THE INFLUENCE OF ANXIETY, AGE, AND RETRIEVAL DEMANDS ON MEMORY

by

Summer Rain Whillock

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

Doctor of Philosophy

in

Psychology

MONTANA STATE UNIVERSITY
Bozeman, Montana

December 2021

DEDICATION

For my parents, and everyone who believed in me.

ACKNOWLEDGEMENTS

This dissertation was made possible through the patience, support, and guidance from many people in my life. First, I want to thank my first advisor, Dr. Ian Handley. Thank you for believing me in 10 years ago and being there for me my entire time at Montana State. Dr. Michelle Meade, I am extremely grateful that you welcomed me into your lab. You are the best mentor I could have ever hoped to have on this dissertation project. Dr. Brandon Scott, your expertise on anxiety and statistics has greatly improved this project. I appreciate all of your advice throughout my time at Montana State. I also want to thank Dr. Keith Hutchison for your thoughtful contributions while serving as a committee member throughout my whole graduate schooling.

To my amazing friends. Thank you, Audrey, my best friend, best collaborator. Courtney, for sitting next to me at every Brown Bag and helping me forget about school every once and a while and enjoy Bozeman. To Stef, Tessa, Bailey, & Kaytlyn, thank you for always believing in me, no matter what I'm doing.

I have the most supportive family in the entire world, and I am so thankful for their love. Thanks to my grandparents, aunts, uncles, cousins, bonus parents and bonus sibling. To Mom, Dad, and Sissy, for supporting me through my hard times and helping me celebrate my successes. Our group chat helps me feel connected, even when my nose is buried in books.

To Kona and Curry, thank you for insisting that I take study breaks to get some fresh air. I did this so that one day I can buy you the backyard you deserve. Lastly, to my love, Mikey. For being there for me through everything. For making me laugh, cooking me food, and cleaning the house. I love you.

TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

TABLE OF CONTENTS CONTINUED

LIST OF TABLES

LIST OF TABLES CONTINUED

Table Page

LIST OF TABLES CONTINUED

LIST OF FIGURES

ABSTRACT

The present dissertation sought to determine if anxiety and hypervigilance can be activated outside the confines of specifically threatening stimuli by examining different situational pressures such as age and retrieval demands. In both experiments, participants studied categorized word lists and were randomly assigned to complete an initial recall test under free, forced, or warning (Exp. 2) recall instructions, followed by a second test under free recall instructions, and a final recognition test. For older adults, forced recall influenced the relationship between trait anxiety and memory such that heightened levels of trait anxiety were associated with greater correct recall and lower false recognition. In contrast, for younger adults, free recall influenced the relationship between memory-specific anxiety, hypervigilance, and memory such that heightened levels of memory-specific anxiety and hypervigilance were associated with lower levels of correct recognition. Further, warning recall influenced the relationship between memory-specific anxiety and memory in young adults, such that heightened levels of memory-specific anxiety were related to greater correct recall at test 1. Across two experiments, results show that it is possible for situational pressures to influence the relationship between anxiety and memory in the absence of specifically threatening stimuli. Additionally, the relationship between anxiety and memory depends on age, the type of anxiety being measured, and the retrieval demands of the task.

INTRODUCTION

Anxiety is an aversive emotional and motivational state comprised of cognitive, behavioral, and physiological responses to stimuli (Eysenck, Derakshan, Santos, & Calvo, 2007). It is characterized by increased surveillance and monitoring of potentially threatening situations (Kimble et al., 2014), however, the situation must be threatening enough to trigger an anxiety response. Once a threat is detected, anxiety ensues, and individuals become hypervigilant to their environment. Hypervigilance refers to the state of being attentive and alert to possible dangers and difficulties--to an excessive degree (Bernstein, Delker, Knight, & Freyd, 2015). Being hypervigilant towards potential threat is a characteristic of anxiety (Aitken, Champion, & Stainer, 2019). With over a quarter of the population experiencing an anxiety disorder at some point in their lives (Kessler et al., 2005), it is important to understand how anxiety influences the cognitive functions that we rely on every day, such as one's memory.

In the current dissertation, I examined the influence of different types of anxiety on the recall and recognition memory performance of both younger and older adults. Specifically, I manipulated different retrieval conditions to determine if situational pressures were enough to activate anxiety and hypervigilance outside the confines of specifically threatening stimuli. Additionally, I propose a model to describe the relationship between anxiety and memory, with source monitoring being the key mechanism to the relationship. Finally, I examined age differences in the extent to which situational pressures and source monitoring influence the relationship between anxiety and memory. Taken together, the current dissertation investigates the role of different types of anxiety on memory, across retrieval demands and different aged populations. Additionally, the current dissertation considers the role that hypervigilance and source monitoring play in the relationship between anxiety and memory.

Anxiety and Memory in Young Adults

Research examining the relationship between anxiety and memory in younger adults has focused almost entirely on the difference in memory between negative/threatening stimuli and neutral stimuli. In these studies, highly anxious participants are presented with negative emotional words and neutral words and the general finding is that the negative emotional words are remembered better than the neutral words (Mitte, 2008). The preferential memory for negative/threatening stimuli over neutral stimuli occurs for individuals with heightened levels of anxiety and is referred to as the negativity bias.

In contrast to the consistent findings regarding anxiety and preferential *attention* towards negative/threatening information (Bar-Haim, Lamy, Pergamin, Bakersmans-Kranenburg, & van Ijzendoorn, 2007; Mogg & Bradley, 2016), research examining the negativity *memory* bias is inconsistent (Coles & Heimberg, 2002; Mitte, 2008). Coles & Heimberg (2002) found support for a negativity memory bias for threatening information in some anxiety disorders, but not in others. This finding suggests that it is important to examine different types of anxiety (e.g., state, trait, memory-specific) to understand the relationship between anxiety and memory. In another meta-analysis, Mitte (2008) examined recall and recognition memory and found a large discrepancy across tasks. For recognition memory, her meta-analysis found no negativity memory bias, meaning that threatening information was not better recognized compared to neutral information. For recall memory, the meta-analysis did find a negativity memory bias, however, the magnitude was strongly influenced by moderators, such as experimental procedures and participant characteristics. Additional research is necessary to further specify the moderating factors that influence the relationship between anxiety and memory.

Several theories have been developed to explain the negativity memory bias for threatening information (Bower, 1981; Beck & Clark, 1997). One theory that assumes differences in memory between high and low anxious individuals is the Associative Network Theory of Memory and Emotion proposed by Bower (1981). This theory assumes that the spreading activation of threatening information from one node to another is the mechanism behind the negativity memory bias. The theory assumes that nodes are comprised of emotions and information, which are connected through an associative network (Bower, 1981). For example, the emotion of anxiety can become connected to threatening information via an associative network. Activation of one node spreads throughout the network to other nodes, subsequently activating them as well. This increased activation aids in the retrieval of events associated with the node (e.g., if anxiety is activated, this will facilitate retrieval of the threatening information associated with the anxiety; Bower, 1981).

Another theory postulated to explain negativity memory biases is the Information Processing Model of Anxiety (Beck & Clark, 1997). This theory assumes that the activation of danger schemas is the mechanism behind negativity memory biases. According to the Information Processing Model of Anxiety (Beck & Clark, 1997), there are three key phases of information processing in anxiety. The first is an initial registration phase which involves automatic recognition of a stimulus and serves as an early warning threat-detection system. If stimuli are identified as threatening, this automatically allocates attentional resources to that threat. In phase 2, “danger schemas” are activated. The danger schemas are cognitive representations of threat, based on past experiences. Once activated, they capture attentional resources which results in a narrowing of cognitive processing onto the threat stimulus, as well as a hypervigilance for threat cues (Beck & Clark, 1997). In the third phase of the Information Processing Model of Anxiety, the individual engages in secondary elaboration where they evaluate their coping resources and ability to deal with the threat. At this stage, participants in the laboratory might compare the threat of the memory test to their confidence in their own memory (Beck, Emery, & Greenberg, 1985). Participants who are less confident in their memories may evaluate the memory test as more threatening than someone who is more confident in their memory.

The Associative Network Theory of Memory and Emotion (Bower, 1981) and the Information Processing Model of Anxiety (Beck & Clark, 1997) propose different mechanisms for why a negativity memory bias for threatening information exists (i.e., spreading activation and schema activation, respectively), however, existing studies have not differentiated these mechanisms, and the models make similar predictions. For example, both theories predict that the memory bias should be present during both recall and recognition tasks. However, the negativity memory bias is seldom found in recognition, and in recall, the results are inconsistent. In her meta-analysis, Mitte (2008) concluded that neither the Information Processing Model of Anxiety or the Associative Network Theory of Memory and Emotion fully explained the data, and there is need to explore additional mechanisms that more comprehensively explain the anxiety/memory relationship.

Further, both theories specify the importance of negative emotional or threatening stimuli in triggering the anxiety response. Focusing on this narrow theoretical view that threatening *stimuli* are necessary to trigger anxiety is unnecessarily limiting. A threat is anything an individual perceives as dangerous, and threats cover a wide range of stimuli and situations (Beck, et al., 1985). For example, one can perceive an immediate threat to their survival, ego, individuality, or functioning (Beck et al., 1985). These threats might be physical and/or social in nature (Mogg, Mathews, & Weinman, 1989). When experiencing a threat, an individual conceptualizes the situation in egocentric terms (Beck et al., 1985). That is, the individual may ask themselves "How does this affect me?" Those with higher levels of trait anxiety may interpret threats as affecting them more than those with lower levels of trait anxiety. Therefore, it is possible that anxiety on memory tests can be "triggered" via other means beyond strictly emotional or threatening stimuli.

The present dissertation tested the theoretical assumption that negative stimuli are necessary to trigger anxiety on memory tests. Specifically, I examined if, rather than specific stimuli, the overarching situational pressures can be threatening enough to trigger an anxiety response. For example, most individuals that have attended school at some point in their lives are familiar with being tested for their memory of the course content. Rather than the actual course content being the "trigger" for anxiety, it is possible that simply being in a situation in which one will be tested is enough to activate the danger schema and/or associative network associated with threat and anxiety. Allowing anxiety to vary outside the confines of emotional stimuli will inform the role of anxiety and hypervigilance on memory tasks by helping to understand if/how anxiety is related to memory for emotionally neutral stimuli across situations. This is important because many stimuli that anxious individuals interact with daily will not be negative or emotional. In the present dissertation, I examined if it is possible to activate anxiety and hypervigilance without using threatening/emotional stimuli, but rather by varying the situational pressures via different retrieval demands of the memory task and/or the populations (e.g., younger and older adults). If anxiety and hypervigilance can be activated by situational pressures, this will indicate that the lens through which we understand the relationship between anxiety and memory should be expanded beyond strictly threatening stimuli.

Retrieval Demands as a Situational Threat

One way to examine the extent to which the overarching situational pressures can increase anxiety and trigger a threat reaction is to vary the retrieval demands of a memory test. That is, if the stakes of the memory test are higher, it is possible that the test itself may be threatening enough to activate anxiety and hypervigilance. In Experiment 1, I manipulated retrieval demands with free vs. forced recall. In a free recall test, participants are instructed to recall as much information as they can and to avoid guessing. Thus, participants can determine their own criterion for writing down the items they are reasonably sure appeared on the study lists. In contrast, forced recall tests require participants to produce a specific number of responses to a memory test, guessing if necessary (Erdelyi & Becker, 1974). In forced recall, participants cannot determine their own criterion for responding, and because of this experimenter-directed response criterion, participants in forced recall conditions often must generate words they do not remember being on the list (i.e., guess), in order to produce the prespecified number of responses. The retrieval demands of the forced recall test may create a more threatening situation compared to free recall because participants are required to produce responses beyond what they would comfortably produce otherwise. The situation can potentially become threatening if participants struggle to produce the required number of responses. Because the forced recall test requires participants to produce more responses, the situational pressures of the forced retrieval demands are likely greater than the pressures of the free retrieval demands.

Research suggests that when the to-be-remembered material is categorically unrelated, participants taking a forced recall test produce generally equivalent levels of correct recall to those taking a free recall test (e.g., Roediger & Payne, 1985), however, when the to-be-remembered material is categorically related, forced recall does show an increase in the proportion of correct recall compared to free recall (Erdelyi, Finks, & Feigin-Pfau, 1989; Huff, Meade, & Hutchison, 2011). Regardless of the categorical relatedness of the to-be-remembered material, participants in the forced recall condition show elevated false recall (i.e., errors) compared to free recall (e.g., Roediger & Payne, 1985). Thus, the elevated retrieval demands in the forced recall condition can elicit differences in memory compared to the standard free recall condition. As such, forced recall is a good way to manipulate situational pressure because it allows us to vary retrieval demands while holding the stimuli constant. By using all non-emotional stimuli, forced recall allows one to investigate if situational pressure beyond emotional stimuli might lead to differences in the relationship between anxiety and memory.

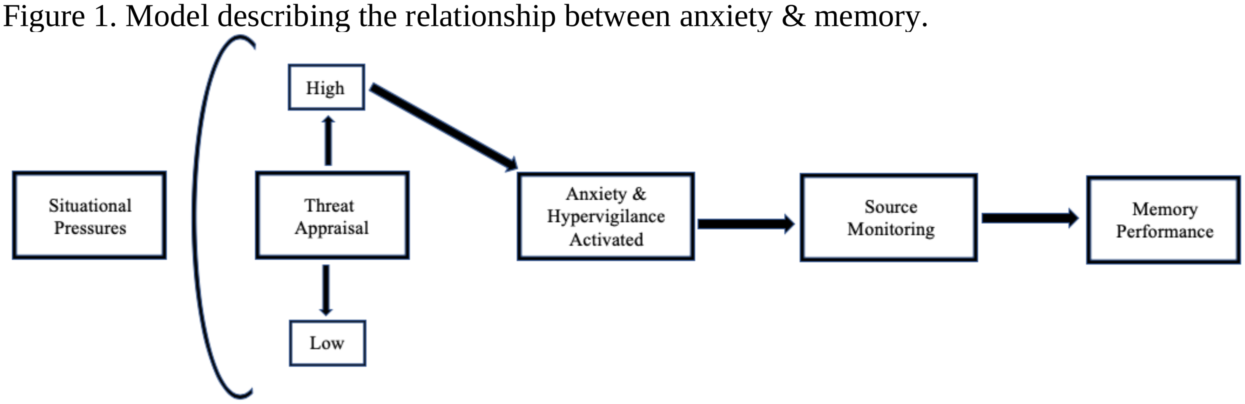
Forced recall tests are uniquely positioned to help inform the literature on anxiety and memory because they can help identify one of the possible mechanisms responsible for the anxiety/memory relationship. Specifically, forced recall isolates source monitoring mechanisms. Source monitoring is the ability to remember and distinguish the origin of information, and the qualities of experience resulting from perceptual and reflective processes inform one’s source monitoring (Johnson, Hashtroudi, & Lindsay, 1993). In the learning phase of the task, participants encode the to-be-remembered items as well as memory characteristics associated with the items. Memory characteristics can include perceptual information (e.g., sound and color), contextual information (spatial and temporal), and cognitive operations (e.g., records of organizing and elaborating information) (Johnson et al., 1993). Different types of sources (e.g., internal vs. external) will have varying levels of each memory characteristic. For example, externally presented stimuli contain perceptual and contextual characteristics, such as additional information regarding the location and color of the to-be-remembered item. In contrast, content that one generated internally will have more cognitive characteristics, such as those associated with the cognitive operations involved in the process of production (Johnson et al., 1993). At retrieval, participants can draw upon the cognitive, contextual, and perceptual memory characteristics associated with that word to help determine if the word appeared on the study list or not. If an individual has high levels of contextual and perceptual information associated with the word, they are likely to view the word as having been presented on the word lists. If an individual has mostly cognitive characteristics associated with the word, they are likely to judge that word as not being on the word lists, and merely a product of their thinking. Additionally, source attributions at retrieval will be determined by the response criterion set by the participant. When setting criteria, participants can assign differing weights to different memory characteristics (e.g., weighting cognitive information as more important than contextual information; Johnson et al., 1993).

Source monitoring is especially difficult in forced recall because participants are required to produce items that did not appear on the to-be-remembered word lists to reach the recall criterion established by the researcher. As such, the recalled words and the words produced as guesses have similar memory characteristics and so are more difficult to differentiate, especially on subsequent tests (cf. Johnson, Foley, & Leach, 1988). Source monitoring deficits may occur when participants are unable to remember the source of the information (e.g., was the word on the lists or did one simply write it down during forced recall). Using a forced recall test allowed me to examine if source monitoring is a mechanism that influences the relationship between memory and anxiety because forced recall implements strict recall criterion, which may influence memory characteristics and the way participants respond on subsequent tests.

As previously mentioned, anxiety activates hypervigilance. It is possible that heightened levels of vigilance will lead participants to pay greater attention to the perceptual and contextual details associated with the words lists, which in turn might improve their source monitoring during retrieval, thus increasing accuracy and decreasing errors. Preliminary evidence suggests that anxiety can increase source monitoring abilities in younger adults. Kania & Krackow (2014) examined the influence of state and trait anxiety on a source monitoring eyewitness memory task. In this study, participants were induced with a state anxiety manipulation before watching a 5-minute crime video and completing a memory questionnaire. The memory questionnaire included information actually present in the crime video as well as misleading details about the video. Kania & Krackow found that an induction of state anxiety increased source monitoring abilities for items seen in the crime video. This is preliminary evidence that higher levels of anxiety can lead to correct identification of the source of information.

The present dissertation proposes a model to describe the relationship between anxiety and memory, and source monitoring is a key component in this relationship (see Figure 1). In this model, situational pressures influence threat appraisal. Situational pressures are anything in the environment that may be appraised as threatening, such as retrieval demands on a memory task. Threat appraisal will be different depending on the type of situational pressures that are present (e.g., free recall retrieval demands versus forced recall retrieval demands). If a threat is appraised as high, anxiety and hypervigilance will be activated (i.e., triggered). As a reminder, hypervigilance is the state of being attentive and alert to possible dangers and difficulties—to an excessive degree (Bernstein et al., 2015). This increased hypervigilance can be directed towards the memory task, and will influence the encoding of memory characteristics, such that individuals may pay greater attention to perceptual, contextual, and/or cognitive information. This greater attention to detail will lead to increased source monitoring abilities at retrieval. These increased source monitoring abilities will result in increased performance on the memory tests because participants will be better able to differentiate between presented and non-presented items. Thus, according to this model, threat can be induced via the situation, rather than strictly emotional stimuli. This could be especially true for highly trait anxious individuals because they have a tendency to overestimate the threat of the situation (Beck & Clark, 1997; Mogg & Bradley, 1998).

Figure 1. Model describing the relationship between anxiety & memory.



Age, Anxiety, and Memory

Age is one factor that can inform the influence of situational pressures on anxiety and memory. Aging is commonly associated with stereotypes surrounding memory abilities. For example, people often associate aging with forgetfulness and a decline in cognitive abilities (Hummert, Garstka, Shaner, & Strahm, 1994). Given these prevalent stereotypes, it is possible that the nature of what is "threatening" might vary between different age groups (e.g., older adults may consider a memory test more threatening and anxiety provoking compared to younger adults). Additionally, research shows that there are age differences in levels of hypervigilance. Because hypervigilance is an important component of the model, it is important to examine if there are age differences in the extent to which anxiety and hypervigilance can be triggered by situational pressures. Studies have found a weak significant relationship between age and hypervigilance such that older adults have higher levels of hypervigilance than younger adults (Bernstein et al., 2015; Kimble, Fleming, & Bennion, 2013). Although this relationship is weak, it is preliminary evidence that older adults may adopt a more vigilant mindset on cognitive tasks. Including younger and older adults in this study helped test the proposed model by examining how possible age differences in perceived threat and hypervigilance influence source monitoring and, subsequently, memory performance.

The body of literature examining the influence of threat on memory primarily uses younger adult subjects, neglecting to consider the extent to which situational pressures may differentially influence younger and older adults. Rather than focus on how threatening stimuli influence the memory of older adults, research using this population focuses on how different types of anxiety (e.g., state, trait, memory-specific) influence memory. State anxiety is the "in the moment" experience of anxiety (Spielberger, 1972), and trait anxiety is the relatively stable behavioral tendency to 1) respond anxiously to perceived threats and 2) become state anxious (Hedberg, 1972; Ree, French, MacLeod, & Locke, 2008). Memory-specific anxiety is anxiety surrounding one's memory (Davidson, Dixon, & Hultsch, 1991). Different types of anxiety influence memory performance in different ways for older and younger adults.

