defy
    e. Bluff

22. A lanuginous substance is
    a. Hard
    b. Sticky
    c. Downy
    d. Long
    e. Slow-moving

23. A myriad group is
    a. Innumerable
    b. Misguided
    c. Angry
    d. Treacherous
    e. Merry

24. An adze is used by a
    a. Teacher
    b. Carpenter
    c. Musician
    d. Decorator
    e. Mathematician

25. A scurrilous attack is
    a. Hurried
    b. Feeble
    c. Desperate
    d. Abusive
    e. Inoffensive

Appendix D

DRM Word Lists

ANGER	**CHAIR**	**COLD**	**DOCTOR**	**FOOT**	**FRUIT**
mad	table	hot	nurse	shoe	apple
fear	sit	snow	sick	hand	vegetable
hate	legs	warm	lawyer	toe	orange
rage	seat	winter	medicine	kick	kiwi
temper	couch	ice	health	sandals	citrus
fury	desk	wet	hospital	soccer	ripe
ire	recliner	frigid	dentist	yard	pear
wrath	sofa	chilly	physician	walk	banana
happy	wood	heat	ill	ankle	berry
fight	cushion	weather	patient	arm	cherry
hatred	swivel	freeze	office	boot	basket
mean	stool	air	stethoscope	inch	juice

NEEDLE	**SLEEP**	**SLOW**	**SPIDER**	**SWEET**	**WINDOW**
thread	bed	fast	web	sour	door
pin	rest	lethargic	insect	candy	glass
eye	awake	stop	bug	sugar	pane
sewing	tired	listless	fright	bitter	shade
sharp	dream	snail	fly	good	ledge
point	wake	cautious	arachnid	taste	sill
prick	snooze	delay	crawl	tooth	house
thimble	blanket	traffic	tarantula	nice	open
haystack	doze	turtle	poison	honey	curtain
thorn	slumber	hesitant	bite	soda	frame
hurt	snore	speed	creepy	chocolate	view
injection	nap	quick	animal	heart	breeze

Recognition Test Instructions

On the following recognition test, you will find some words that you have studied, and some words that you have not studied. You are to make three decisions about these words.

First, for each word, decide if it is **Old** – meaning it was one of the words you studied; or it is **New** – meaning it was not one of the words you studied.

Second, if you selected **Old**, you are to decide if the you are **Remembering**, **Knowing**, or **Guessing**. Although these decisions sound similar, their meanings are quite distinct. Here is what they mean:

> **Remembering**: You have a conscious recollection of what happened or what was experienced at the time the word was presented. You can recall details like: how the word looked, what words preceded or followed, what you were doing or thinking, or what was going on in the room when the word was presented.
> **Knowing**: You recognize the word as being part of the list but cannot vividly recollect anything about its actual occurrence or what happened at the time it was presented. The word does not evoke any specific conscious recollection but you are certain you recognize the word.
> **Guessing**: You have no recollection whether the word was on the studied list or not, and you are just making a guess.

Please use these definitions as you make your decisions.

Lastly, if you selected **Old**, you are to decide what color font the word was presented in.

> Red, Yellow, Green, or Blue

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