When examining older adults, the relationship between different types of anxiety and memory is inconclusive. Memory-specific anxiety generally hurts older adults' recall but does not influence young adults' recall. Davidson et al. (1991) examined the influence of memory-specific anxiety on list and narrative story recall. Importantly, this study included younger, middle-aged, and older adult participants and all memory stimuli were neutral in valence. Memory-specific anxiety was negatively related to list recall, but only for subjects in the oldest age group. Memory-specific anxiety did not predict memory performance in younger adults. In another study that examined age differences in the relationship between memory-specific anxiety and memory, Andreoletti, Veratti, & Lachman (2006) found that memory anxiety was negatively related to memory performance for middle aged and older adults, but not younger adults. Thus, both studies suggest that memory anxiety negatively influences older adult's recall performance but is unrelated to the memory performance in younger adults. Also notable is that some research finds that older adults have higher levels of memory-specific anxiety compared to younger adults (Dixon, de Frias, & Maitland, 2001; Dixon & Hultsch, 1983) whereas other research does not find this difference (Andreoletti et al., 2006; Davidson et al., 1991).

Regarding trait anxiety, research suggests that higher levels of trait anxiety are associated with poorer memory performance, or no difference in memory performance, for both young and older adults. Pajkossy, Keresztes, & Racsmány (2017) examined the influence of trait anxiety on the recall and recognition memory performance of younger adults. Their results show that across 4 studies, trait anxiety was not related to recognition performance. However, in 3 out of the 4 studies, higher levels of trait anxiety led to lower levels of recall memory performance. Their results suggest that, for younger adults, trait anxiety is negatively related to recall memory and unrelated to recognition memory. Yochim, Mueller, & Segal (2013) examined the influence of trait anxiety on the memory of community dwelling older adults by separating anxiety into cognitive (e.g., I worried too much), affective (e.g., I felt restless, keyed up, or on edge), and somatic components (e.g., my heart raced or beat strongly). They found that affective symptoms of trait anxiety were negatively related to immediate verbal memory recall but were unrelated to free recall of information after a time delay. The authors argued that this suggests anxiety may interfere more with learning information and less with the retention of what they are able to learn (Yochim et al., 2013). Taken together, trait anxiety generally appears to negatively influence, or have no influence on memory for both younger and older adults.

Finally, research investigating the relationship between state anxiety and memory is also mixed. When examining state anxiety, Andreoletti et al. (2006) did not find a significant relationship between state anxiety and memory performance for any age group. In contrast, Davidson et al. (1993) found that state anxiety significantly predicted list recall such that higher state anxiety led to better recall (Davidson et al., 1991). However, this relationship was only significant in the oldest age group (69-78). Additionally, this effect was task specific such that it was present for list recall but not prose recall, further suggesting that the nature of the retrieval demands of the memory task are important moderating factors to the anxiety/memory relationship.

Taken together, the results of the previously mentioned studies suggest that there are differences in the extent to which different types of anxiety influence the memory performance of younger and older adults. In general, memory-specific anxiety has a negative influence on memory performance for older, but not younger adults. There are similar influences of trait anxiety on the memory performance for older and younger adults such that higher levels of trait anxiety lead to lower recall memory performance. The influence of state anxiety on the memory performance of older and younger adults is inconclusive. The results of Davidson et al. (1991) suggest state anxiety is beneficial for the memory of older adults, however, Andreoletti et al. (2006) did not find any influence of state anxiety on memory for older or younger adults. The previously mentioned studies suggest that age differences in the relationship between anxiety and memory depend on the type of anxiety being measured. The way in which anxiety is measured clearly influences the anxiety/memory relationship, thus, further research is necessary to determine how the different types of anxiety differentially influence the memory performance of older and younger adults.

Age is also critical to testing the role of source monitoring as a factor in the model. Previous research has found that older adults have greater source monitoring deficits compared to younger adults, such that older adults have trouble identifying the source of their memories (McIntyre & Craik, 1987). During forced recall tests, older adults have an especially hard time differentiating between words that were produced as guesses during the forced recall and words that actually appeared on the study lists. This results in higher false recall and recognition on subsequent tests for older adults compared to younger adults (Huff et al., 2011; Meade & Roediger, 2006).

Further, there are individual differences in the extent to which older adults demonstrate source monitoring deficits across free and forced recall tasks. Meade, Geraci, & Roediger (2012) gave older adults a battery of neuropsychological tests designed to separate older adults into those with high frontal functioning and low frontal functioning. Meade et al. (2012) found that under free recall retrieval demands, low frontal functioning older adults produced higher levels of false recall compared to high frontal functioning older adults and younger adults. That is, high frontal functioning older adults showed similar source monitoring abilities to younger adults when under free recall retrieval demands. However, this pattern did not hold when participants were tested after previously recalling under forced recall retrieval demands. When older adults were forced to write down a certain number of words, both high and low functioning older adults demonstrated higher levels of false recall on subsequent recall tests compared to younger adults. This is evidence that the differing retrieval demands between free and forced recall can exaggerate source monitoring differences between older adults and that source monitoring abilities in older adults are sensitive to individual differences. Including older adults in Experiment 1 allowed me to test the novel idea that source monitoring may also be sensitive to individual differences in anxiety. Examining the influence of age and retrieval demands helped to test the proposed model and determine if source monitoring is a mechanism that influences the relationship between memory and anxiety.

Interim Summary

In summary, past theories designed to explain the relationship between anxiety and memory have fallen short in identifying a mechanism that explains the relationship. These theories have focused on the influence of threatening stimuli on memory, which provides a narrow lens through which to examine how anxiety influences different cognitive processes. Additionally, using threatening/emotional stimuli can be problematic because of item characteristics and personal relevance matters. Depending on personal relevance and past experiences, not all items are equally emotionally evocative and threatening from one individual to another. To more fully understand the influence of anxiety on memory performance, it is important to examine different ways that threat can be triggered by situational pressures, such as through differing retrieval demands and across populations. When a threat is identified, hypervigilance for future threat is heightened. This hypervigilance may lead to better source monitoring abilities. If the memory test itself is threatening, participants can attend to the threat by paying special attention to the test. Thus, anxiety may play a facilitative role for improving memory. Finally, it is important to examine age differences in hypervigilance and threat felt towards the memory test because it will help to determine if source monitoring is a potential mechanism that can inform the relationship between anxiety and memory.

EXPERIMENT 1

Experiment 1 and Hypotheses

Experiment 1 was designed to examine the influence of age and retrieval demands on the relationship between anxiety and memory. In this study, older and younger adults recalled categorized word lists. In the first recall test, participants recalled under either free or forced retrieval instructions. To test how prior retrieval demands influence subsequent recall, all participants completed a second recall test under free retrieval demand instructions. Participants also completed a recognition test, which was designed to measure source monitoring abilities. In addition, participants completed questionnaires measuring trait and memory-specific anxiety to determine if the relationship between anxiety and memory depends on the type of anxiety being measured. Additional health status questionnaires were included to separate the influence of anxiety on memory from other health related factors.

Regarding memory performance, I predicted that the results of Experiment 1 would replicate Meade and Roediger, 2006. Specifically, for recall test 1 & 2, I predicted that, older and younger adults would have equal levels of correct recall, however, age differences would emerge for false recall such that older adults would produce more critical items than younger adults. Next, I predicted that prior forced recall would increase error rates on subsequent tests such that previously recalling under forced retrieval demand instructions would result in higher levels of false recall compared to previously recalling under free retrieval demand instructions. On a final recognition test, I predicted that there would be no differences for correct recognition between older and younger adults. However, age differences would emerge in false recognition such that older adults, compared to younger adults, would falsely recognize more non-presented critical items as studied items.

More important are my hypotheses about the role of anxiety on memory across retrieval demands and populations. According to my model (see Figure 1), higher levels of anxiety should correspond with better memory. Specifically, I predicted that higher levels of anxiety would relate to better source monitoring, as evidenced by higher levels of correct recall and recognition as well as lower levels of false recall and recognition. Importantly, I expected to find this positive correlation between anxiety and memory performance only when anxiety is triggered by situational pressures. Specifically, I predicted that forced recall would be more threatening than free recall and thus trigger anxiety to a greater extent, leading to stronger relationships between anxiety and memory for those in the forced recall condition. Finding stronger correlations between anxiety and memory in forced recall would support my model in showing that situational pressures (not just emotional stimuli) can trigger anxiety. Finally, I predicted age differences in the impact of anxiety on memory performance. Specifically, I predicted that older adults would be more threatened by forced recall than younger adults, and that older adults would especially benefit from higher levels of anxiety because this would increase hypervigilance towards the memory task, improving the source monitoring abilities that are generally lower for older adults (cf. McIntrye & Craik, 1987). If there are age differences in the extent to which situational pressures trigger anxiety, then any correlation between anxiety and memory should be greater for older adults than younger adults, especially in the forced recall condition.

Lastly, my predictions for the different types of anxiety were somewhat exploratory. The literature is mixed regarding the influence of different types of anxiety on memory, thus the potential existed for different patterns to emerge. One possibility was that differences between age and retrieval demand groups would be most evident when looking at trait anxiety compared to memory-specific anxiety. Each individual has their own level of trait anxiety, which requires a trigger to be activated (Beck et al., 1985). In contrast, those who had high levels of memory-specific anxiety might not have been influenced by different retrieval demands because their memory anxiety was high across different memory tests (Davidson et al., 1991). That is, participants high in memory-specific anxiety might have approached the memory task with heightened levels of anxiety, which would negate any influence of situational pressures. Again, because the literature is mixed, these ideas were exploratory. Finally, I included an open-ended questionnaire to gain more insight into possible differences in the content of older and younger adults' anxious thoughts. It was possible that older adults would report having more memory-related anxious thoughts compared to younger adults. This questionnaire is not reported here.

Experiment 1

Experiment 1 was conducted as a pilot study to determine the feasibility and effectiveness of the experimental manipulations and measures I plan to use in Experiment 2. The goal of Experiment 1 was to determine if anxiety and hypervigilance can be activated outside the confines of threatening stimuli by allowing anxiety to vary across retrieval demands, populations, and type of anxiety.

Method

Participants

A total of 64 people participated in Experiment 1. Of that, 32 were undergraduate students from Montana State University and 32 were community-dwelling older adults (age 65+) from the Bozeman area. One older adult participant was excluded from analyses because their score on the Mini-Mental State Exam was outside of the normal range of 24-30, resulting in a final sample size of 63.

Design

This study was a 2 (retrieval demand: free vs. forced) x 2 (age: young vs. old) between-subjects factorial design. Type of retrieval demand (free vs. forced) was manipulated between-subjects and age (young vs. old) was a between-subjects quasi-independent variable. Thus, there were 16 participants per condition. The primary dependent variables were correct and false recall on recall test 1 and 2, as well as correct and false recognition. Additionally, correlations between anxiety and memory measures were examined.

Materials

Memory Stimuli. Materials for the memory portion of the study were selected from Meade and Roediger (2006) and included six categorized word lists (Birds, Human Body Parts, Flowers, Vegetables, Articles of Clothing, and Four-Footed Animals) constructed from Battig & Montague (1969). For each category, the top 22 exemplars were selected from the Battig & Montague (1969) norms. From there, the top 5 exemplars were removed from the list to serve as the critical items and measure of false recall. Thus, each categorized word list contained 17 presented words and 5 non-presented critical lures (see Appendix A), resulting in 102 total presented words across the 6 lists. The recognition test was selected from Meade & Roediger (2006) and contained 90 total items: 30 unrelated filler items, five critical items from each word list, and 5 presented items from each word list.

Anxiety Questionnaires. Participants completed four questionnaires designed to measure anxiety. Trait anxiety was measured using the Screen for Adult Anxiety Related Disorders (SCAARED; Angulo et al., 2017) and the Geriatric Anxiety Scale (GAS; Segal, June, Payne, Coolidge, & Yochim, 2010). The SCAARED is a 44-item scale adapted for individuals over the age of 18. Participants were instructed to indicate on a three-point scale the extent to which they have experienced various anxiety related symptoms over the past three months (Angulo et al., 2017). To note, the SCAARED was designed as a measure of "disordered anxiety symptoms" and not trait anxiety specifically. However, the SCAARED and GAS were highly correlated in Experiment 1 (r (56) = .791, $p < .001$) and Experiment 2 (r (121) = .826, $p < .001$). The GAS is a 30-item scale designed for older adults. Participants were instructed to indicate on a four-point scale the extent to which they have experienced general anxiety symptoms (25 items), as well as the extent to which they have experienced older-age-specific anxiety symptoms (five items) (Segal et al., 2010). Memory-specific anxiety was measured using the anxiety questionnaire subscale of the Metamemory in Adulthood (MIA) scale (Davidson et al., 1991). The MIA is validated for younger and older adults (Dixon & Hultsch, 1983). In addition to these anxiety questionnaires, participants also completed a locally developed free-response anxiety questionnaire. Participants responded to three prompts: 1) What are you most scared, afraid, or nervous about? 2) If and when do you have bodily sensations such as upset stomach, shortness of breath, etc? 3) Do you avoid certain activities? If so, what and when? This questionnaire was exploratory, because little is known about how older and younger adults differ with respect to the content of their anxious thoughts. This open-ended questionnaire was designed to help to inform this issue. Are older adults actually more anxious about their memories or is this simply a societal stereotype? It is possible that age specific differences exist for the type of activities one avoids as well as the specific fears different-aged participants might have. As previously mentioned, these data are not reported here.

Health Status Questionnaires. Participants completed assessments of their current and past mental and physical health to separate the influence of anxiety from other health related factors. The Geriatric Depression Scale (GDS) is a 30-item self-report questionnaire designed to measure depressive symptoms in an older adult population (Yesavage et al., 1983). The Short Loneliness Scale (SLS) is a 3-item scale designed to assess loneliness in participants (Hughes, Waite, Hawkley, & Cacioppo, 2004). Participants also completed a locally developed health questionnaire designed to assess participant's opinion of their physical health. Participants indicated which, if any, health problems they have experienced in the past or present. To establish that all participants were within the normal range of cognitive functioning, participants completed the Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975) and the Shipley Vocabulary Test (Shipley, 1940).

Additional Materials. Additional materials included a mathematical filler task and a demographics questionnaire (e.g., age, race, education).

Procedure

After providing informed consent, participants were randomly assigned to complete the memory phase of the experiment first or the questionnaire phase of the experiment first. During the memory phase of the experiment, participants viewed a series of six word lists containing 17 words per list. Participants were instructed to pay attention to each word because their memory for the word lists would be tested later. After encoding the items from all 6 lists, participants completed two minutes of a mathematical filler task before moving on to the recall portion of the study. In the first recall test (recall 1), participants were randomly assigned to the free retrieval demands condition or the forced retrieval demands condition. In the free retrieval demands condition, participants had two minutes per list to recall as many of the studied items as possible. Participants were instructed not to guess and to write down words only if participants were reasonably sure they appeared on the list. Participants recalled one list at a time, in the same order they were presented. In the forced retrieval demands condition, participants had 4 minutes per list to recall 20 items from each list. Participants in the forced condition are given 4 minutes per list, rather than 2 minutes, to equate recall time per word (cf., Meade & Roediger, 2006). Participants were instructed to guess if they could not remember 20 items from each list. Each presented list only contained 17 items so this condition forces individuals to produce answers beyond their actual memories.

After recalling all six lists in recall 1, participants immediately moved into recall 2. In recall 2, all participants completed the recall test under free retrieval demand instructions. All participants had two minutes per list to recall as many words as possible and were instructed not to guess and to only write down words they were reasonably sure appeared on the list. The third memory test was a recognition test designed to measure source monitoring abilities. In the recognition test, participants were given a sheet of paper with 90 words with the goal of identifying the source of the words. Participants were asked to indicate if each word appeared on the study list and/or they themselves had recalled it during the previous recall tests. Additionally, participants had the option to indicate that the word was not present on the study list, and they did not write it down during the recall tests.

During the questionnaire phase of the experiment, participants were given a packet of questionnaires designed to assess different anxiety and health related variables. The questionnaire phase of the experiment was not timed, and participants were given as much time as necessary to complete the questionnaires at their own pace. The only exception was the MMSE, which was verbally administered by the experimenter after participants had completed all other questionnaires. Participants completed four different measures of anxiety. One of the anxiety measures was an open-ended questionnaire designed to assess differences in the content of anxious thoughts in older and younger adults. In addition to the anxiety questionnaires, participants completed depression, loneliness, and general health scales.

Results

Data Analytic Plan

To examine differences between younger and older adults, I used *t*-tests, ANOVAs, and correlations. All analyses are collapsed across memory phase/questionnaire phase order. First, I conducted independent samples *t*-tests to examine differences between younger and older adults on several demographic and individual difference variables (i.e., age, vocabulary, cognitive status, depression, loneliness, and anxiety). The primary dependent variables for Experiment 1 were Test 1 Correct and False Recall, Test 2 Correct and False Recall, and Correct and False Recognition. First, I conducted analyses on Correct and False Recall at Test 1 using independent samples *t*-tests. Correct recall represents the proportion of words participants recalled that appeared on the study lists. False recall represents the proportion of critical lures participants indicated as having appeared on the lists. In test 1, free and forced recall were analyzed separately using *t*-tests, rather than ANOVAs, because the tasks are fundamentally different. Items produced during free recall likely represent memory of the items because participants are free to set their own criterion and write down items they remember as being on the lists. On the other hand, items produced during forced recall likely represent a combination of memory plus guessing, because participants are forced to write down guesses in addition to items they actually remember to achieve the response criterion (e.g., produce 20 words). Next, I conducted a 2 (age: young vs. old) x 2 (retrieval demand: prior free vs. prior forced) between-subjects ANOVA on each of the four remaining primary dependent variables (i.e., Test 2 Correct and False Recall, and Correct and False Recognition). The recognition test allows one to directly examine source monitoring abilities. Correct recognition scores are the proportion of items correctly indicated by participants as having been present on the word lists ("list only" responses plus "both list and self" responses). That is, participants indicated a word appeared on the list when it did in fact appear on the list. False recognition scores are the proportion of critical items incorrectly indicated as having been present on the words lists ("list only" responses plus "both list and self" responses). Lastly, I conducted Pearson correlations to examine differences in the relationship between anxiety and memory for younger and older adults, separated by retrieval demand condition. A separate correlation was run for each of the three primary anxiety variables (i.e., trait anxiety, as measured by the Geriatric Anxiety Scale and the Screen for Adult Anxiety Related Disorders, and memory-specific anxiety, as measured by the Meta-Memory in Adulthood scale) and the six primary memory variables (i.e., Test 1 Correct and False Recall, Test 2 Correct and False Recall, and Correct and False Recognition).

Demographics

Older adults (*M* = 72.84, *SD* = 6.30) were significantly older than younger adults (*M* = 19.63, *SD* = 2.01); $t(35.88) = -44.84$, $p < .001$. Older adults (*M* = 36.00, *SD* = 2.60) scored higher than younger adults (*M* = 29.53, *SD* = 4.09) on the Shipley vocabulary test ($t(52.88) = -7.51$, $p < .001$) and lower than younger adults on the MMSE ($t(48.60) = 3.09$, $p = .003$). Importantly, both older adult scores on the MMSE (*M* = 28.13, *SD* = 1.50) and younger adult scores on the MMSE (*M* = 29.09, *SD* = .89) were in the normal/healthy range (24-30). According to the GDS, older adults (*M* = .35, *SD* = .08) had lower levels of depression compared to younger adults (*M* = .42, *SD* = .14); $t(49.97) = 2.49$, $p = .016$. However, according to the SLS, younger (*M* = 1.83, *SD* = .65) and older (*M* = 1.71, *SD* = .50) adults did not differ in levels of loneliness; $t(53) = .778$, $p > .05$.

Anxiety Performance

According to the SCAARED, younger adults (*M* = .63, *SD* = .35) had higher levels of disordered anxiety symptoms than older adults (*M* = .31, *SD* = .24); $t(54.58) = 4.05$, $p < .001$. Similarly, according to the GAS, younger adults (*M* = .69, *SD* = .56) had higher levels of trait anxiety than older adults (*M* = .34, *SD* = .28); $t(47.69) = 3.08$, $p = .003$. In contrast, younger (*M*

= 3.00, *SD* = .59) and older adults (*M* = 2.99, *SD* = .58) had equal levels of memory-specific anxiety according to the MIA; $t(59) = .066$, $p > .05$.

Recall 1: Memory Performance

Correct Recall. In the free retrieval demand condition, there were no differences between younger (*M* = .41, *SD* = .11) and older adults (*M* = .37, *SD* = .09) on correct recall; $t(29) = .958$, $p > .05$. In the forced retrieval demand condition, there were no differences between younger (*M* = .57, *SD* = .09) and older (*M* = .59, *SD* = .08) adults on correct recall; $t(30) = -.713$, $p > .05$. These results allow us to have an equal baseline to examine changes in memory performance on subsequent tests. See Table 1 for recall test 1 means.

False Recall. In the free retrieval demand condition, older adults (*M* = .32, *SD* = .21) had significantly higher false recall compared to younger adults (*M* = .15, *SD* = .13); $t(29) = -2.60$, $p = .015$. Older adults recalled more critical lures than younger adults. In the forced retrieval demand condition, there were no differences in older (*M* = .67, *SD* = .09) and younger (*M* = .62, *SD* = .10) adults in false recall; $t(30) = -1.45$, $p > .05$. This result is expected because participants were forced to write down 20 responses. See Table 1 for recall test 1 means.

Table 1. Mean proportion of items recalled as a function of age (young/old) and recall condition (free/forced) on recall test 1 (N = 63). Standard deviations are in parentheses.

	Young	Old
Correct Recall		
Free	.41 (.11)	.37 (.09)
Forced	.57 (.09)	.59 (.08)
False Recall		
Free	.15 (.13)	.32 (.21)
Forced	.62 (.10)	.67 (.09)

Recall 1: Anxiety and Memory Correlations

Younger Adults. Looking next at the relationship between anxiety and recall 1 for younger adults, there was not a significant correlation between any of the anxiety measures and recall 1 when free and forced retrieval demand conditions were analyzed separately (free recall all *r*s < .400, all *p*s > .125; forced recall all *r*s < .374, *p*s > .153). See Table 2 for Pearson correlation coefficients.

Older Adults. Importantly, anxiety did correlate with older adults' recall 1 performance, but only when the situational pressures were high (i.e., when older adults were recalling under forced retrieval demand conditions). For older adults in the free retrieval demands condition there were no significant relationships between recall 1 and memory-specific or trait anxiety (all *r*s < .347, all *p*s > .246). In contrast, for older adults in the forced retrieval demands condition, higher trait anxiety was associated with higher correct recall. In this condition, trait anxiety was positively correlated with correct recall on test 1 as measured by the SCAARED ($r(11) = .691$, $p = .009$) and the GAS ($r(11) = .784$, $p = .002$). Memory-specific anxiety was not correlated with correct recall on test 1 for older adults in the forced recall condition ($r(11) = -.246$, $p > .05$). Neither trait nor memory specific anxiety were related to false recall on recall 1 for older adults in the forced retrieval demands condition (all *r*s < .401, all *p*s > .174). See Table 2 for Pearson correlation coefficients.

Table 2. Pearson zero-order correlations for younger and older adult's anxiety and Correct and False Recall at Test 1, separated by retrieval demand condition.

	SCAARED	GAS	MIA
	Younger Adults		
Free			
Recall 1 Correct	-.05	-.14	-.43
Recall 1 False	.18	.40	.08
Forced			
Recall 1 Correct	.09	-.24	-.36
Recall 1 False	-.06	-.05	.23
	Older Adults		
Free			
Recall 1 Correct	.35	.33	-.14
Recall 1 False	.25	-.08	-.08
Forced			
Recall 1 Correct	.69**	.78**	.12
Recall 1 False	-.17	-.15	-.03

Recall 2: Memory Performance

Correct Recall. As a reminder, all participants completed recall 2 under free retrieval demand instructions. This is important because it allows one to measure the effects of prior free and prior forced retrieval demands on subsequent memory performance. There was not a significant main effect of age ($F(1, 59) = .195$, $MSE = .01$, $p > .05$). Older ($M = .42$, $SD = .11$) and younger ($M = .43$, $SD = .11$) adults recalled the same amount of correct information. There was a significant main effect of retrieval demands ($F(1, 59) = 6.43$, $MSE = .01$, $p = .014$). Those who previously recalled under forced retrieval demand instructions ($M = .46$, $SD = .10$) recalled significantly more correct items than did those who previously recalled under free retrieval demand instructions ($M = .39$, $SD = .11$). There was no significant age x retrieval demand condition interaction ($F(1, 59) = .507$, $MSE = .01$, $p > .05$), suggesting that prior forced retrieval demand conditions had similar effects on young and older adults' correct recall. See Table 3 for recall test 2 means.

False Recall. There was a significant main effect of age on false recall ($F(1, 59) = 14.27$, $MSE = .04$, $p < .001$), such that older adults ($M = .47$, $SD = .23$) produced significantly more critical lures than did younger adults ($M = .28$, $SD = .23$). Thus, regardless of prior retrieval condition, older adults had more false recall than younger adults. In addition, there was a significant main effect of retrieval demands ($F(1, 59) = 23.23$, $MSE = .04$, $p < .001$), such that prior forced retrieval demand participants ($M = .49$, $SD = .22$) had significantly more false recall than those who previously recalled freely ($M = .25$, $SD = .21$). There was no significant interaction between age and retrieval demands, ($F(1, 59) = .003$, $MSE = .04$, $p > .05$). See Table 3 for recall test 2 means.

Table 3. Mean Proportion of Items Recalled as a Function of Age (Young/Old) and Prior Recall Condition (Free/Forced) on Recall Test 2 (N = 63). Standard Deviations are in Parentheses.

	Young	Old
Correct Recall		
Prior Free	.40 (.13)	.37 (.09)
Prior Forced	.45 (.08)	.46 (.12)
False Recall		
Prior Free	.16 (.16)	.34 (.23)
Prior Forced	.39 (.23)	.58 (.15)

Recall 2: Anxiety & Memory Correlations

Younger Adults. For younger adults, there was no relationship between anxiety and memory. Looking at the correlations broken down by prior retrieval condition, there was not a significant correlation between any of the anxiety measures and recall 2 for participants who had previously recalled under free retrieval demand instructions (all *r*s < .413, *p*s > .112) or forced retrieval demand instructions (all *r*s < .488, *p*s > .055). See Table 4 for Pearson correlation coefficients.

<u>Older Adults.</u> For older adults who previously recalled under free retrieval demand instructions, there were no significant relationships between recall 2 and trait or memory-specific anxiety (all *r*s < .418, all *p*s > .155). In contrast, there was a marginally significant positive correlation between trait anxiety scores as measured by the GAS and correct recall on recall 2 ($r(11) = .549$, $p = .052$) for older adults who had previously recalled under forced retrieval demand instructions. Note the pattern of data on recall test 2 is similar to recall 1 which showed that anxiety was positively associated with older adults' memory under forced retrieval demand instructions; however, the correlation failed to reach significance on recall test 2. Memory-specific anxiety was not related to correct or false recall on test 2 for older adults who had previously recalled under forced retrieval demand instructions (all *r*s < .401, all *p*s > .174). See Table 4 for Pearson correlation coefficients.

Table 4. Pearson zero-order correlations for younger and older adult's anxiety and Correct and False Recall at Test 2, separated by retrieval demand condition.

	SCAARED	GAS	MIA
	Younger Adults		
Prior Free			
Recall 2 Correct	-.12	-.18	-.46
Recall 2 False	.24	.40	.08
Prior Forced			
Recall 2 Correct	-.08	-.49	-.27
Recall 2 False	-.21	.05	.23
	Older Adults		
Prior Free			
Recall 2 Correct	.42	.27	-.08
Recall 2 False	.27	-.09	-.01
Prior Forced			
Recall 2 Correct	.38	.55	-.18
Recall 2 False	-.20	-.10	-.29

Recognition: Memory Performance

Correct Recognition. The ANOVA on correct recognition revealed no main effects of age or prior retrieval demands, F's < 1.0, p's $> .05$. There was no significant interaction between age and prior retrieval demands ($F(1, 59) = 2.64$, $MSE = .01$, $p = .107$). See Table 5 for correct recognition means.

Table 5. Mean proportion of correct recognition as a function of age (young/old) and prior recall condition (free/forced). Standard Deviations are in Parentheses.

	Young	Old
	Prior Free	
List Only	.44 (.15)	.44 (.23)
Both List and Self	.43 (.17)	.41 (.16)
Total Correct Recognition	.88 (.08)	.85 (.10)
Self	.002 (.008)	.01 (.02)
Neither	.12 (.07)	.14 (.10)
	Prior Forced	
List Only	.30 (.14)	.25 (.13)
Both List and Self	.52 (.18)	.64 (.10)
Total Correct Recognition	.81 (.13)	.88 (.12)
Self	.06 (.07)	.02 (.04)
Neither	.12 (.09)	.10 (.10)

False Recognition. In the ANOVA on false recognition, there was a significant main effect of age on false recognition ($F(1, 59) = 4.50$, $MSE = .06$, $p = .038$). Older adults ($M = .78$, $SD = .26$) had significantly higher false recognition than younger adults ($M = .64$, $SD = .2$). This age difference in false recognition was likely driven by older adults' inability to distinguish between words they recalled during previous recall tests and words that actually appeared on the study lists. There was no main effect of prior retrieval demands ($F(1, 59) = .069$, $MSE = .06$, $p > .05$) and no age x prior retrieval demands interaction ($F(1, 59) = 2.55$, $MSE = .06$, $p = .115$). The higher false recall rates following forced retrieval demand instructions disappeared on the recognition test likely because task demands of recognition reduced false memory (cf. Multhaup, 1995). See Table 6 for false recognition means.

Table 6. Mean proportion of false recognition as a function of age (young/old) and prior recall condition (free/forced). Standard Deviations are in Parentheses.

	Young	Old
	Prior Free	
List Only	.52 (.18)	.40 (.22)
Both List and Self	.18 (.17)	.33 (.25)
Total False Recognition	.70 (.19)	.74 (.27)
Self	.002 (.008)	.01 (.03)
Neither	.29 (.20)	.25 (.27)
	Prior Forced	
List Only	.20 (.21)	.19 (.13)
Both List and Self	.38 (.26)	.63 (.24)
Total False Recognition	.58 (.29)	.82 (.25)
Self	.24 (.22)	.07 (.12)
Neither	.17 (.11)	.11 (.18)

Recognition: Anxiety and Memory Correlations

Younger Adults. For younger adults, when broken down by prior retrieval condition, differences emerged between the relationship of recognition performance and the different types of anxiety. For younger adults who had previously recalled under forced retrieval demand instructions, there was no significant correlation between recognition and trait or memory-specific anxiety (all *r*s < .473, *p*s > .064). For younger adults who had previously recalled under free retrieval demand instructions, there was no significant correlation between recognition and trait anxiety (all *r*s < .411, *p*s > .114). However, there was a significant relationship between memory-specific anxiety (as measured by the MIA) and correct recognition for younger adults who previously recalled under free retrieval demand instructions ($r(14) = -.513$, $p = .042$). Higher levels of memory anxiety were related to lower levels of correct recognition, but only for those who had previously recalled under free retrieval demand instructions. See Table 7 for Pearson correlation coefficients.

Older Adults. Additionally, I examined the correlations for older adults separated by prior free and forced retrieval conditions. For older adults who previously recalled under free retrieval demand instructions, there were no correlations between recognition and trait or memory-specific anxiety (all *r*s < .374, all *p*s > .208). For older adults who previously recalled under forced retrieval demand instructions, there were no correlations between correct recognition and trait anxiety (all *r*s < .420, all *p*s > .153).

For older adults who previously recalled under forced retrieval demand instructions in recall test 1, there were significant correlations between trait anxiety and false recognition. For these participants, higher trait anxiety, as measured by the GAS, was related to lower levels of false recognition ($r(11) = -.809$, $p = .001$). These participants were less likely to say a word was on the lists when it was not. In addition, higher levels of trait anxiety, as measured by the GAS, were related to higher levels correctly choosing the "self only" option in the recognition test ($r(11) = .595$, $p = .032$). Older adults with higher levels of trait anxiety who had previously recalled under forced retrieval demand instructions were able to use the structure of the recognition test to their advantage. In the prior forced retrieval demands condition, the more trait anxiety these participants had, the better able they were to indicate that they had produced a word that was not on the list, which was associated with overall reduction in false recognition. Memory-specific anxiety was not related to recognition for older adults who previously recalled under forced retrieval demand instructions (all *r*s < .550, all *p*s > .051). See Table 7 for Pearson correlation coefficients.

Table 7. Pearson zero-order correlations for younger and older adult's anxiety and correct and false recognition, separated by retrieval demand condition. *p < .05.

	SCAARED	GAS	MIA
	Younger Adults		
Prior Free			
Recognition Correct	-.41	-.36	-.51*
Recognition False	.20	.38	.08
Prior Forced			
Recognition Correct	-.33	-.47	-.09
Recognition False	-.36	-.02	.15
	Older Adults		
Prior Free			
Recognition Correct	.04	.05	.16
Recognition False	.33	-.09	.10
Prior Forced			
Recognition Correct	.02	-.42	-.32
Recognition False	-.52	-.81**	-.46

Experiment 1 Discussion

The results of Experiment 1 suggest that age, retrieval demands, and different types of anxiety have significant influences on the relationship between anxiety and memory. Consistent with the proposed model, greater situational pressures, without emotional stimuli, were related to anxiety on the memory tests and anxiety was correlated with memory performance. Importantly, age differences in the anxiety/memory relationship emerged such that trait anxiety was positively associated with older adults' correct recall and negatively associated with older adults' false recognition. Further, memory-specific anxiety was associated with lower levels of correct recognition in younger adults' memories. The results demonstrate feasibility and raise important new questions I explored in Experiment 2.

Regarding memory performance, the results from Experiment 1 were a direct replication of Meade & Roediger (2006) in regard to the influence of retrieval demands and age on memory performance. Younger and older adults were matched on correct recall; however, age differences emerge on false recall such that younger adults made fewer errors than older adults, especially under forced retrieval demand instructions. Additionally, older adults had higher levels of false recognition than younger adults because of source monitoring failures. These results suggest that age and type of retrieval demand have significant influences on memory.

Most important to the present research, is how anxiety levels are differentially related to memory for older and younger adults under different retrieval demands. Results show that for both younger and older adults, the relationship between anxiety and memory is influenced by the type of anxiety being measured as well as the retrieval demands of the tasks. However, the age groups differ on which type of anxiety is related to memory as well as which type of retrieval demands are related to anxiety. For younger adults, regardless of prior free or forced retrieval demand instructions, trait anxiety was not related to recall or recognition memory. In contrast, higher levels of memory-specific anxiety in younger adults were related to lower levels of correct recognition memory but were unrelated to recall memory. However, this negative relationship between memory-specific anxiety and recognition was constrained to younger adults who had previously recalled under free retrieval demand instructions in recall test 1. Thus, free retrieval demand instructions influence the relationship between memory-specific anxiety and memory for younger adults.

For older adults, regardless of prior free or forced retrieval demand instructions, memory-specific anxiety was not related to recall or recognition memory. In contrast, trait anxiety in older adults was related to recall and recognition scores, but only for those who had recalled under forced retrieval demand instructions. For older adults who had recalled under forced retrieval demand instructions, higher levels of trait anxiety were related to higher levels of correct recall. Further, for these participants, higher levels of trait anxiety were related to lower levels of false recognition. Additionally, older adult participants who had previously recalled under forced recall instructions were better able to indicate that they had previously said a word that did not appear on the word lists if they had higher levels of trait anxiety. Taken together, trait anxiety seems to be related to increased correct recall and decreased false recognition for older adults, particularly under forced retrieval demands. It is possible that the retrieval demands of forced recall are more challenging than the free retrieval demands, resulting in higher levels of perceived situational pressures for older adults. For older adults, the forced retrieval demand condition provided a way to examine how anxiety is related to memory performance. These results are evidence that the constraints of the situation can influence the relationship between memory and anxiety, in the absence of emotional stimuli. Additionally, these results suggest that it is important to include different types of anxiety when examining the relationship between anxiety and memory.

The results from Experiment 1 suggest that there are age differences in how differing retrieval demands and types of anxiety influence the anxiety/memory relationship. Memory anxiety is important for the memory of younger adults, while trait anxiety is important for the memory of older adults. Additionally, free recall tasks are important to the relationship between anxiety and memory for younger adults, while forced recall tasks are important to this relationship for older adults. This is preliminary evidence that different types of anxiety and different retrieval demands differentially influences the relationship between anxiety and memory for younger and older adults. Experiment 1 was the first step in testing my proposed model that situational pressures can activate anxiety and hypervigilance outside the confines of specifically negative or emotional stimuli. These results suggest that age and retrieval demands may be associated with specific anxious responses, and likely hypervigilance, which correspond to increased source monitoring abilities. Experiment 1 demonstrated the feasibility of testing my model using differing populations and retrieval demands.

Experiment 2

The aim of Experiment 2 was to replicate and extend the findings from Experiment 1. Experiment 1 provided evidence that increased levels of trait anxiety are related to increased memory performance for older adults. My model proposes that this is likely due to the situational constraints of the forced retrieval demand condition activating anxiety and hypervigilance. Importantly, the situational pressures of the forced retrieval demand instructions were not related to anxiety in young adults. Due to COVID-19, I could not run older adults in Experiment 2, however, it was still possible to test my theoretical model using a younger adult sample. Specifically, Experiment 2 included a warning retrieval demand condition with the goal of increasing the threat felt by younger participants, and thus, activating hypervigilance towards the task and increasing memory performance. Including this additional condition allowed me to further test the model prediction that situational pressures can be threatening, in the absence of emotional stimuli, and in turn, can be associated with anxiety and hypervigilance. It is important to further manipulate situational pressures to determine if there are age differences in the extent to which situational pressures are related to anxiety and hypervigilance. Is the influence of situational pressures restricted to older adults or can situational pressures also affect younger adults, if the situation is threatening enough?

As in Experiment 1, threat was manipulated via retrieval demands, because the goal of this dissertation was to allow anxiety to vary by activating hypervigilance without using threatening stimuli. Experiment 2 again utilized free and forced retrieval demands, but it also included a new “warning” retrieval demand condition. In the warning condition, participants were told that their memory score is based on their correct responses minus their incorrect responses (Huff et al., 2011). Participants were given a harsh warning against guessing, which provides a more conservative criterion compared to free and forced retrieval demands. This warning condition changed the retrieval demands of the task by pushing participants to be more careful in their responses. Previous research shows that this warning condition differentially influences the recall and recognition performance of younger and older adults (Huff et al., 2011). It is possible that this warning manipulation could be more threatening compared to the standard free or forced retrieval conditions because of the penalties associated with guessing. Attempting to heed this warning may make participants more vigilant towards the task and the items they write down during recall. Utilizing this warning condition was important because it was another way to potentially activate anxiety and hypervigilance via retrieval demands. The warning condition further tested my theoretical model that differing situational pressures may be associated with anxiety and hypervigilance in the absence of specifically threatening stimuli. It is important to determine if manipulating retrieval demands can increase anxiety and hypervigilance across the lifespan.

Further, Experiment 2 extended upon the results of Experiment 1 in several other ways. First, Experiment 2 included a larger sample size to achieve sufficient power to detect significant effects. Second, Experiment 2 included measures to test my model more directly. My model assumes that threat is activated via appraisal of the situational pressures, yet threat was not explicitly measured in Experiment 1. Experiment 2 measured levels of threat felt by each participant. My model assumes that hypervigilance is important to increasing memory performance. Experiment 2 included a measure of hypervigilance to test this part of the model. Third, Experiment 2 added additional measures to rule out/test for possible alternative explanations for the results. Specifically, Experiment 2 included a direct measure of state anxiety. Past research suggests that state anxiety has been related to memory performance (Davidson et al., 1991). Experiment 2 measured state anxiety to further examine the relationship between different types of anxiety and memory. Additionally, Experiment 2 included measures of positive and negative affect, effort, challenge, and arousal as potential alternative factors that relate to memory performance.

Hypotheses

Experiment 2 followed a similar procedure to Experiment 1. In recall 1, younger adults recalled categorized word lists under free, forced, or warning retrieval demand instructions. To examine the influence of retrieval demands on subsequent recall, all participants completed a second recall test under free recall instructions, followed by a recognition test. Participants completed measures of state, trait, and memory-specific anxiety. To assess potential third variables, participants completed measures of affect, valence, arousal, and appraisal. Additionally, Experiment 2 measured level of threat, challenge, and hypervigilance experienced by participants. As in Experiment 1, Experiment 2 included measures of other health related factors to separate the influences of anxiety from other health related factors such as depression and loneliness. Lastly, Experiment 2 again included an open-ended anxiety questionnaire designed to assess the content of younger adults’ anxious thoughts and avoidance tendencies. As with Experiment 1, this open-ended questionnaire data is not reported here

Experiment 2 tested similar hypotheses as were tested in Experiment 1. According to my model, higher levels of anxiety should correspond with better memory. As in Experiment 1, I predicted that higher levels of trait and memory-specific anxiety would relate to better source monitoring, as evidenced by higher levels of correct recall and recognition as well as lower levels of false recall and recognition. Importantly, I expected to find this positive relationship between anxiety and memory performance only the situational pressures were high. Specifically, I predicted that warning recall would be more threatening than free recall or forced recall and thus be associated with stronger relationships between anxiety and memory for those in the warning recall condition. Finding stronger relationships between anxiety and memory in warning recall would support my model in showing that manipulating situational pressures (not just emotional stimuli) may provide favorable conditions to examine the relationship between anxiety and memory.

Because I included the additional measures of state anxiety and hypervigilance, Experiment 2 also tested several new hypotheses. First, it is possible that the different retrieval demand conditions will result in different levels of state anxiety and hypervigilance, such that the highest levels of state anxiety and hypervigilance may be in the warning retrieval demand condition. Further, I predicted that increased levels of hypervigilance and state anxiety would be related to increased memory performance but only for those in the warning retrieval condition. Higher levels of memory performance for younger adults in conditions involving higher levels of hypervigilance and state anxiety will be evident in higher levels of correct recall and recognition as well as lower levels of false recall and recognition.

Method

Participants

A total of 128 undergraduate students from Montana State University were recruited to take part in the study for partial fulfillment of a course requirement. One participant was removed because their age did not fall within the criteria for a younger adult. The younger adult age range in Experiment 2 was 17-30. One participant was removed because they were not able to complete the forced recall test as instructed. One participant was excluded because they required a language translator when completing the questionnaire portion of the study. Lastly, two participants were excluded to ensure an even number of participants across conditions. Thus, a total of 5 participants were excluded from analysis, resulting in a final sample size of 123. An a priori power analysis was conducted using G*Power and indicated that a total sample of 81 was necessary to achieve .80 power, thus, this experiment was sufficiently powered to detect the correlations, main effects, and interactions of interest. To determine the necessary sample size to achieve .80 power, I input the following information into G*Power: statistical test of linear multiple regression with a single regression coefficient, 2 tail, effect size of .10, alpha of .05, and number of predictors as 3. However, after data was collected, I discovered that this G*Power analysis did not accurately capture the nature of my experimental design. Further, G*Power does not have the ability to test the a priori power of a moderated regression with a continuous predictor and a predictor independent variable that has three groups (e.g., free, forced, warning). Thus, it is possible that my experiment was not sufficiently powered to detect interactions.

Design

In this experiment, retrieval demands (free vs. forced vs. warning) were manipulated between subjects. Anxiety and hypervigilance served as continuous predictors of memory performance. The anxiety and hypervigilance measures were analyzed as continuous predictors in separate moderated regressions. The primary dependent variables were correct and false recall on recall test 1 and 2, as well as correct and false recognition.

Materials

Memory Stimuli. Materials for the memory portion of the study were the same six categorized word lists used in Experiment 1 (Birds, Human Body Parts, Flowers, Vegetables, Articles of Clothing, and Four-Footed Animals; Meade & Roediger, 2006). Again, each categorized word list contained 17 presented words and 5 non-presented critical lures (e.g., the top 5 exemplars in each category). The recognition test was the same test used in Experiment 1 and contained 90 total items: 30 unrelated filler items, five critical items from each word list, and 5 presented items from each word list (Meade & Roediger, 2006).

Anxiety and Hypervigilance Questionnaires. As in Experiment 1, trait anxiety was measured using the 44-item SCAARED (Angulo et al., 2017) and the 30-item GAS (Segal et al., 2010). As a reminder, the SCAARED was designed as a measure of "disordered anxiety symptoms" and not trait anxiety specifically. However, the SCAARED and GAS were highly correlated in Experiment 1 (r (56) = .791, $p < .001$) and Experiment 2 (r (121) = .826, $p < .001$). Participants also completed the same locally developed free-response anxiety questionnaire that was used in Experiment 1. As in Experiment 1, memory-specific anxiety was measured using the anxiety questionnaire subscale of the MIA (Davidson et al., 1991). However, for Experiment 2, this scale was updated to include an additional item from Huff et al. (2011). The additional item was "When taking a memory test, I feel it is a more serious error to leave something out than it is to write down something extra," to which participants responded on a 1 (*strongly disagree*) to 5 (*strongly agree*) Likert scale. This item was added in Experiment 2 because I wanted to examine the extent to which being conservative about one's memory was related to anxiety level. In addition, several new measures were added to Experiment 2. Specifically, state anxiety was measured using the state scale of the State Trait Inventory for Cognitive and Somatic Anxiety (STICSA) (Ree et al., 2008). The STICSA is a self-report questionnaire with 10 items designed to measure cognitive symptoms of anxiety and 11 items designed to measure somatic symptoms. The STICSA state scale measured how participants feel "right now, at this very moment." Previous research suggests that the STICSA is superior to the State-Trait Anxiety Inventory (Spielberger, 1983) in discriminating between depression and anxiety symptoms and may provide a more specific assessment of anxiety by separating cognitive and somatic symptoms (Grös, Antony, Simms, & McCabe, 2007). Also new to Experiment 2, participants completed the Brief Hypervigilance Scale (BHS; Berstein et al., 2015). The BHS is intended for use in research with college samples (Bernstein et al., 2015). The BHS is a 5-item questionnaire and participants responded on a 0 (*not at all like me/never true*) to 4 (*very much like me/always true*) scale to each of the items. The BHS contains items addressing thinking ahead, watching for trouble, and being aware of surroundings in public.

Threat, Challenge, and Effort Questionnaires. New to Experiment 2, participants completed measures of threat, challenge, and effort to better test model predictions and determine the extent to which these factors were related to memory performance. Participants completed a locally developed, one-item measure designed to assess the amount of threat participants felt while taking the memory tests. Participants responded on a 1 (*not at all threatened)* to 5 (*extremely threatened*) scale how threatened they felt during the memory portion of the experiment. Participants completed a locally developed, one-item measure designed to assess the amount of challenge participants felt while taking the memory tests. Participants responded on a 1 (*not at all challenged)* to 5 (*extremely challenged*) scale how challenged they felt during the memory portion of the experiment. Additionally, participants completed the Appraisal of Challenge or Threat Scale (ACTS) to determine the extent to which participants tended to view various situations as challenging or threatening (Tomaka, Palacios, Champion, & Monks, 2018). The ACTS is a 24-item questionnaire and participants responded on a 1 (*not at all)* to 5 (*very much*) scale of how demanding each event would be for them as well as how able they are to deal with that event. The ACTS contains situations such as “You’re asked to introduce yourself at a public forum” and “You receive unwanted medical news.” In Experiment 2, participants also completed the Rating Scale of Mental Effort (RSME; Zijlstra, 1993; Hadwin, Brogan, & Stevenson, 2005). Past research suggests that anxious individuals will exert additional effort to achieve comparable performance to their non-anxious peers (Eysenck et al., 2007). The RSME was included as an exploratory measure. In this scale, participants were required to place a cross on a 15cm line that represented a continuum of mental effort. The line had nine anchor points ranging from “I tried very little” to “I tried extremely hard.” Their mark along the line represented their subjective mental effort invested.

Affect Questionnaires. New to Experiment 2, participants completed measures of affect. Again, these were included to test for potential alternative factors that may be related to memory performance, over and above the influence of anxiety. Participants completed the 20-item Positive Affect Negative Affect Scale (PANAS) to determine the extent to which participants were currently experiencing different feelings and emotions (Watson, Clark, & Tellegen, 1988). Participants indicated on a 1 (*very slightly or not at* all) to 5 (*extremely*) scale the extent to which they were currently experiencing 20 different feelings and emotions (e.g., excited, upset, determined). Participants also completed the 3-item Self-Assessment Manikin (SAM) to assess their emotional response to the memory test. The SAM is designed to measure present moment feelings of valence/pleasure (from positive to negative), perceived arousal (from high to low levels), and dominance/control (from high to low levels) (Bynion & Feldner, 2017). The SAM is a picture-oriented instrument that contains five images (Manikins) for each of the three affective dimensions. Participants circled a number either directly under or between one of the five figures to indicate their levels of valance, arousal, and dominance (thus, making this a 9-point scale).

Health Status Questionnaires. As in Experiment 1, participants completed assessments of their current and past mental and physical health to separate the influence of anxiety from other health related factors. Participants completed the 30-item GDS (Yesavage et al., 1983), the 3-item SLS, (Hughes et al., 2004), the locally developed health questionnaire, the MMSE (Folstein et al., 1975) and the Shipley Vocabulary Test (Shipley, 1940).

Additional Materials. Additional materials included a mathematical filler task and a demographics questionnaire (e.g., age, race, education).

Procedure

After participants provided informed consent, they completed the memory portion of the experiment and were randomly assigned to the free retrieval demand condition, forced retrieval demand condition, or the warning retrieval demand condition. As in Experiment 1, participants viewed a series of 6 categorized wordlists presented on the computer screen. The lists were presented sequentially, one word at a time, with each word visible for 2 seconds followed by a 500ms interstimulus interval. Each list contained 17 presented items, for a total of 102 items. Participants were instructed to pay attention to the stimuli because their memory would be tested at a later time. After encoding all 102 items, participants completed a 2-minute mathematical filler task.

Next, participants completed recall test 1. Like Experiment 1, all participants recalled one list at a time, but within each list they could recall the words in any order. The category name was written at the top of the recall sheet, in addition to being verbally introduced by the experimenter. In the free retrieval demands condition, participants had two minutes per list to recall as many of the studied items as possible. Participants were told “Do not guess.” In the forced retrieval demands condition, participants had four minutes per list to recall 20 items from each list. Participants were told “There are 20 items for each list, meaning that you must produce 20 responses. I understand that it will be hard for you to come up with all 20 items—if you cannot remember them all, you must guess.” In reality, participants only saw 17 items per list, so by definition they must guess in order to produce 20 responses. Instructions for the warning condition were taken from Huff et al. (2011). In the warning retrieval demands condition, participants had two minutes per list to recall as many of the studied items as possible.

Participants were told "Please do your best. Points will be rewarded for correct answers. Your score on the test will be based on correct responses minus incorrect responses. That is, there is a strong penalty for guessing. It is to your advantage to write down only those items that you are absolutely positive occurred in the list because any item you write down that is incorrect will be counted against your score."

After completing recall test 1, participants moved immediately into recall test 2. As in Experiment 1, all participants completed recall test 2 under the free retrieval demand instructions. Again, participants recalled one list at a time, and were allowed to recall items within each list in any order. Participants were given two minutes per list to recall as many items as possible and instructed to avoid guessing and only write down words they were reasonably sure appeared on the lists. The final memory test was designed to measure source monitoring abilities. This recognition test was the same test used in Experiment 1 and there was no time limit for the recognition test.

Immediately after the memory phase of the experiment, participants completed the questionnaire phase. As in Experiment 1, participants were given a packet containing all of the questionnaires. Participants were instructed to carefully read the instructions at the top of each questionnaire and to complete each questionnaire at their own pace. There was no time limit for completing the questionnaires. Five of the questionnaires were designed to measure anxiety (e.g., open-ended anxiety questionnaire, STICSA, SCAARED, GAS, MIA). Three were designed to measure threat and challenge (locally developed threat questionnaire, locally developed challenge questionnaire, ACTS). One was designed to measure hypervigilance (BHS). Two were designed to measure affect (PANAS, SAM). Seven were designed to measure other physical and mental health related factors (e.g., GDS, SLS, health questionnaire, demographics questionnaire, Shipley Vocabulary test, RSME, MMSE). The questionnaires were completed in the same order for all participants. The most time sensitive measures were taken at the beginning of the questionnaire packet (i.e., the questionnaires that ask about feelings *during* the memory test). Participants completed the STICSA-S before the open-ended anxiety questionnaire because it was important to measure levels of state anxiety as close to completion of the memory test as possible. The more exploratory measures (PANAS, RMSE, and BHS) were taken at the end of the packet to keep the questionnaire order as close to Experiment 1 as possible. Upon completion of the questionnaire packet, the experimenter administered the MMSE. Once participants finished both the memory and questionnaire phases of the experiment, they were thanked, fully debriefed, and given credit on SONA.

Data Analytic Plan

Moderated regression analyses were conducted to examine the relationship between the independent (predictor) variables and the dependent (criterion) variables. I used a multiple regression framework to regress correct and false recall and recognition memory scores on retrieval demand condition, anxiety/hypervigilance scores, and the retrieval demand x anxiety/hypervigilance interaction. Experiment 2 had six primary dependent variables (i.e., Test 1 Correct and False Recall, Test 2 Correct and False Recall, and Correct and False Recognition). Correct recall represents the proportion of words participants recalled that appeared on the study lists. False recall represents the proportion of critical lures participants indicated as having appeared on the lists. Correct recognition scores are the proportion of items correctly indicated by participants as having been present on the word lists ("list only" responses plus "both list and self" responses). That is, participants indicated a word appeared on the list when it did in fact appear on the list. False recognition scores are the proportion of critical items incorrectly indicated as having been present on the words lists ("list only" responses plus "both list and self" responses). That is, participants indicated a critical lure appeared on the list when it did not appear on the list. The recognition test allows one to directly examine source monitoring abilities. The dependent variables were examined in separate regressions.

Retrieval demand condition served as one independent variable. Given that the retrieval demand factor has three levels (free, forced, warning), it was necessary to create dummy coded variables to represent the groups. I created one dummy code to represent the forced retrieval demand condition (henceforth referred to as the forced condition) and one dummy code to represent the warning retrieval demand condition (henceforth referred to as the warning condition). Thus, free recall served as the reference group. It is important to note that when discussing the results of Recall 2 and Recognition, these conditions will be referred to as prior free, prior forced, and prior warning, because the retrieval demand manipulation only occurs in Recall 1. In Recall 2 and Recognition, all participants received the same instructions. Additionally, each moderated regression analysis included one continuous independent variable that represented scores of anxiety or hypervigilance. Stemming from my hypotheses and proposed model, the two primary continuous independent variables were hypervigilance (BHS) and state anxiety (STICSA), and three secondary continuous independent variables were trait anxiety (SCAARED & GAS) and memory-specific anxiety (MIA). Each one of these continuous independent variables was mean centered prior to analysis and entered into its own regression analysis. This means that each regression analysis only included one continuous independent variable. For example, in the regression examining hypervigilance (BHS), retrieval demand condition, and Correct Recall at Test 1, hypervigilance, forced condition, and warning condition are the independent, predictor variables and Correct Recall at Test 1 is the dependent, criterion variable. Thus, a total of 30 moderated regressions were run to fully capture the relationship between the six dependent variables and the five different continuous predictor variables.

Results

Preliminary Examination of the Data.

Preliminary examination of the data indicated no missing data for each of the variables central to the primary hypotheses (i.e., the memory variables and the BHS & STICSA scales). However, one participant failed to complete the SCAARED, resulting in the total sample size of 122 for the SCAARED variable.

Next, I tested for univariate outliers in my primary variables and my exploratory variables. A univariate outlier was any case that was greater than 3.29 standard deviations above or below the mean (Field, 2013). In my primary variables, I identified one outlier on the STICSA variable and one outlier on the correct recognition variable. To maintain consistency across analyses, if an outlier was identified, it was removed from the dataset and was not included in the analyses involving that variable. Thus, due to the existence of outliers, not all analyses reported use the same sample size. In my exploratory variables, I identified one univariate outlier each in the RMSE, health, PANAS positive, and PANAS negative variables. These outliers were removed prior to examining the correlations between the memory measures and the RMSE, health, PANAS positive, and PANAS negative variables.

Additionally, I examined the data to determine the extent to which multivariate outliers influence the significant interaction terms in the moderated regression analyses. First, I ran the moderated regressions to determine which interactions were significant. Next, in the event of a significant interaction, I visually examined the correlation scatterplots to identify potential multivariate outliers. If I identified a potential outlier by looking at the data visualization, I then examined measures of distance (i.e., Cook's distance, leverage, Mahalanobis distance) and influence statistics (i.e., standardized DFBeta's, standardized DFFit's, covariance ratio) to further determine if this case was a potential outlier. If the distance and influence statistics indicated that a certain participant may be a potential multivariate outlier, this participant was removed from the dataset and was not included in the analyses reported here. Thus, all analyses reported herein exclude univariate and multivariate outliers. I removed two multivariate outliers when examining Correct Recall at Test 1 and BHS; three multivariate outliers when examining False Recall at Test 1 and BHS; two multivariate outliers when examining Correct Recognition and BHS; seven multivariate outliers when looking at False Recognition and BHS; one multivariate outlier when examining False Recall at Test 1 and GAS; and three multivariate outliers when examining Correct Recall at Test 1 and MIA.

Next, I examined the potential relationships between the exploratory measures and dependent variables (i.e., the memory measures). For example, participants completed several measures (e.g., affect, challenge, health) that could theoretically be related to memory performance (DV), and thus serve as covariates in the regression models. I calculated Pearson correlations between Correct and False Recall at Test 1 & 2, Correct and False Recognition, and the average score of each measure. There were just 4 significant correlations. Higher levels of happiness on the SAM valence questionnaire were significantly correlated with lower levels of false recognition (r = -.251, p = .005); higher levels of dominance on the SAM dominance questionnaire were significantly correlated with higher levels of correct recall at Test 2 (r = .209, p = .021); higher levels of challenge on the locally developed challenge questionnaire significantly correlated with higher levels of false recall at Test 1 (r = .224, p = .013); higher levels of health were significantly correlated with higher levels of correct recognition (r = .229, p = .011). However, because there is no consistent pattern to these associations, and no other relationships were significant (all r's < .172, all p's > .058; see Table 8), I did not covary for any of the exploratory measures in the regression analyses.

Table 8. Pearson correlations for memory and affect, threat, challenge, effort, and health variables. **p < .01, *p < .05

	Recall 1 Correct	Recall 1 False	Recall 2 Correct	Recall 2 False	Correct Recognition	False Recognition
SAM Valence	.03	-.14	.13	-.15	-.13	-.25**
SAM Arousal	.04	.05	.06	.04	-.02	.04
SAM Dominance	.17	-.07	.21*	-.14	-.02	-.11
PANAS Positive	.05	.06	.03	-.02	.06	.03
PANAS Negative	.00	.09	.00	.00	.03	.06
Threatened	-.04	.06	-.02	.04	.08	.09
Challenged	.14	.22*	.03	.11	.00	.03
ACTS	.00	-.01	.00	-.02	-.01	-.05
GDS	-.05	-.07	-.06	-.10	-.10	-.12
SLS	-.07	-.14	-.10	-.13	-.04	-.07
RMSE	.14	.04	.12	.01	.04	-.09
Health	-.06	-.04	-.03	.10	.23**	.15

Demographics

The final sample included 123 younger adults (M_{age} = 19.14 years, SD_{age} = 2.14 years; $M_{years\ post\text{-}high\ school\ education}$ = 0.82 years, $SD_{years\ post\text{-}high\ school\ education}$ = 0.89 years). The majority of the sample was female (59%), native English speaking (99%), non-Hispanic/Latino (99%) and White (93%). Descriptive statistics for each study variable are presented in Table 9 by retrieval demand condition and total sample. All participants were within the normal range for the MMSE (M = 28.87, SD = 1.06, min = 26, max = 30). The highest possible score on the MMSE is 30, and the normal range for the MMSE is 24-30. On average, participants scored 28.46 (SD = 3.96, min = 20, max = 37) on the Shipley vocabulary test. The Shipley vocabulary test includes 40 questions, thus, on average, participants were able to correctly identify 71.2% of the words on the vocabulary test. Important to the predictions of Experiment 2, there were no significant differences between the free, forced, and warning retrieval conditions for self-reported hypervigilance ($F(2, 120) = 1.25$, $p > .05$), state anxiety ($F(2, 120) = .153$, $p > .05$), or threat ($F(2, 120) = .722$, $p > .05$). It is possible that there were not differences among the free, forced, and warning conditions because the questionnaires were not completed immediately following the retrieval demand condition manipulations.

Table 9. Mean of anxiety, threat, challenge, effort, affect, and health status variables as a function of recall condition (free/forced/warning). Standard deviations are in parentheses.

	Free	Forced	Warning	Total Sample
Anxiety				
STICSA	1.79 (.55)	1.74 (.47)	1.80 (.50)	1.78 (.51)
BHS	2.34 (1.07)	2.00 (.80)	2.20 (1.02)	2.18 (.97)
SCAARED	.93 (.39)	.82 (.32)	.82 (.45)	.86 (.39)
GAS	.97 (.63)	.80 (.50)	.87 (.48)	.88 (.54)
MIA	3.19 (.73)	3.11 (.67)	3.00 (.84)	3.10 (.75)
Threat, Challenge, & Effort				
Threatened	1.73 (.92)	1.54 (.87)	1.54 (.74)	1.60 (.85)
Challenged	3.85 (.73)	4.24 (.66)	3.82 (.63)	3.98 (.69)
ACTS	.59 (.98)	.35 (.69)	.16 (.96)	.37 (.90)
RSME	109.21 (21.68)	116.27 (20.66)	113.02 (21.81)	112.83 (21.41)
Affect				
SAM				
Valence	4.98 (1.27)	4.66 (1.15)	5.07 (1.33)	4.90 (1.26)
Arousal	4.83 (2.31)	4.88 (1.91)	4.66 (2.19)	4.79 (2.13)
Dominance	4.80 (1.49)	4.61 (1.53)	4.61 (1.76)	4.67 (1.59)
PANAS				
Positive	2.18 (.72)	2.24 (.64)	2.28 (.74)	2.23 (.70)
Negative	1.67 (.66)	1.57 (.50)	1.58 (.53)	1.61 (.57)
Health				
GDS	.44 (.26)	.37 (.22)	.37 (.22)	.39 (.23)
SLS	2.36 (.72)	2.01 (.66)	2.14 (.62)	2.17 (.68)
Age	19.61 (2.70)	18.83 (1.05)	18.98 (2.27)	19.14 (2.14)
Health	3.57 (.81)	3.57 (.81)	3.64 (.81)	3.59 (.80)
MMSE	28.90 (1.07)	29.10 (.77)	28.61 (1.24)	28.87 (1.06)
Shipley	28.51 (4.28)	28.44 (4.15)	28.41 (3.49)	28.46 (3.96)

Primary Analyses

Brief Hypervigilance Scale

When analyzing the Recall 1, Recall 2, and Recognition tests, the most direct test of my hypotheses is the test of the warning x BHS interaction because I predicted that the highest levels of hypervigilance would be in the warning condition due to the potential of the warning condition to be more situationally threatening, and therefore activate greater levels of hypervigilance, compared to the free and forced conditions. In turn, I predicted that increased levels of hypervigilance would be related to increased correct recall and recognition, and decreased false recall and recognition, but only for those in the warning condition.

Recall 1. See Table 10 for recall test 1 means.

Table 10. Mean proportion of items recalled as a function of recall condition (free/forced/warning) on recall test 1 and 2 (n = 123). Standard deviations are in parentheses.

Memory Variable	Free	Forced	Warning	Total Sample
Test 1				
Correct Recall	.34 (.09)	.57 (.10)	.34 (.11)	.42 (.15)
False Recall	.19 (.14)	.61 (.10)	.13 (.15)	.31 (.25)
Test 2	Prior Free	Prior Forced	Prior Warning	Total Sample
Correct Recall	.35 (.10)	.49 (.11)	.38 (.12)	.41 (.13)
False Recall	.20 (.15)	.45 (.18)	.16 (.18)	.27 (.21)

Recall 1 Correct Recall. The regression on Correct Recall at Test 1 revealed that the model including BHS was significant ($F(5, 115) = 32.75$, $MSE = .01$, $p < .01$). See Table 11 for full results. The forced condition was significant (B = .25, $t = 11.18$, $p < .01$), indicating that those in the forced condition recalled significantly more correct items than those in the free condition. Additionally, the forced x BHS interaction was significant (B = .06, $t = 2.07$, $p = .04$). See Figure 2. However, a probe of the interaction revealed no significant effects. Thus, it is not possible to definitively state that retrieval demand condition influences the extent to which hypervigilance is related to correct recall. The effect of BHS, warning condition, and the warning x BHS interaction were not significant (all t's < 0.61, all p's > .53).

Table 11. Summary of final model for regression analyses with BHS, forced recall, & warning recall predicting correct recall test 1. ***p* < .01, **p* < .05

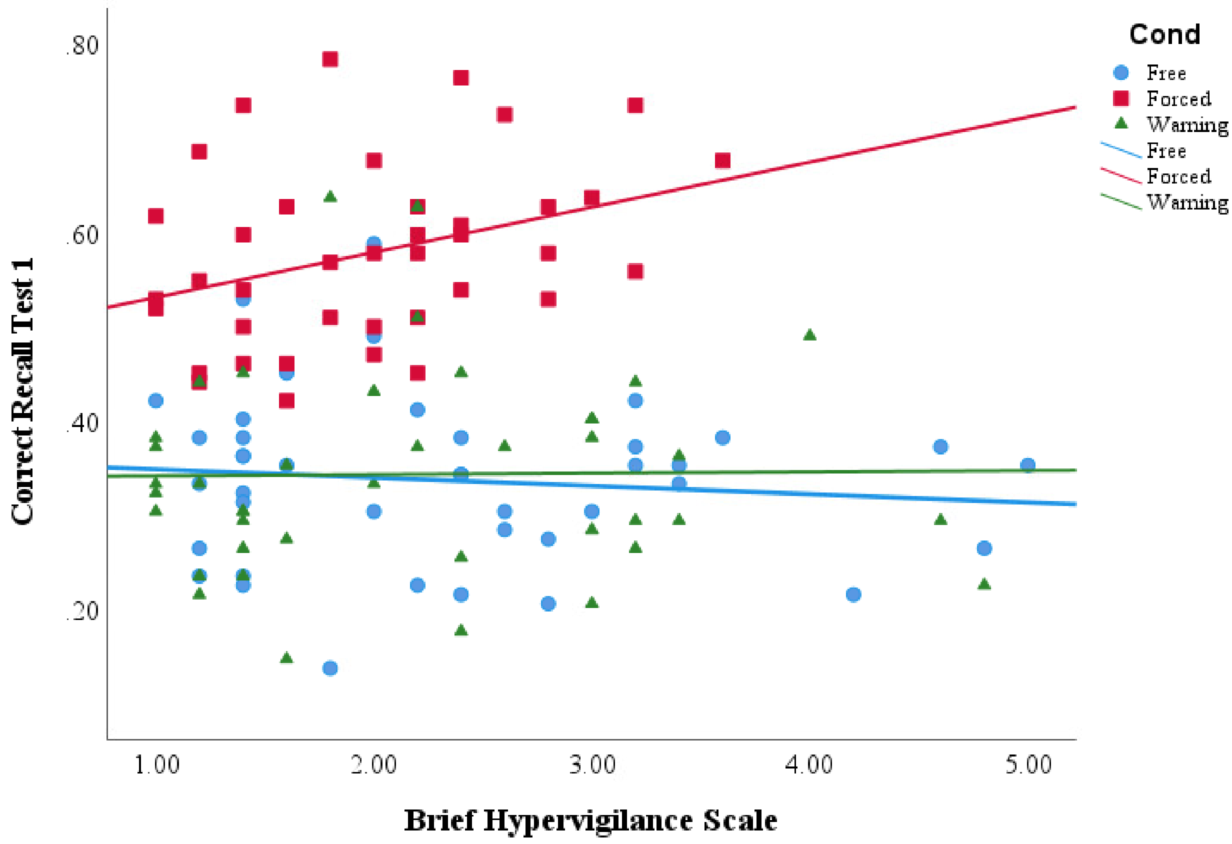
Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	0.59**						
BHS		-0.01	0.01	-0.61	.54	-0.04	0.02
Forced		0.25**	0.02	11.18	< .01	0.21	0.29
Warning		0.01	0.02	0.23	.82	-0.04	0.05
BHS*Forced		0.06*	0.03	2.07	.04	0.00	0.11
BHS*Warning		0.01	0.02	0.49	.63	-0.03	0.05

Recall 1 False Recall. The regression on False Recall at Test 1 revealed that the model including BHS was significant ($F(5, 114) = 62.40$, $MSE = .02$, $p < .01$). See Table 12 for full results. The forced condition was significant (B = 0.41, $t = 13.62$, $p < .01$), indicating that those in the forced condition recalled significantly more false items than those in the free condition. The warning condition was significant (B = -0.06, $t = -2.21$, $p = .03$), indicating that those in the warning condition recalled significantly less false items than those in the free condition. The effect of BHS, the forced x BHS interaction, and the warning x BHS interaction were not significant (all *t*'s < 0.62, all *p*'s > .54). Taken together, these results suggest that differences in hypervigilance were not related to False Recall at Test 1.

Table 12. Summary of final model for regression analyses with BHS, forced recall, & warning recall predicting false recall test 1. ***p* < .01, **p* < .05

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.73**						
BHS		-0.01	0.02	-0.61	.55	-0.05	0.03
Forced		0.41**	0.03	13.62	< .01	0.35	0.47
Warning		-0.06*	0.03	-2.21	.03	-0.12	-0.01
BHS*Forced		0.02	0.04	0.47	.64	-0.06	0.09
BHS*Warning		-0.02	0.03	-0.59	.55	-0.07	0.04

Figure 2. Scatterplot representing the interaction between BHS and retrieval demand condition on correct recall at test 1.



Recall 2. See Table 10 for recall test 2 means. As a reminder, the most direct test of my hypotheses is the test of the prior warning x BHS interaction.

Recall 2 Correct Recall. The regression on Correct Recall at Test 2 revealed that the model including BHS was significant ($F(5, 117) = 8.22$, $MSE = .01$, $p < .01$). See Table 13 for full results. The prior forced condition was significant (B = 0.14, $t = 5.79$, $p < .01$), indicating that those who recalled under forced retrieval demand instructions during test 1 recalled significantly more correct items at test 2 compared to those who previously recalled under free retrieval demand instructions. The effect of BHS, prior warning condition, prior forced x BHS interaction, and the prior warning x BHS interaction were not significant (all *t*'s < 1.79, all *p*'s > .07). These results suggest that differences in hypervigilance were not related to Correct Recall at Test 2.

Table 13. Summary of final model for regression analyses with BHS, forced recall, & warning recall predicting correct recall test 2. ***p* < .01

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.26**						
BHS		-0.02	0.02	-1.02	.31	-0.05	0.02
Forced		0.14**	0.02	5.79	< .01	0.09	0.19
Warning		0.02	0.02	0.94	.35	-0.03	0.07
BHS*Forced		0.05	0.03	1.78	.08	-0.01	0.10
BHS*Warning		0.01	0.02	0.48	.63	-0.04	0.06

Recall 2 False Recall. The regression on False Recall at Test 2 revealed that the model including BHS was significant (*F*(5, 117) = 14.79, *MSE* = .03, *p* < .01). See Table 14 for full results. The prior forced condition was significant (B = 0.24, *t* = 6.32, *p* < .01), indicating that those who recalled under forced retrieval demand instructions during test 1 recalled significantly more false items at test 2 compared to those who previously recalled under free retrieval demand instructions. The effect of BHS, prior warning, prior forced x BHS interaction, and the prior warning x BHS interaction were not significant (all *t*'s < 1.19, all *p*'s > .23). These results suggest that differences in hypervigilance were not related to False Recall at Test 2.

Table 14. Summary of final model for regression analyses with BHS, forced recall, & warning recall predicting false recall test 2. ***p* < .01

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.39**						
BHS		-0.01	0.02	-0.49	.62	-0.06	0.04
Forced		0.24**	0.04	6.32	< .01	0.16	0.31
Warning		-0.04	0.04	-1.18	.24	-0.12	0.03
BHS*Forced		-0.01	0.04	-0.27	.79	-0.09	0.07
BHS*Warning		-0.03	0.04	-0.96	.34	-0.11	0.04

Recognition. See Table 15 for correct and false recognition means. Again, the most direct test of my hypotheses is the test of the prior warning x BHS interaction because I predicted that participants in the prior warning condition would be hypervigilant, which in turn would be related to increased correct recognition and decreased false recognition.

Table 15. Mean proportion of correct & false recognition as a function of prior recall condition (free/forced/warning). Standard deviations are in parentheses.

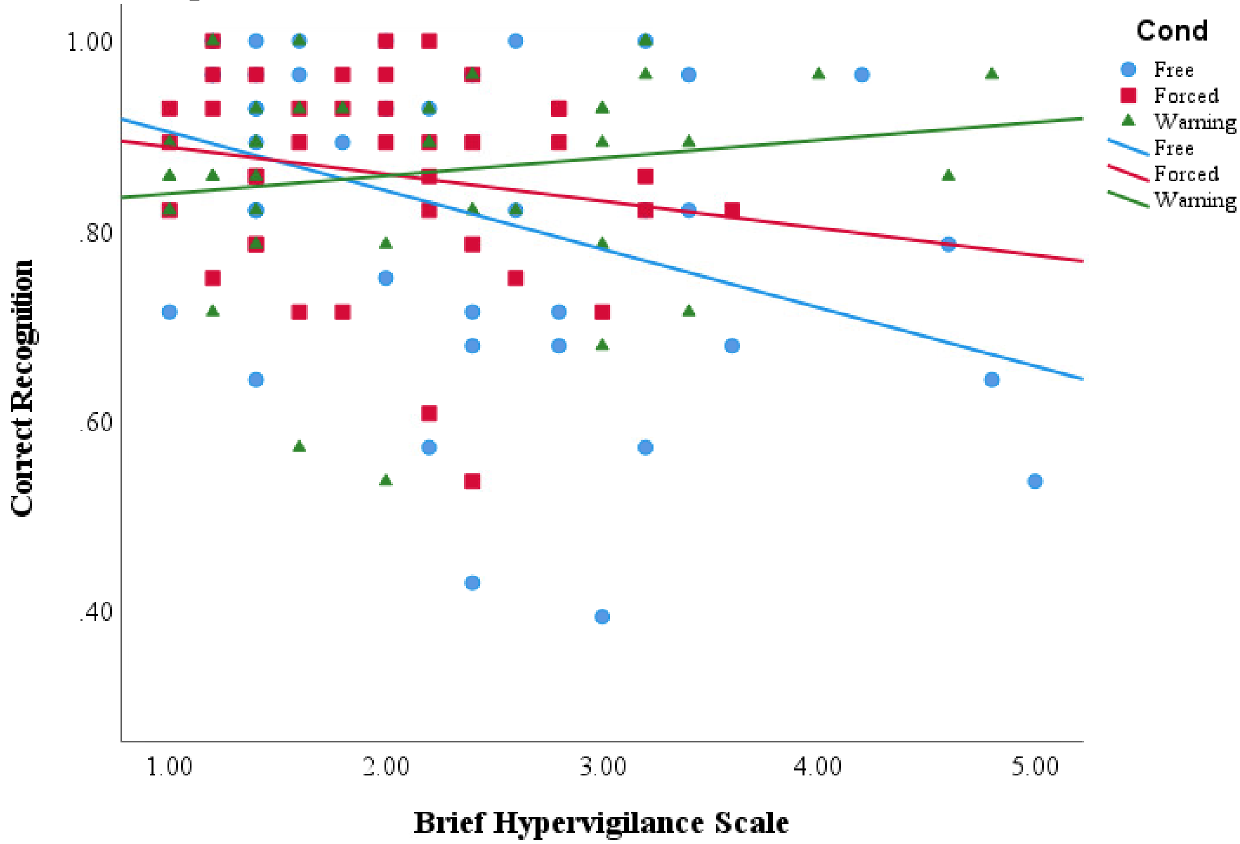
Memory Variable	Prior Free	Prior Forced	Prior Warning	Total Sample
Correct Recognition				
List Only	.43 (.18)	.23 (.14)	.42 (.19)	.36 (.19)
Both List and Self	.40 (.16)	.62 (.13)	.44 (.16)	.48 (.18)
Total Correct Recognition	.82 (.17)	.85 (.11)	.86 (.11)	.84 (.13)
Self	.01 (.05)	.04 (.05)	.01 (.04)	.02 (.04)
Neither	.17 (.15)	.11 (.08)	.13 (.10)	.14 (.12)
False Recognition				
List Only	.44 (.23)	.18 (.12)	.46 (.21)	.36 (.23)
Both List and Self	.21 (.14)	.50 (.22)	.18 (.19)	.30 (.24)
Total False Recognition	.65 (.27)	.68 (.28)	.64 (.23)	.66 (.26)
Self	.02 (.07)	.15 (.17)	.04 (.12)	.07 (.14)
Neither	.33 (.28)	.17 (.15)	.32 (.20)	.27 (.23)

Correct Recognition. The regression on Correct Recognition revealed that the model including BHS was significant ($F(5, 114) = 2.64$, $MSE = .02$, $p = .03$). See Table 16 for full results. The BHS effect was significant (B = -0.06, $t = -3.11$, $p < .01$), such that higher levels of hypervigilance were related to lower levels of correct recognition. Additionally, the prior warning x BHS interaction was significant (B = .08, $t = 2.88$, $p < .01$). See Figure 3. A probe of the interaction revealed that BHS significantly predicted Correct Recognition, but only for individuals who were in the free retrieval demands condition at Recall Test 1 (B = -0.06, SE = 0.02, $t = -3.11$, $p < .01$, CI = [-0.09, -0.02]. In the prior free retrieval demands condition, higher levels of hypervigilance were related to lower levels of correct recognition. Thus, retrieval condition does moderate the relationship between hypervigilance and correct recognition. This finding is partially in line with my hypotheses. Although I predicted that the effects of hypervigilance would be evident in the warning x BHS interaction, I predicted that hypervigilance would be positively, not negatively, related to correct recognition for those who previously recalled under warning retrieval instructions. Taken together, hypervigilance is related to correct recognition, albeit only for those who recalled under free recall instructions at test 1. The effects of prior forced, prior warning, and prior forced x BHS interaction were not significant (all *t*'s < 0.81, all *p*'s > .42).

Table 16. Summary of final model for regression analyses with BHS, forced recall, & warning recall predicting correct recognition. $**p < .01$

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.10**						
BHS		-0.06**	0.02	-3.11	< .01	-0.09	-0.02
Forced		0.01	0.03	0.51	.61	-0.04	0.07
Warning		0.02	0.03	0.76	.45	-0.03	0.07
BHS*Forced		0.03	0.03	0.81	.42	-0.04	0.10
BHS*Warning		0.08**	0.03	2.88	< .01	0.02	0.13

Figure 3. Scatterplot representing the interaction between BHS and retrieval demand condition on correct recognition.



<u>False Recognition.</u> The regression on False Recognition revealed that the model including BHS was not significant (*F*(5, 110) = 1.70, *MSE* = .06, *p* = .14). This result is not in line with my hypotheses, because I predicted that increased levels of hypervigilance in the prior warning condition would be related to decreased levels of false recognition. It is possible that false recognition was not influenced by the warning manipulation because the warning retrieval demand instructions made all participants, regardless of hypervigilance levels, respond more conservatively.

Taken together, the results of the regressions that examined correct and false recognition suggest that, under free recall, higher levels of hypervigilance are related to lower levels of correct recognition, but unrelated to false recognition. Under warning conditions, hypervigilance was not related to correct or false recognition.

State-Trait Inventory of Cognitive and Somatic Anxiety-State Scale

When analyzing the Recall 1, Recall 2, and Recognition tests, the most direct test of my hypotheses is the test of the warning x STICSA interaction because I predicted that the highest levels of state anxiety would be in the warning retrieval demand condition due to the potential of the warning condition to be more situationally threatening than the free and forced conditions. In turn, I predicted that increased levels of state anxiety would be related to increased correct recall and recognition, and decreased false recall and recognition, but only for those in the warning condition. As a reminder, my preliminary examination of the data revealed one univariate outlier for the STICSA variable, thus, the analyses reported here exclude the outlier.

Recall 1 Correct Recall. The regression on Correct Recall at Test 1 revealed that the model including STICSA was significant ($F(5, 116) = 29.22$, $MSE = .01$, $p < .01$). See Table 17 for full results. The forced condition was significant (B = 0.23, $t = 10.48$, $p < .01$), indicating that those in the forced condition recalled significantly more correct items than those in the free condition. The effects of STICSA, warning condition, forced x STICSA interaction, and the warning x STICSA interaction were not significant (all t's < 0.93, all p's > .35). These results suggest that differences in state anxiety were not related to correct recall at test 1.

Table 17. Summary of final model for regression analyses with STICSA, forced recall, & warning recall predicting correct recall test 1. ***p* < .01

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	0.56**						
STICSA		-0.03	0.03	-1.17	.24	-0.09	0.02
Forced		0.24**	0.02	10.66	< .01	0.19	0.28
Warning		0.01	0.02	0.25	.80	-0.04	0.05
STICSA*Forced		0.03	0.04	0.78	.44	-0.05	0.12
STICSA*Warning		0.06	0.04	1.33	.19	-0.03	0.14

Recall 1 False Recall. The regression on False Recall at Test 1 revealed that the model including STICSA was significant ($F(5, 116) = 71.64$, $MSE = .02$, $p < .01$). See Table 18 for full results. The forced condition was significant (B = 0.42, $t = 15.00$, $p < .01$), indicating that those in the forced condition recalled significantly more false items than those in the free condition. The warning condition was significant (B = -0.06, $t = -2.17$, $p = .03$), indicating that those in the warning condition recalled significantly less false items than those in the free condition. The effects of STICSA, forced x STICSA interaction, and the warning x STICSA interaction were not significant (all *t*'s < 1.68, all *p*'s > .09). These results suggest that differences in state anxiety were not related to false recall at test 1.

Table 18. Summary of final model for regression analyses with STICSA, forced recall, & warning recall predicting false recall test 1. ***p* < .01, **p* < .05

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.75**						
STICSA		0.03	0.04	0.81	.42	-0.04	0.10
Forced		0.42**	0.03	15.06	< .01	0.37	0.48
Warning		-0.06*	0.03	-2.25	.03	-0.12	-0.01
STICSA*Forced		0.08	0.06	1.48	.14	-0.03	0.19
STICSA*Warning		0.04	0.05	0.77	.44	-0.07	0.15

Recall 2 Correct Recall. The regression on Correct Recall at Test 2 revealed that the model including STICSA was significant ($F(5, 116) = 7.20$, $MSE = .01$, $p < .01$). See Table 19 for full results. The prior forced condition was significant (B = 0.14, $t = 5.54$, $p < .01$), indicating that those in the forced condition recalled significantly more correct items than those in the free condition. The effects of STICSA, prior warning condition, prior forced x STICSA interaction, and the prior warning x STICSA interaction were not significant (all t's < 0.86, all p's > .38). Similar to recall 1, these results suggest that differences in state anxiety were not related to correct recall at test 2.

Table 19. Summary of final model for regression analyses with STICSA, forced recall, & warning recall predicting correct recall test 2. $^{**}p < .01$

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.25**						
STICSA		-0.03	0.03	-0.94	.35	-0.09	0.03
Forced		0.14**	0.02	5.71	< .01	0.09	0.19
Warning		0.02	0.02	1.01	.32	-0.02	0.07
STICSA*Forced		0.03	0.05	0.70	.48	-0.06	0.13
STICSA*Warning		0.05	0.05	1.06	.29	-0.04	0.14

Recall 2 False Recall. The regression on False Recall at Test 2 revealed that the model including STICSA was significant ($F(5, 116) = 14.21$, $MSE = .03$, $p < .01$). See Table 20 for full results. The forced condition was significant (B = 0.25, $t = 6.66$, $p < .01$), indicating that those in the forced condition recalled significantly more false items than those in the free condition. The effects of STICSA, prior warning condition, prior forced x STICSA interaction, and the prior warning x STICSA interaction were not significant (all t's < 1.17, all p's > .24). Similar to recall 1, these results suggest that differences in state anxiety were not related to false recall at test 2.

Table 20. Summary of final model for regression analyses with STICSA, forced recall, & warning recall predicting false recall test 2. **$p < .01$

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.38**						
STICSA		0.05	0.05	1.05	.30	-0.05	0.15
Forced		0.25**	0.04	6.58	< .01	0.17	0.32
Warning		-0.04	0.04	-1.16	.25	-0.12	0.03
STICSA*Forced		-0.02	0.07	-0.31	.76	-0.17	0.12
STICSA*Warning		0.00	0.07	-0.02	.98	-0.14	0.14

Recognition. See Table 15 for recognition means. Again, the most direct test of my hypotheses is the test of the prior warning x STICSA interaction because I predicted that the warning condition would activate state anxiety, and therefore be related to increased correct recognition and decreased false recognition.

Correct and False Recognition. The regression on Correct Recognition revealed that the model including STICSA was not significant ($F(5, 115) = 0.36$, $MSE = .02$, $p = .87$). Additionally, the regression on False Recognition revealed that the model including STICSA was not significant ($F(5, 116) = 0.15$, $MSE = .07$, $p = .98$). Thus, these results suggest that state anxiety is not related to correct or false recognition.

Taken together, these results suggest that state anxiety, as measured by the STICSA, is not related to recall or recognition memory performance. These results are not in line with my hypotheses, because I predicted that the warning retrieval demand condition would activate state anxiety, and lead to increased correct recall and recognition performance, as well as decreased false recall and recognition performance.

Secondary Analyses

Stemming from my hypotheses and proposed model, the secondary analyses were conducted using trait anxiety (i.e., SCAARED, GAS) and memory-specific anxiety (e.g., MIA) variables. A separate set of moderated regressions were run using the SCAARED as a continuous predictor, the GAS as a continuous predictor, and the MIA as a continuous predictor. Again, the most direct test of my hypotheses is the test of the warning x anxiety interaction, because I predicted that the warning condition would be the most situationally threatening for younger adults, and thus trigger an anxious response in individuals with heightened levels of trait and memory-specific anxiety. In turn, I predicted that this activated trait and memory-specific anxiety in the warning condition would be related to increased levels of correct recall and recognition, as well as decreased levels of false recall and recognition. Of importance, in each significant regression model involving the SCAARED, GAS, and MIA, a consistent pattern of recall condition main effects emerged such that participants in the forced retrieval demands condition at Test 1 had higher levels of correct and false recall at Test 1 and 2 compared to participants in the free retrieval demands condition. Additionally, participants in the warning retrieval demands condition at Test 1 had lower levels of false recall at Test 1 compared to participants in the free retrieval demands condition. Because these main effects are unrelated to the anxiety measures, and to avoid repetition, these effects will not be discussed further.

Screen for Adult Anxiety Related Disorders

Separate regressions were run on Correct and False Recall at Test 1 and 2, as well as Correct and False Recognition, with SCAARED and retrieval demand condition as predictors.

The regressions on Correct and False Recall at Test 1 and 2 revealed that the overall models including SCAARED were significant (all *F*'s > 8.06, all *p*'s < .01), however, in each model, there was not a significant effect of SCAARED (all *t*'s < 1.91, all *p*'s > .05). See Tables 21, 22, 23, & 24 for summary of full models. The regressions on Correct and False Recognition revealed that the models including SCAARED were not significant (all *F*'s < .85, all *p*'s > .51). These results conceptually replicate Experiment 1 and show that trait anxiety, as measured by the SCAARED, is not related to correct and false recall and recognition in younger adults. Contrary to Experiment 2 predictions, even with the addition of the warning condition, trait anxiety was not related to memory performance.

Table 21. Summary of final model for regression analyses with SCAARED, forced recall, & warning recall predicting correct recall test 1. $**p < .01$

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.57**						
SCAARED		-0.05	0.04	-1.23	.22	-0.13	0.03
Forced		0.23**	0.02	10.55	< .01	0.19	0.28
Warning		0.00	0.02	0.21	.84	-0.04	0.05
SCAARED*Forced		0.12	0.06	1.85	.07	-0.01	0.24
SCAARED*Warning		0.10	0.05	1.90	.06	0.00	0.20

Table 22. Summary of final model for regression analyses with SCAARED, forced recall, & warning recall predicting false recall test 1. $**p < .01$, $*p < .05$

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.73**						
SCAARED		-0.04	0.05	-0.66	.51	-0.14	0.07
Forced		0.41**	0.03	13.95	< .01	0.36	0.47
Warning		-0.06*	0.03	-2.16	.03	-0.12	-0.01
SCAARED*Forced		0.07	0.08	0.82	.41	-0.10	0.24
SCAARED*Warning		0.06	0.07	0.82	.42	-0.08	0.20

Table 23. Summary of final model for regression analyses with SCAARED, forced recall, & warning recall predicting correct recall test 2. ***p* < .01

Predictors	***R*²**	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.26**						
SCAARED		-0.05	0.04	-1.06	.29	-0.14	0.04
Forced		0.04**	0.02	5.59	< .01	0.09	0.19
Warning		0.02	0.02	0.95	.35	-0.03	0.07
SCAARED*Forced		0.12	0.07	1.75	.08	-0.02	0.26
SCAARED*Warning		0.08	0.06	1.42	.16	-0.03	0.20

Table 24. Summary of final model for regression analyses with SCAARED, forced recall, & warning recall predicting false recall test 2. ***p* < .01

Predictors	***R*²**	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.36**						
SCAARED		-0.03	0.07	-0.45	.65	-0.17	0.11
Forced		0.24**	0.04	6.27	< .01	0.17	0.32
Warning		-0.05	0.04	-1.21	.23	-0.12	0.03
SCAARED*Forced		0.06	0.11	0.54	.59	-0.16	0.28
SCAARED*Warning		0.00	0.09	0.04	.97	-0.18	0.19

Geriatric Anxiety Scale

Separate regressions were run on Correct and False Recall at Test 1 and 2, as well as Correct and False Recognition, with GAS and retrieval demand condition as predictors. The regressions on Correct Recall at Test 1 and 2, and False Recall at Test 2, revealed that the overall models including GAS were significant (all *F*'s > 8.04, all *p*'s < .01), however, in each model, there was not a significant effect of GAS (all *t*'s < 1.78, all *p*'s > .07). See Tables 25, 26, & 27 for summary of full models. Using regression, these Experiment 2 results conceptually replicate the correlational findings of Experiment 1.

Table 25. Summary of final model for regression analyses with GAS, forced recall, & warning recall predicting correct recall test 1. **$p < .01$

Predictors	***R*²**	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.57**						
GAS		-0.02	0.02	-0.93	.35	-0.07	0.03
Forced		0.24**	0.02	10.64	< .01	0.19	0.28
Warning		0.00	0.02	0.23	.82	-0.04	0.05
GAS*Forced		0.04	0.04	1.10	.27	-0.03	0.12
GAS*Warning		0.07	0.04	1.77	.08	-0.01	0.15

Table 26. Summary of final model for regression analyses with GAS, forced recall, & warning recall predicting correct recall test 2. **$p < .01$

Predictors	***R*²**	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.26**						
GAS		-0.03	0.03	-1.11	.27	-0.09	0.02
Forced		0.14**	0.02	5.65	< .01	0.09	0.19
Warning		0.02	0.02	0.95	.35	-0.03	0.07
GAS*Forced		0.05	0.04	1.17	.24	-0.04	0.14
GAS*Warning		0.07	0.05	1.47	.14	-0.02	0.16

Table 27. Summary of final model for regression analyses with GAS, forced recall, & warning recall predicting false recall test 2. **$p < .01$

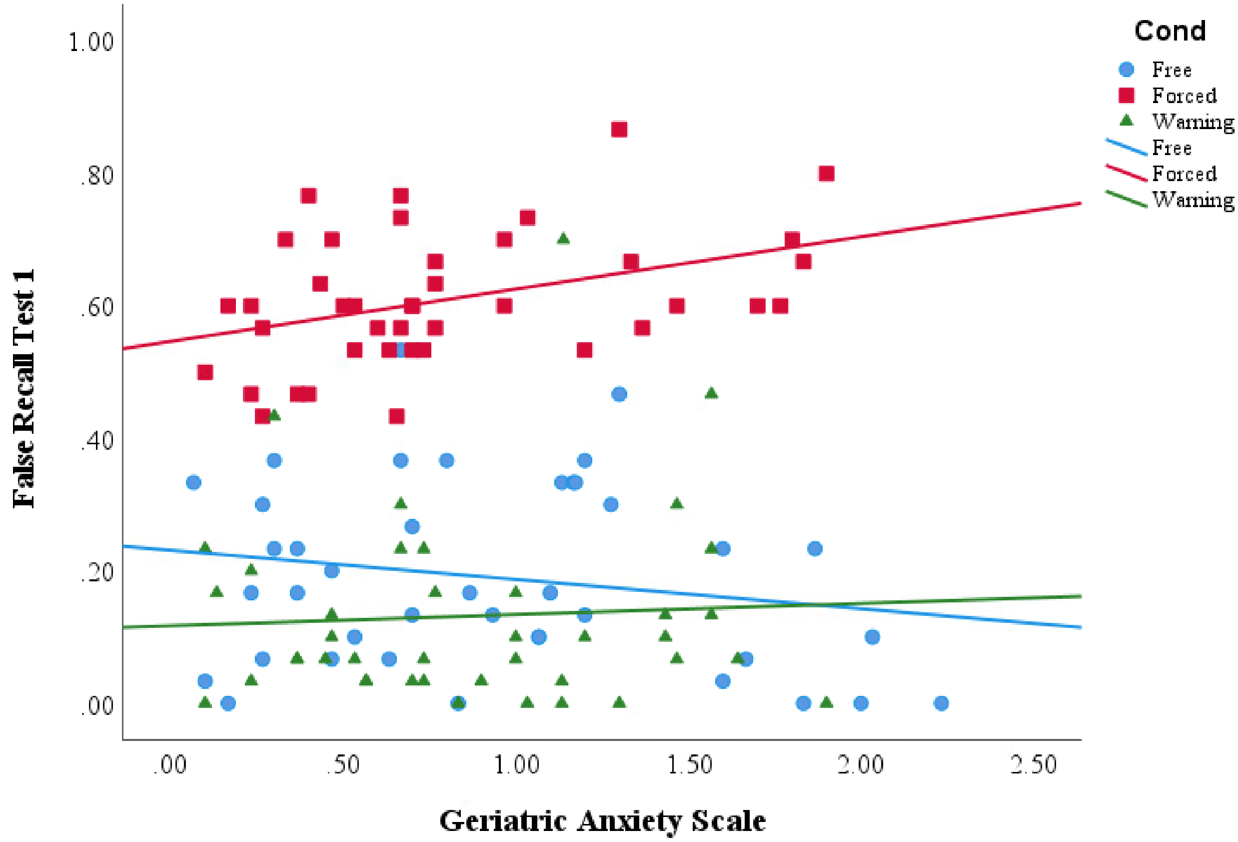
Predictors	***R*²**	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.37**						
GAS		-0.02	0.04	-0.46	.64	-0.11	0.07
Forced		0.24**	0.04	6.42	< .01	0.17	0.32
Warning		-0.05	0.04	-1.19	.24	-0.12	0.03
GAS*Forced		0.03	0.07	0.49	.62	-0.10	0.17
GAS*Warning		-0.01	0.07	-0.17	.86	-0.15	0.13

The overall model on False Recall at Test 1 and GAS was significant ($F(5, 116) = 68.18$, $MSE = .02$, $p < .01$). Further, the forced x GAS interaction was significant (B = .12, $t = 2.30$, $p = .02$), however, a probe of the interaction revealed no significant effects. See Table 28 for summary of full model and Figure 4 for plot of the interaction.

Table 28. Summary of final model for regression analyses with GAS, forced recall, & warning recall predicting false recall test 1. ** $p < .01$, * $p < .05$

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.75**						
GAS		-0.04	0.04	-1.26	.21	-0.11	0.03
Forced		0.42**	0.03	14.64	< .01	0.36	0.48
Warning		-0.06*	0.03	-2.13	.04	-0.12	0.00
GAS*Forced		0.12*	0.05	2.30	.02	0.02	0.23
GAS*Warning		0.06	0.05	1.12	.27	-0.05	0.17

Figure 4. Scatterplot representing the interaction between GAS and retrieval demand condition on false recall at test 1.



The regressions on Correct and False Recognition revealed that the models including GAS were not significant (all F's < 1.01, all p's > .41). Taken together, these findings conceptually replicate the results of Experiment 1, showing that trait anxiety, as measured by the

GAS, was not related to correct or false recall or recognition for younger adults. Thus, these results suggest that trait anxiety was not related to memory performance.

Meta-Memory in Adulthood Scale

Separate regressions were run on Correct and False Recall at Test 1 and 2, as well as Correct and False Recognition, with MIA and retrieval demand condition as predictors. The regressions on Correct Recall at Test 2, and False Recall at Test 1 and 2, revealed that the overall models including MIA were significant (all *F*'s > 7.89, all *p*'s < .01), however, in each model, there was not a significant effect of MIA (all *t*'s < 1.24, all *p*'s > .21). See Tables 29, 30, & 31 for summary of full models. Using regression, these Experiment 2 results conceptually replicate the correlational findings of Experiment 1.

Table 29. Summary of final model for regression analyses with MIA, forced recall, & warning recall predicting false recall test 1. ***p* < .01, **p* < .05

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.73**						
MIA		-0.01	0.03	-0.35	.73	-0.07	0.05
Forced		0.42**	0.03	14.25	< .01	0.36	0.47
Warning		-0.06*	0.03	-2.07	.04	-0.12	0.00
MIA*Forced		0.02	0.04	0.46	.64	-0.06	0.10
MIA*Warning		0.03	0.04	0.81	.42	-0.04	0.10

Table 30. Summary of final model for regression analyses with MIA, forced recall, & warning recall predicting correct recall test 2. ***p* < .01

Predictors	R^2	**B**	**SE**	***t***	***p***	**Lower CI**	**Upper CI**
Full Model	.25**						
MIA		-0.01	0.02	-0.56	.57	-0.06	0.03
Forced		0.14**	0.02	5.67	< .01	0.09	0.19
Warning		0.03	0.02	1.09	.28	-0.02	0.08
MIA*Forced		0.03	0.04	0.71	.48	-0.05	0.10
MIA*Warning		0.04	0.03	1.23	.22	-0.02	0.10

Table 31. Summary of final model for regression analyses with MIA, forced recall, & warning recall predicting false recall test 2. **$p < .01$

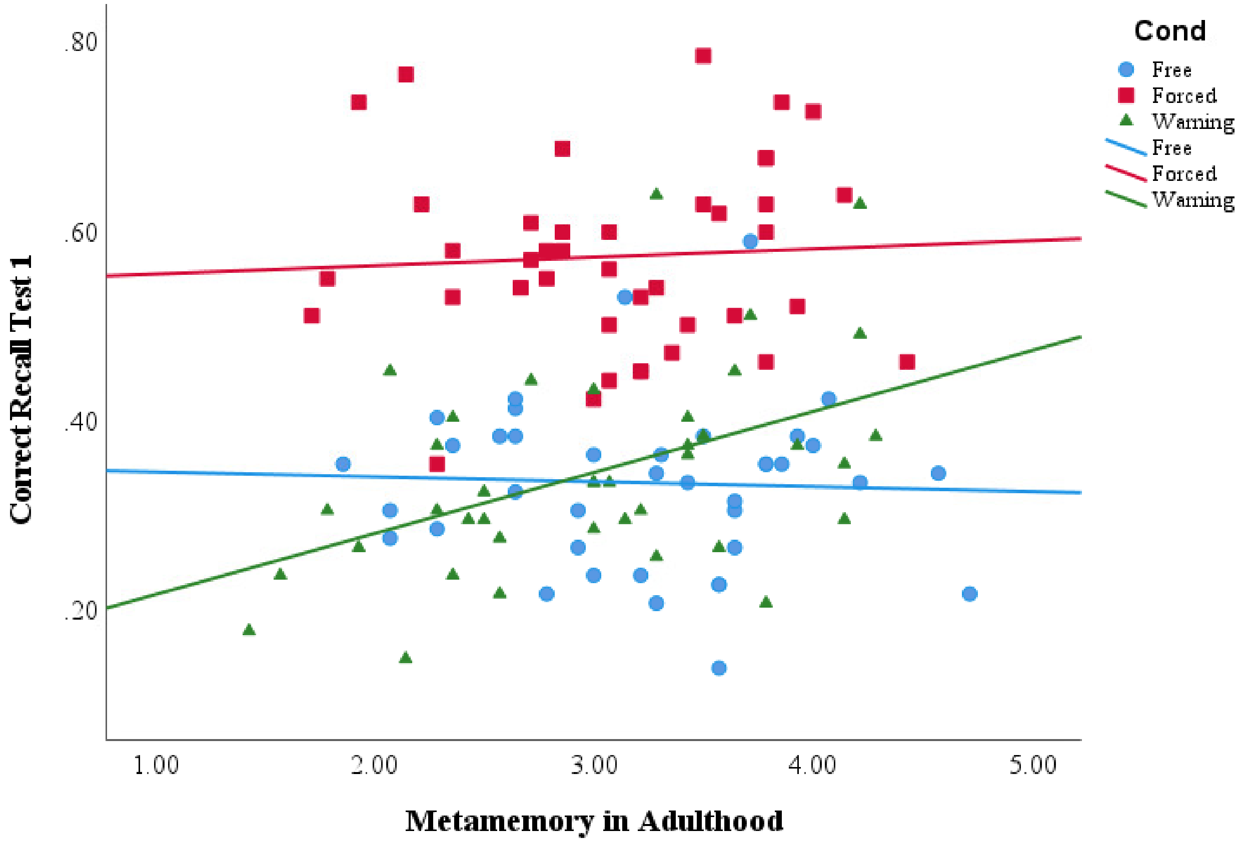
Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.38**						
MIA		-0.01	0.04	-0.26	.80	-0.08	0.06
Forced		0.25**	0.04	6.50	< .01	0.17	0.32
Warning		-0.04	0.04	-1.14	.26	-0.12	0.03
MIA*Forced		-0.04	0.05	-0.75	.46	-0.15	0.07
MIA*Warning		0.02	0.05	0.32	.75	-0.08	0.11

The overall model on Correct Recall at Test 1 and MIA was significant ($F(5, 114) = 34.68$, $MSE = .01$, $p < .01$). See Table 32 for summary of full model. Further, the warning x MIA interaction was significant (B = .07, $t = 2.33$, $p = .02$). See Figure 5. A probe of the warning x MIA interaction revealed a significant effect, such that heightened levels of memory-specific anxiety, as measured by the MIA, were related to greater correct recall at Test 1, but only for those who recalled in the warning recall condition (B = .07, $SE = 0.02$, $t = 3.23$, $p = .002$, CI = [0.025, 0.104]). This pattern of results supports my Experiment 2 hypotheses because I predicted that the high situational pressures of the warning retrieval demand instructions would create a condition in which I could observe a relationship between anxiety and memory. This result suggests that retrieval condition does moderate the relationship between memory-specific anxiety and Correct Recall at Test 1.

Table 32. Summary of final model for regression analyses with MIA, forced recall, & warning recall predicting correct recall test 1. **$p < .01$, *$p < .05$

Predictors	R^2	B	SE	*t*	*p*	Lower CI	Upper CI
Full Model	.60**						
MIA		-0.01	0.02	-0.23	.82	-0.05	0.04
Forced		0.24**	0.02	11.18	< .01	0.20	0.28
Warning		0.02	0.02	0.82	.42	-0.03	0.06
MIA*Forced		0.01	0.03	0.44	.66	-0.05	0.08
MIA*Warning		0.07*	0.03	2.33	.02	0.01	0.13

Figure 5. Scatterplot representing the interaction between MIA and retrieval demand condition on correct recall at test 1.



The regressions on Correct and False Recognition revealed that the models including MIA were not significant (all *F*'s < .77, all *p*'s > .57). The recognition results of Experiment 2 partially replicate Experiment 1. In both experiments, there was no relationship between memory-specific anxiety, as measured by the MIA, and false recognition. However, in Experiment 1, memory-specific anxiety was related to correct recognition, such that higher memory-specific anxiety was related to lower correct recognition, but only for those who previously recalled under free retrieval demand instructions. In Experiment 2, memory-specific anxiety was unrelated to correct recognition. Thus, even with the addition of the warning retrieval demand condition, memory-specific anxiety was not related to correct recognition for the prior free, forced, or warning conditions. It is possible that differences in statistical analysis between Experiment 1 and 2 explain the lack of replication. To explore this possibility, I examined the correlations between correct recognition and memory-specific anxiety and found that there were no significant correlations between correct recognition and memory-specific anxiety collapsed across condition, or separated by condition (all r's < .178, all p's > .268). Taken together, the Experiment 2 results involving memory-specific anxiety, as measured by the MIA, partially replicate Experiment 1. Both experiments provided evidence that memory-specific anxiety was not related to correct recall at test 2, false recall at test 1 and 2, or false recognition. In Experiment 1, memory-specific anxiety was negatively related to correct recognition, however, this relationship was not present in Experiment 2. With the addition of the warning condition in Experiment 2, memory-specific anxiety was positively related to correct recall at test 1.

Experiment 2 Discussion

The results of Experiment 2 suggest that retrieval demands, hypervigilance, and different types of anxiety have significant influences on the relationship between anxiety and memory. Results from Experiment 2 show that hypervigilance is negatively related to memory performance for younger adults and memory-specific anxiety is positively related to memory performance. Further, these relationships depend upon retrieval demand condition. Elevated levels of hypervigilance were related to lower levels of correct recognition, but only for participants who previously recalled under free retrieval demand instructions. Elevated levels of memory-specific anxiety were related to greater correct recall at test 1, but only for those who recalled under the warning retrieval demand instructions. State anxiety and trait anxiety were not related to memory performance, regardless of retrieval demand condition. Taken together, the type of anxiety and retrieval demand condition are important in determining whether anxiety has a beneficial or harmful relationship with memory in younger adults.

DISCUSSION AND CONCLUSION

Discussion

The present dissertation was designed to examine the extent to which situational pressures can trigger anxiety and hypervigilance outside the confines of specifically threatening stimuli, and how this activation, in turn, influences the memory performance of younger and older adults. Because there were not significant differences in levels of perceived threat, hypervigilance, and state anxiety among the free, forced, and warning retrieval demand conditions in Experiment 2, it is not possible to definitively conclude that the retrieval demand conditions *triggered* anxiety. However, across two studies, there is clear evidence that the differing situational pressures of the retrieval demand conditions create conditions in which it is possible to capture the association between anxiety and memory in younger and older adults. The results also suggest that the relationship between anxiety and memory performance depends on the type of anxiety being measured. Specifically, results from Experiment 1 showed that the forced retrieval demands condition created a suitable situation to observe a relationship between anxiety and memory in older adults. For older adults, under forced retrieval demand instructions, higher levels of trait anxiety were related to higher levels of correct recall and lower levels of false recognition. However, under free retrieval demand instructions, older adults' memory performance was not associated with trait anxiety or memory-specific anxiety. The results demonstrate that higher levels of trait anxiety are related to heightened memory performance for older adults, but only when the situational pressures are sufficiently demanding, such as in the forced retrieval demands condition.

Further, results showed that the different situational pressures of the retrieval demand instructions created suitable conditions to observe a relationship between anxiety and memory in younger adult, albeit in a different pattern than older adults. The forced retrieval demands condition was not threatening enough to trigger an anxious response in younger adults. However, the warning and free retrieval demand conditions established situational pressures that made it possible to examine how anxiety is associated with memory. In Experiment 2, the warning retrieval demand condition showed that higher levels of memory-specific anxiety were associated with higher levels of correct recall at test 1. Importantly, for younger adults, the relationship between anxiety and memory also varied under free retrieval demand conditions. In Experiment 1, the free retrieval demand condition showed that higher levels of memory-specific anxiety were related to lower levels of correct recognition. In Experiment 2, the free retrieval demand condition showed that higher levels of hypervigilance were related to lower levels of correct recognition. This pattern of results highlights the importance of the free retrieval demand instructions influencing subsequent recognition performance. Again, because levels of memory-specific anxiety and hypervigilance did not differ among retrieval demand conditions, it is not possible to conclude that the retrieval demand conditions *triggered* anxiety, however, it is possible to conclude that the retrieval demand conditions influence the way in which the anxiety/memory relationship can be observed. Taken together, results suggest that it is important to consider the type of anxiety, type of retrieval demands, and type of memory task when examining the influence anxiety on memory.

The pattern of results supports my predictions when examining the influence of retrieval demand conditions on memory performance of older adults. I predicted that higher levels of anxiety would relate to better source monitoring, as evidenced by higher levels of correct recall and recognition as well as lower levels of false recall and recognition. Importantly, I expected to find this positive association between anxiety and memory performance only when anxiety is triggered by situational pressures. Specifically, I predicted that forced retrieval demands would be more threatening than free retrieval demands and thus trigger anxiety to a greater extent, leading to stronger relationships between anxiety and memory for those in the forced recall condition. Additionally, I predicted that older adults would be more threatened by forced recall than younger adults, and that older adults would especially benefit from higher levels of anxiety because this would increase hypervigilance towards the memory task, improving the source monitoring abilities that are generally lower for older adults (cf. McIntrye & Craik, 1987). This prediction was generally supported by correlational findings such that higher levels of trait anxiety were related to higher levels of correct recall, and lower levels of false recognition, but only for older adults who recalled under forced retrieval instructions at test 1. The negative correlation between trait anxiety and false recognition suggests that older adults with increased levels of trait anxiety were able to use their source monitoring abilities to correctly indicate that the critical lures present on the recognition test were not present on the word lists. Finding stronger correlations between anxiety and memory in forced recall for older adults supported my model in showing that situational pressures (not just emotional stimuli) can create a condition in which to observe the relationship between anxiety and memory, and in turn, provide correlational evidence that increased levels of anxiety can be associated with an increase in source monitoring abilities and memory performance.

For younger adults, I also predicted that increased levels of hypervigilance and state, trait, and memory-specific anxiety would be related to increased correct recall and recognition, and decreased false recall and recognition, but only when the situation was threatening enough, such as in the warning retrieval demand condition. Broadly speaking my results show that differing situational pressures can lead to different associations between anxiety and memory in young adults. The situational pressure of the warning condition in Experiment 2 created a condition in which higher levels of memory-specific anxiety were related to higher levels of correct recall at test 1. The situational pressure of the free condition created a condition in which higher levels of memory-specific anxiety (Exp. 1) and hypervigilance (Exp. 2) were related to lower levels of correct recognition. Although I did find broadly that situational pressures influence the relationship between anxiety and memory, there were a lot of nuances to this finding, even though my predictions were the same for each type of anxiety. Across two experiments, the pattern of results depends on the type of anxiety being examined and retrieval condition, and subsequently, provides mixed support for my hypotheses.

Memory-specific anxiety was consistently related to memory, albeit not always in the predicted direction. When taking a closer look at the relationship between memory-specific anxiety across experiments, the results are both consistent and inconsistent with my hypotheses, depending on retrieval demand condition. For example, when examining memory-specific anxiety in Experiment 1, I found a significant relationship for younger adults who previously recalled under free retrieval demand instructions such that the more memory-specific anxiety they had, the lower their correct recognition, and this finding goes against my overarching predictions that higher levels of anxiety will correspond to better memory performance. This suggests that being able to set one's own recall criterion in the free recall condition was not beneficial for younger adults with heightened levels of memory-specific anxiety when taking a subsequent source monitoring test. Importantly, for participants who recalled in the free condition at test 1, the relationship between memory-specific anxiety and memory varies across memory tests. The source recognition test cues participants into not only the previously presented items, but it also introduces new items and requires participants to think about the oldness/newness (i.e., the source) of each item. In contrast, in the free recall test, one can use their preferred retrieval and monitoring strategies and only needs to think about items that were previously presented. Those higher in memory-specific anxiety are more anxious about their memories, so when the recognition task requires them to think about the source, it is possible that the extra task information leads individuals with higher levels of memory-specific anxiety to become more cautious in their response criterion than they previously were under free retrieval demands in recall test 1. That being said, this negative relationship between memory-specific anxiety and correct recognition for those who recalled under free instructions was not present in Experiment 2. There are a couple of potential reasons this pattern of results changed between experiments. First, the sample size in Experiment 1 was small (n = 16). It is possible that this was a spurious correlation due to a small sample size coupled with running multiple correlations. Second, Experiment 1 was conducted pre-COVID-19 pandemic, and Experiment 2 was collected during the COVID-19 pandemic. It is possible that the participant's experiences during the pandemic altered their perceptions and perceived importance of memory-specific anxiety and their memory in general.

Importantly, an examination of memory-specific anxiety in the warning condition reveals that the results do align with my hypotheses. In Experiment 2, I found that higher levels of memory-specific anxiety were related to higher levels of correct recall at test 1 for those who recalled in the warning condition. It is possible that younger adults with higher levels of memory-specific anxiety were especially sensitive to the strict warning against guessing, because that strict warning was explicitly related to the source of their anxiety, namely, their memory. This increased sensitivity may have led to an improvement in source monitoring abilities, and in turn, higher levels of correct recall at test 1. One explanation for why memory-specific anxiety was not related to memory performance on recall test 2 or the recognition test is that the activation of memory-specific anxiety in the warning condition may be time sensitive. It is possible that the warning condition activated memory-specific anxiety during the memory test in which participants received the harsh instructions, but this activation may have dissipated at recall test 2 and the recognition test because the instructions no longer included a harsh warning. Bensadon (2010) found differences in levels of memory-specific anxiety, as measured by the MIA, when memory-specific anxiety was measured before the memory test compared to after completing the memory test. This suggests that levels of memory-specific anxiety can be affected by memory tests and differ between timepoints, and further suggests that the timing of the questionnaire phase in relation to the retrieval demand manipulation is important.

Turning next to hypervigilance, I predicted that the warning condition would trigger hypervigilance and lead to better recall and recognition. Instead, I found that under free recall instructions, higher levels of hypervigilance were related to lower levels of correct recognition. Because the warning retrieval demands condition instructed participants to pay special attention to the items they wrote down, it is possible that this condition did not allow levels of hypervigilance to vary enough to see differences in the relation to memory. It is possible that there was too much shared variance between the warning recall instructions and hypervigilance for the influence of hypervigilance on memory to appear. Additionally, when an individual is hypervigilant, they are excessively attentive and alert to possible dangers and difficulties in their environment. It is possible that participants considered avoiding errors a greater difficulty than approaching the correct answers, and therefore, paid more attention to avoiding errors than achieving maximum correctness. Thus, it is possible that higher levels of hypervigilance were related to lower, instead of higher, levels of correct recognition because the focus of their hypervigilance was not on achieving the most correct answers, but upon avoiding the most incorrect answers. In line with this idea, past research has found that participants with higher levels of anxiety score higher on trait avoidance tendencies compared to individuals with lower levels of anxiety (Struijs et al., 2017).

Although this finding is in contrast with my hypotheses, it does suggest that in some situations, hypervigilance is important for memory performance. Further, this finding conceptually aligns with the memory-specific anxiety results in Experiment 1 in highlighting the role of anxiety on recognition performance following free recall. Under free recall conditions, memory-specific anxiety and hypervigilance are important for correct recognition. It is possible that the relationship between hypervigilance and correct recognition, and memory-specific anxiety and correct recognition, was present for those in the prior free retrieval demand condition because that is the only condition where participants have full autonomy over their recall criterion at test 1. Under free retrieval demand instructions, participants can use their preferred retrieval and monitoring strategies to determine which items to include and which items to exclude, without any influence of outside information other than the category name. When participants were presented with a recognition test following free recall, they could rely on their preferred retrieval and monitoring strategies to complete the recognition test. However, the recognition test cues participants to think about the memory items in a different manner by requiring participants to consider the origin of the recalled item as well as introducing new items. It is possible that when one is hypervigilant and anxious about their memory, the task demands of the source monitoring test leads these individuals to be more conservative in their answers, leading to lower levels of correct recognition. However, this option to be more conservative on the recognition test compared to their own preferred retrieval and monitoring that was used in test 1 is only possible in the free retrieval demands condition. In the forced and warning conditions, individuals are not able to use their preferred retrieval and monitoring strategies because the retrieval demands are manipulated such that participants are required to respond according to experimenter determined criteria. Thus, for those in the forced and warning conditions, those higher in hypervigilance and memory-specific anxiety were not able to be more conservative on the recognition test because they were not able to use their own criterion, and subsequently, their monitoring was thrown off by the experimenter determined criteria from recall 1 (cf., Meade et al., 2012).

Regarding trait anxiety, results show that younger adults have higher levels of trait anxiety than older adults and, contrary to predictions, trait anxiety was consistently unrelated to memory performance in younger adults. It is possible that trait anxiety is unrelated to memory for younger adults because this trait anxiety is always activated to a certain extent and thus, younger adults have learned to adapt to this level of anxiety. Similarly, it is possible that the retrieval demands on the recall and recognition tasks were not threatening enough to activate levels of trait anxiety because college students are exposed to testing situations throughout the entire semester. Thus, to activate this anxiety over and above their already elevated levels, a greater amount of threat may need to be present in the situation for their trait anxiety to have a meaningful influence on memory. This effect may have been exacerbated in Experiment 2 due to the COVID-19 pandemic. It is possible that being in a global pandemic due to COVID-19 was already exerting such a strong force on the trait anxiety of younger adults that a simple memory test was not enough to activate their trait anxiety over and above the level of anxiety younger adults were currently experiencing. However, it is also possible that my experiment did not capture the relationship between trait anxiety and memory for younger adults because this relationship does not exist.

Finally, contrary to predictions, state anxiety was not related to recall or recognition memory for younger adults. There are several possible reasons this relationship was not captured. First, the younger adults in these experiments were college students. It is possible that state anxiety was unrelated to memory because, as students, they are required to take exams on a regular basis. Thus, they are accustomed to testing situations, and therefore, their experienced levels of state anxiety do not influence how well they perform on the exams because they have been exposed to similar situations. Further, it is possible that these students were less state anxious than they would normally be during an exam, because they took the recall and recognition tests alone during the experiment, whereas in a college class, one also must deal with the social pressures of taking an exam in a large room full of people who may complete the exam at a much faster (or slower) pace. Additionally, it is possible that the way in which the questionnaires were administered did not allow me to fully capture the levels of state anxiety participants were feeling during the memory tests. After finishing the recognition test, participants filled out 3 questionnaires before they filled out the state anxiety questionnaire (e.g., Self-Assessment Manikin, threat questionnaire, challenge questionnaire). The preceding questionnaires only contained 5 questions total; however, it is possible that this was enough time for their state anxiety to dissipate. Considered together, the results with younger adults are broadly consistent with my predictions that situational pressures influence the relationship between anxiety and memory, but there is nuance regarding which situational pressures are related to which types of anxiety and memory.

Across two experiments, results are both consistent and inconsistent with previous literature. Regarding memory-specific anxiety, my results replicate Davidson et al. (1991), who found no differences in levels of memory-specific anxiety between younger and older adults. Further, past research shows that memory-specific anxiety was negatively related to memory for older adults and was unrelated to memory for younger adults (Davidson et al., 1991; Andreoletti et al., 2006). My findings are inconsistent with this literature. Across studies, I found that memory-specific anxiety was unrelated to memory performance for older adults and was positively related to correct recall and negatively related to correct recognition for younger adults, depending on type of retrieval demand instruction. There are several potential explanations for the differences between experiments. First, Davidson et al. (1991) and Andreoletti et al. (2006) used a free recall test, but not a recognition test. It is possible that this past research did not observe a relationship for younger adults between memory-specific anxiety and memory because they did not include a recognition test. Additionally, these studies only used the free retrieval demands condition, and not a forced or warning condition. Third, my study uses different operational definitions of what age range constitutes younger and older adults. For example, my age range for younger adults was 17-30 years old, Davidson et al.'s age range was 20-26 years old, and Andreoletti et al.'s age range was 21-39. My age range for older adults was 65-92 years old, Davidson et al.'s age range was 69-78 years old, and Andreoletti et al.'s age range was 60-83. Davidson et al. (1991) did not observe a significant relationship between memory-specific anxiety and recall in the 62–68 year old group, thus, it is possible that I did not replicate the memory-specific anxiety and older adult relationship Davidson et al. found because my older adult age range also included those participants 65-68 years old.

Regarding trait anxiety, past research has examined the influence of trait anxiety on the recall and recognition memory performance of younger adults and found that trait anxiety was not related to recognition performance (Pajkossy et al., 2017). My experiments replicate this finding. However, in 3 out of their 4 studies, higher levels of trait anxiety led to lower levels of recall memory performance. In my experiments, I did not find a relationship between trait anxiety and recall memory for younger adults. Pajkossy et al. (2017) separated the influence of trait anxiety and trait worry, whereas the present dissertation did not. It is possible that my experimental design created a suppressor situation such that the effects of trait anxiety and trait worry canceled out one another, thus making my results appear that trait anxiety was not related to recall performance for younger adults (Pajkossy et al., 2017). Turning to older adults, the results regarding trait anxiety are inconsistent with previous work. Yochim et al. (2013) found that affective symptoms of trait anxiety were negatively related to immediate verbal memory recall but were unrelated to free recall of information after a time delay. In contrast, my results show that higher levels of trait anxiety were related to higher levels of correct recall and lower levels of false recognition, for those who recalled under forced retrieval demand instructions at test 1. It is possible that I observed this beneficial relationship because the forced retrieval demand condition was sufficient to activate an anxious response in older adults. However, I cannot definitively conclude this based on the correlational results.

When examining state anxiety, Andreoletti et al. (2006) did not find a significant relationship between state anxiety and memory performance for any age group. In contrast, Davidson et al. (1991) found that state anxiety significantly predicted list recall such that higher state anxiety led to better recall. However, this relationship was only significant in the oldest age group (69-78). Kania & Krackow (2014) found that an induction of state anxiety in younger adults increased source monitoring abilities for items seen in the crime video. Unfortunately, I do not have data to examine the relationship between state anxiety and memory performance for older adults. However, for younger adults, state anxiety was not related to memory performance, so this replicates some past work (Andreoletti et al., 2006; Davidson et al., 1991) but does not replicate other work (Kania & Krackow, 2014). It is possible that differences emerged between the present dissertation and Kania & Krackow (2014) because the present dissertation used retrieval demand conditions to influence state anxiety, whereas Kania & Krackow explicitly manipulated state anxiety by requiring participants to read and listen to anxiety provoking statements. Overall, my work broadly replicates past work in that there are age differences in the relationship between different types of anxiety and memory.

Implications, Alternative Explanations, Limitations, and Future Directions

Implications

Results from two experiments show that age and different retrieval demands were enough of a situational pressure to reveal a relationship between anxiety and memory, outside the confines of specifically threatening stimuli. When thinking about the implications for my proposed model, it is important to consider which types of anxiety were related to memory for younger and older adults. For older adults, higher levels of trait anxiety were related to higher levels of correct recall and lower levels of false recognition in the forced retrieval demand condition. These results suggest that higher levels of situational pressures, and likely, threat appraisal, are important factors to consider when examining the activation of underlying levels of trait anxiety for older adults. This suggests that trait anxiety may be beneficial in helping older adults with their memory performance. Further, the older adult results show that the actual stimuli do not need to be threatening to observe a relationship between trait anxiety and memory in older adults.

Younger adults showed a different pattern. Higher levels of situational pressures were related hypervigilance and memory-specific anxiety, and the relationship between this anxiety and memory depends on the type of retrieval condition. This has several implications. First, the results suggest that hypervigilance and memory-specific anxiety are important factors that are related to memory in younger adults. Thus, theories designed to describe the relationship between anxiety and memory will benefit from updating their predictions from blanket "anxiety" terms to specific types of anxiety. Further, like the results from older adults, these results suggest that *stimuli* do not need to be threatening in nature to observe a relationship between memory and anxiety in younger adults. This finding may be especially important when applying these results to a school setting, where students are tested on their memories on a regular basis. The content of the exams does not need to be threatening for the overall memory test to activate memory-specific anxiety. Also important is that across two studies, forcing young adults to write down a specific number of responses was not threatening, perhaps because the control was taken away from the participants, therefore putting less responsibility on participants. Future research may benefit from designing situational pressures that place the responsibility directly on the younger adults, like the retrieval demands of the free and warning conditions. Following this line of thinking, future research may also benefit from examining how one's dispositional need for control influences the relationship among retrieval demands, anxiety, and memory.

Further, it is possible that the threshold for the activation of different types of anxiety is different for younger and older adults. For example, it is possible that memory-specific anxiety was not related to memory performance for older adults because the threat needs to be greater to activate the memory-specific anxiety, compared to the level of threat needed to activate trait anxiety. Additionally, it is possible that trait and state anxiety were not related to memory performance for younger adults because the perceived threat needs to be greater to activate state and trait anxiety, compared to the level of threat needed to activate hypervigilance and memory-specific anxiety. If older and younger adults do have different thresholds for threat activation, existing theories should be updated to better reflect these nuances. For example, in the second phase of the Information Processing Model of Anxiety (Beck & Clark, 1997), danger schemas are activated. These danger schemas are cognitive representations of threat, based on past experiences. It may be beneficial for this theory to be more specific about which past experiences lead to which types of anxiety being activated. This would lead to more specific predictions about which situations have higher or lower threat activation for younger and older adults.

An additional explanation for differences in how anxiety was related to memory performance between younger and older adults is source monitoring abilities. Because source monitoring is the proposed mechanism that connects anxiety to memory in my model, it is possible that older adults saw a greater benefit from anxiety than younger adults because older adults have greater source monitoring difficulties compared to younger adults, therefore, have greater room for improvement. To improve the hypotheses derived from my model, future research may benefit from making more specific predictions about *which* situational pressures will activate *which* types anxiety. Again, this specificity has important implications for theory. Coles & Heimberg (2002) concluded that different anxiety disorders show different patterns of memory bias. My findings conceptually replicate this finding by showing that different types of non-disordered anxiety are differentially related to memory for non-threatening stimuli. Further, in line with the meta-analysis conducted by Mitte (2008), I found that experimental procedures (e.g., type of retrieval demand and memory task) and participant characteristics (e.g., age) are important when examining the relationship between anxiety and memory. Future theories designed to explain the relationship between anxiety and memory must acknowledge that this relationship depends on a wide variety of factors and include these factors in the theoretical predictions.

Alternative Explanations

The primary goal of this dissertation was to examine the influence of anxiety and hypervigilance on memory. A secondary goal was to examine alternative factors that may be related to the recall and recognition memory performance of younger and older adults. To achieve this goal, in Experiment 1, I included measures of depression, loneliness, and health. In Experiment 2, I included the previously mentioned measures as well as measures of positive and negative affect, threat, challenge, effort, and arousal. Across experiments, there was no consistent pattern of relation between the alternative factors and recall or recognition memory performance. Specifically, for older adults, higher levels of depression were related to higher levels of correct recall at Test 1. For younger adults, recall and recognition memory were not related to depression, loneliness, arousal, threat, negative affect, or effort. Higher levels of happiness on the SAM valence questionnaire were significantly correlated with lower levels of false recognition, and higher levels of dominance on the SAM dominance questionnaire were significantly correlated with higher levels of correct recall at Test 2. Further, higher levels of challenge on the locally developed challenge questionnaire significantly correlated with higher levels of false recall at Test 1. Higher levels of health were significantly correlated with higher levels of correct recognition. Although there are several significant correlations between the exploratory measures and memory, there is a lack of pattern, such that each of the exploratory measures are only related to one out of the six memory dependent variables. Further, there are no duplicate effects in regard to which dependent variable is showing the significant effects. Although the present dissertation ruled out a handful of alternative explanations, future research may benefit from examining the Self-Assessment Manikin, depression, health, and challenge scales in greater detail.

Limitations

There were several limitations to these studies that must be addressed. First, my experiments were likely underpowered. Experiment 1 was run as a pilot study to test the feasibility of my manipulations; thus, the sample size was small. Second, as previously mentioned, although I ran an a priori power analysis before collecting data for Experiment 2, this power analysis did not adequately capture the interaction terms that I ended up using in my regression analyses, thus, Experiment 2 was likely underpowered as well. In fact, according to G*Power 3.1, to test for a two-tailed point biserial model correlation with an effect size of .1, one needs 779 participants to achieve .80 Power using an alpha of .05. Further, because of the nature of my experimental question and my number of dependent variables, it was necessary to run many regressions in Experiment 2. I controlled for this large number of regressions by making very specific predictions about where I thought the experimental results would be significant. I specified that hypervigilance and state anxiety were involved in my primary hypotheses and trait anxiety and memory-specific anxiety were my secondary hypotheses. Additionally, I was very specific in that I predicted differences to emerge in the warning x BHS interactions and the warning x STICSA interactions. Another limitation is that the younger adult sample was enrolled in college. It is possible that there are differences in level of anxiety triggered by a memory test for younger adults who are in college versus younger adults who are not enrolled in college. Lastly, Experiment 1 data was collected prior to the onset of the COVID-19 pandemic and Experiment 2 data was collected during the COVID-19 pandemic (September-December 2020). This results in a couple of limitations. First, due to COVID-19 restrictions, I was not allowed to collect older adult data for Experiment 2. Thus, I was not able to determine the influence of hypervigilance, state anxiety, or the warning condition on the memory performance of older adults. Second, it is possible that underlying levels of anxiety for younger adults were different between experiments and subsequently influenced the results. For example, participants rated themselves as numerically more anxious at Experiment 2 in both measures of trait anxiety (e.g., SCAARED: Exp. 1: $M = .63$ vs. Exp. 2: $M = .86$; GAS: Exp. 1: $M = .69$ vs. Exp. 2: $M = .88$).

Future Directions

To address the limitations of the reported experiments, future research should start by including older adults in the design that was used in Experiment 2. It is important to further determine which types of anxiety and which retrieval demand conditions are most important when examining the relationship between anxiety and memory for older adults. Additionally, it is important to examine the facilitating effect of anxiety for older adults when the situational pressures are high (e.g., in the forced and warning retrieval demand conditions). Further, past research shows that older adults have higher levels of hypervigilance compared to younger adults (Bernstein et al., 2015; Kimble et al., 2013). It is important to determine if these elevated baseline levels of hypervigilance result in a different relationship between hypervigilance and memory when comparing older adults to younger adults. Next, it will be important for future research to collect a large enough sample to adequately power the statistical analyses necessary to test the experimental questions. Future research may also want to consider how being enrolled in college influences the extent to which memory tests trigger an anxious response. It will likely be important to conduct this research in younger adults that are not enrolled in college and compare their performance to not only older adults, but middle-aged adults as well. Additionally, because state anxiety was unaffected by the retrieval demand conditions used in this study, future research may wish to manipulate state anxiety in the laboratory using a different method (such as counting backwards by 17 starting at 500). This would allow for the stimuli used in the study to remain neutral, while still examining the influence of situational pressures on memory, outside the confines of specifically threatening stimuli.

Conclusion

Past research on memory and anxiety has focused on the negativity memory bias, namely, differences in memory for neutral stimuli compared to emotional/threatening stimuli. My results show that it is important to expand the lens through which we assess the relationship between anxiety and memory. Across two experiments, results show that it is possible for situational pressures, such as retrieval demand conditions and age, to influence the relationship between anxiety and memory in the absence of specifically threatening stimuli. Younger and older adults differ in the extent to which anxiety is positively or negatively related to memory performance. Additionally, the relationship between anxiety and memory depends on the type of anxiety being measured, as well as the retrieval demands of the task. Future research should continue to examine the influence that situational pressures, age differences, and different types of anxiety have on memory performance.

REFERENCES CITED

Aitken, B. M., Champion, J. C., & Stainer, M. J. (2019). Anxious individuals predict the onset of aggression earlier in a CCTV surveillance task. *Journal of Experimental Psychology: Applied, 25*(3), 343-353.

Andreoletti, C., Veratti, B. W., Lachman, M. E. (2006). Age differences int he relationship between anxiety and recall. *Aging & Mental Health, 10*(3), 265-271.

Angulo, M., Rooks, B. T., Gill, M., Goldstein, T., Sakolsky, D., Goldstein, B., Monk, K., Hickey, M. B., Diler, R. S., Hafeman, D., Merranko, J., Axelson, D., & Birmaher, B. (2017). Psychometrics of the screen for adults related anxiety disorders (SCAARED)-A new scale for the assessment of DSM-5 anxiety disorders. *Psychiatry Research, 253,* 84-90.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1-24.

Battig, W. F., & Montague, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monograph, 80,* 1-45.

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour Research and Therapy, 35,* 49-58.

Beck, A. T., Emery, G., & Greenberg, R. (1985). The cognitive model of threat reactions. In A. T. Beck, G. Emery, & R. Greenberg (Eds.), *Anxiety Disorders and Phobias: A Cognitive Perspective.* (pp. 37-53). Cambridge, MA: Basic Books.

Bensadon, B. A. (2010). Memory self-efficacy and stereotype effects in aging. *University of Florida, ProQuest Dissertations Publishing.*

Bernstein, R. E., Delker, B. C., Knight, J. A., & Freyd, J. J. (2015). Hypervigilance in college students: Associations with betrayal and dissociation and psychometric properties in a brief hypervigilance scale. *Psychological Trauma: Theory, Research, Practice & Policy, 7*(5), 448-455.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36,* 129-148.

Bynion, T. M. & Feldner, M. T. (2017). Self-assessment manikin. *Encyclopedia of Personality and Individual Differences.* https://doi.org/10.1007/978-3-319-24612-3_77

Coles, M. E., & Heimberg, R. G. (2002). Memory biases in the anxiety disorders: Current status. *Clinical Psychology Review, 22,* 587-627.

Davidson, H. A., Dixon, R. A., & Hultsch, D. F. (1991). Memory anxiety and memory performance in adulthood. *Applied Cognitive Psychology, 5*, 423-434.

Dixon, R. A., de Frias, C. M., & Maitland, S. B. (2001). Memory in midlife. In M. E. Lachman (Ed.), Handbook of midlife development (pp. 248–278). New York: John Wiley.

Dixon, R. A. & Hultsch, D. F. (1983). Metamemory and memory for text relationships in adulthood: A cross-validation study. *Journal of Gerontology, 38*(6), 689-694.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*(2), 336-353.

Erdelyi, M. H., & Becker, J. (1974). Hypermnesia for pictures: Incremental memory for pictures but not words in multiple recall trials. *Cognitive Psychology, 6,* 159-171.

Erdelyi, M. H., Finks, J., & Feigin-Pfau, M. B. (1989). The effect of response bias on recall performance, with some observations on processing bias. *Journal of Experimental Psychology: General, 118,* 245-254.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). SAGE.

Folstein, M. F., Folstein, S. F., & 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.

Hadwin, J. A., Brogan, J., & Stevenson, J. (2005). State anxiety and working memory in children: A test of processing efficiency theory. *Educational Psychology, 25*(4), 379-393.

Hedberg, A. G. (1972). Review of the state-trait anxiety inventory. *Professional Psychology, 3*(4), 389-390.

Huff, M. J., Meade, M. L., & Hutchison, K. A. (2011). Age-related differences in guessing on free and forced recall tests. *Memory, 19*(4), 317-330.

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Res Aging, 26*(6), 655-672.

Hummert, M. L., Garstka, T. A., Shaner, J. L., Strahm, S. (1994). Stereotypes of the elderly held by young, middle-aged, and elderly adults. *Journals of Gerontology, 49,* 240-249.

Grös, D. F., Antony, M. M., Simms, L. J., & McCabe, R. E. (2007). Psychometric properties of the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA): Comparison to the state-trait anxiety inventory (STAI). *Psychological Assessment, 19,* 369–381. http://dx.doi.org/ 10.1037/1040-3590.19.4.369

Johnson, M. K., Foley, M. A., & Leach, K. (1988). The consequences for memory of imagining in another person's voice. Memory & Cognition, 16, 337-342.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114,* 3-28.

Kania, K., & Krackow, E. (2014). The impact of state and trait anxiety on performance in an eyewitness source monitoring task. *Imagination, Cognition, & Personality, 33*(3), 311-327.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. *Arch Gen Psychiatry, 62,* 593-602.

Kimble, M., Boxwala, M., Bean, W., Maletsky, K., Halper, J., Spollen, K., & Fleming, K. (2014). The impact of hypervigilance: Evidence for a forward feedback loop. *Journal of Anxiety Disorders, 28*(2), 241-245.

Kimble, M. O., Fleming, K., & Bennion, K. A. (2013). Contributors to hypervigilance in a military and civilian sample. *Journal of Interpersonal Violence, 28*(8), 1671-1692.

McIntyre, J. S., & Craik, F. I. M. (1987). Age differences in memory for item and source information. *Canadian Journal of Psychology, 41*(2), 175-192.

Meade, M. L., & Geraci, L. D., & Roediger, H. L. III (2012). Neuropsychological status in older adults influences susceptibility to false memories. *American Journal of Psychology, 145*(4), 449-467.

Meade, M. L., & Roediger, H. L., III (2006). The effect of forced recall on illusory recollection in younger and older adults. *American Journal of Psychology, 119,* 433-462.

Mitte, K. (2008). Memory bias for threatening information in anxiety and anxiety disorders: A meta-analytic review. *Psychological Bulletin, 134*(6), 886-911.

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour Research & Therapy, 36,* 809-848.

Mogg, K., & Bradley, B. P. (2016). Anxiety and attention to threat: Cognitive mechanisms and treatment with attention bias modification. *Behaviour Research and Therapy, 87,* 76-108.

Mogg, K., Mathews, A., & Weinman, J. (1989). Selective processing of threat cues in anxiety states: A replication. *Behavior Research and Therapy, 27*(4), 317-323.

Multhaup, K. S. (1995). Aging, source, and decision criteria: When false fame errors do and do not occur. *Psychology and Aging, 10*(3), 492-497.

Pajkossy, P., Keresztes, A., & Racsmány, M. (2017). The interplay of trait worry and trait anxiety in determining episodic retrieval: The role of cognitive control. *The Quarterly Journal of Experimental Psychology, 70*(11), 2234-2250.

Ree, M. J., French, D., MacLeod, C., & Locke, V. (2008). Distinguishing cognitive and somatic dimensions of state and trait anxiety: Development and validation of the state-trait inventory for cognitive and somatic anxiety (STICSA). *Behavioural and Cognitive Psychotherapy, 36,* 313-332.

Roediger, H. L. III, & Payne, D. G. (1985). Recall criterion does not affect recall level or hypermnesia: A puzzle for generate/recognize theories. *Memory & Cognition, 13*(1), 1-7.

Segal, D. L., June, A., Payne, M., Coolidge, F. L., & Yochim, B. (2010). Development and initial validation of a self-report assessment took for anxiety among older adults: The Geriatric Anxiety Scale. *Journal of Anxiety Disorders, 24,* 709-714.

Shipley, W. C. (1940). A self-administering scale for measuring intellectual impairment and deterioration. *The Journal of Psychology, 9*(2), 371-377. DOI: 10.1080/00223980.1940.9917704

Speilberger, C. D. (1972). Anxiety as an emotional state. In C. D. Speilberger (Ed.), *Anxiety: current trends in research and theory,* Vol. 1(pp. 23-49). New York: Academic Press.

Spielberger, C. D. (1983). Manual for the State-Trait Anxiety Inventory. *Consulting Psychologists Press.* Palto Alto, CA.

Struijs, S. Y., Lamers, F., Vroling, M. S., Roelofs, K., Spinhoven, P., & Penninx, B.W.J.H. (2017). Approach and avoidance tendencies in depression and anxiety disorders. *Psychiatry Research, 256,* 475-481.

Tomaka, J., Palacios, R. L., Champion, C., & Monks, S. (2018). Development and validation of an instrument that assesses individual differences in threat and challenge appraisal. *Journal of Depression & Anxiety, 7*(3), 313.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063-1070.

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1983). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17*(1), 37-49.

Yochim, B. P., Mueller, A. E., Segal, D. L. (2013). Late life anxiety is associated with decreased memory and executive functioning in community dwelling older adults. *Journal of Anxiety Disorders, 27,* 567-575.

Zijlstra, F. R. H. (1993). *Efficiency in work behaviour: A design approach for modern tooks.* Delft: Delft University Press.

APPENDIX A

MEMORY STIMULI

Memory Stimuli. Categorized study list items that were presented followed by the top five exemplars from each category that were used as critical items.

Birds: crow, bluebird, canary, parakeet, hawk, blackbird, wren, oriole, parrot, pigeon, hummingbird, starling, woodpecker, vulture, swallow, chicken, dove
Critical Items: robin, sparrow, cardinal, blue jay, eagle

Human Body Parts: nose, finger, ear, hand, toe, mouth, stomach, hair neck, heart, knee, chest, liver, brain, lungs, tooth, elbow
Critical Items: legs, arms, head, eye, foot

Vegetables: tomato, lettuce, spinach, asparagus, broccoli, celery, cabbage, string beans, cauliflower, beets, lima beans, squash, onions, radishes, Brussel sprouts, cucumber, turnip
Critical Items: carrot, peas, corn, bean, potato

Four-footed animals: tiger, elephant, pig, bear, mouse, rat, deer, sheep, giraffe, goat, zebra, squirrel, wolf, donkey, rabbit, leopard, mule
Critical Items: dog, cat, horse, cow, lion

Articles of clothing: skirt, coat, dress, hat, sweater, tie, slip, jacket, slacks, gloves, belt, underwear, shorts, scarf, suit, T-shirt, vest
Critical Items: shirt, socks, pants, shoes, blouse

Flowers: orchid, chrysanthemum, lily, pansy, petunia, gardenia, daffodil, dandelion, iris, lilac, geranium, peony, sunflower, azalea, gladiola, lily of the valley, snapdragon
Critical Lures: rose, tulip, carnation, daisy, violet