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EFFECTS OF CONTEXT AND INDIVIDUAL DIFFERENCES ON MEMORY FOR
PRIOR REMEMBERING

By
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B. A., University of Wisconsin – Milwaukee, 2010
M. S., University of Louisville, 2015

A Dissertation
Submitted to the Faculty of the
College of Arts and Sciences of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Doctor of Philosophy
in Experimental Psychology

Department of Psychological and Brain Sciences
University of Louisville
Louisville, Kentucky

August 2018

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A Dissertation Approved on

July 13, 2018

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DEDICATION

This dissertation is dedicated to my grandfather, Arnold Mueller, who sadly passed away shortly after I began graduate school. He was always one of my biggest supporters and is greatly missed.

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This dissertation would not have been possible without the help of many people along the way. Ideally I would be able to thank everyone, but it is impossible to remember everything that has been done to support me over the years. I would not be in graduate school completing this dissertation if it were not for Keith Lyle's belief in my ability and willingness to accept me as a graduate student. I would not be the academic that I am today without his hard work, assistance, and attention to detail. I am more confident in my ability as an instructor and was able to teach a course as the instructor of record because of the encouragement and selfless assistance of Marci DeCaro. I gained invaluable experience with neuroimaging analyses that I hope to be able to use in the future thanks to the time and effort of Brendan Depue. I gained valuable feedback on my writing and an improved ability to organize my ideas from Tamara Newton's efforts as a member of my preliminary exam committee. My dissertation committee would not have been complete without Guy Dove's willingness to help a student outside of his department and to provide valuable feedback on my research ideas. Thank you to Jasmine Thomas for helping with data collection. Last, but not least, I would not be who I am today without the unwavering support of my family and friends (you know who you are). Thank you all for believing in me.

ABSTRACT

EFFECTS OF CONTEXT AND INDIVIDUAL DIFFERENCES ON MEMORY FOR PRIOR REMEMBERING

Marcus L. Leppanen

July 13, 2018

Though people often remember experiences from their lives, they are also able to remember whether a memory has previously been retrieved, which is known as memory for prior remembering. Frequent failures of memory for prior remembering can have negative consequences on how people perceive their own cognitive health. The recurrence of traumatic memory retrieval can be interpreted as a consequence of intrusive memory for prior remembering. This dissertation was conducted to improve our understanding of the factors that influence the efficacy of memory for prior remembering. The two factors that were investigated were context change and individual differences. Participants ($N = 180$) completed a three-phase memory procedure. In the first phase, participants learned a series of cue-target word pairs. In the second phase, participants were given a cued-recall test (Test 1) for some of the pairs that they learned. Half of those targets were tested in the same context as the learning phase (same-context targets) and the other half were tested in a new context in which one feature had changed from the learning phase (changed-context targets). Three different types of contextual features could have changed in between-subjects fashion: the semantic context, background color

context, or screen location context. In the third phase, participants were given a second cued-recall test (Test 2) in which all of the learned targets were tested in the original study context. During the third phase, participants were also asked to make a judgment about whether each target was retrieved during Test 1. Results showed that memory for prior remembering was only impaired for changed-context targets in the semantic change condition. Participants also completed questionnaires to measure individual differences in dispositional mindfulness and absorption. The only significant predictor of memory for prior remembering was absorption and only in the semantic change condition. The findings support a distinction between categorizing contextual features into local and global categories based on their associations with memory for stimuli and memory for prior remembering. Individual difference findings are discussed with respect to whether attention is focused on internal thoughts or external stimuli. Future directions and implications are also discussed.

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CHAPTER I

LITERATURE REVIEW

People not only remember the events of their lives, but also whether they have recollected those events previously. In some instances, people also make judgments about whether they have previously recollected a memory before or if they do not think they have. The focus of this dissertation will be on one type of judgment that people make, specifically when they decide whether or not they have previously remembered something before, which will be referred to as their memory for prior remembering. People are frequently asked to make judgments about their memory retrieval. For example, people are often asked on clinical assessments how often they have retrieved memories of traumatic events (e.g., the Clinician-Administered PTSD Scale for the DSM-5; Weathers et al., 2013). Such assessments rest on the assumption that people can accurately remember their own prior remembering. The accuracy of our memory for prior remembering is also relevant to the debate over the validity of repressed, or recovered, memories (e.g., Schooler, 2001). For those reasons, it is important to better understand what affects the accuracy of memory for prior remembering. The specific purpose of this dissertation was to explore factors that influence how well people remember their own prior instances of memory retrieval and whether particular individual differences are related to how accurately people judge their own prior remembering to be.

To test factors that influence memory for prior remembering a three-phase memory procedure was adapted to address two important questions. The first question was: What types of contextual features can be changed across instances of retrieval that will lead to impaired memory for prior remembering? Currently, it is only known that changes to semantic context (e.g., Arnold & Lindsay, 2002) and the method of retrieving information (e.g., free recall versus recognition; Padilla-Walker & Poole, 2002) have effects on the accuracy of memory for prior remembering. How those factors influence memory for prior remembering will be discussed further in the Contextual Features and Memory for Prior Remembering section of this dissertation. It has been proposed that memory for prior remembering operates on the same principles as memory for stimuli. As such, it should be possible to determine whether other types of contextual features (e.g., background, location) that are associated with memory for stimuli are also associated with memory for prior remembering. Because memories can be embedded in a large number of contextual details, it is important to demonstrate whether any effects of context change on memory for prior remembering can be generalized across multiple kinds of context.

The second question was: Can individual differences in the accuracy of memory for prior remembering be predicted by personality traits? People differ in the accuracy of their memory for prior remembering, but the underlying causes of those differences remain unknown. Understanding individual differences in memory for prior remembering can lead to the development of theories about what causes some people to have better memory for prior remembering than others. Differences in how people attend to their own cognitions (e.g., acts of memory retrieval) may affect how well those

cognitions are encoded into memory. Specifically, being mindful of, or absorbed in, one's cognitions could affect the accuracy of memory for prior remembering. The research supporting why mindfulness and absorption were tested in this dissertation is evaluated in greater detail in the Individual Differences and Memory for Prior Remembering section.

The following sections form the body of the literature review and establish the framework behind the design of this dissertation, the specific research questions, and my research hypotheses. In the following section, I will discuss what memory for prior remembering is and current theorizing about why people forget about prior acts of memory retrieval. Then I will discuss the role that context plays in memory for stimuli and memory for prior remembering. There will be specific discussions about the types of contextual features I studied in this dissertation: background color and screen location. At the end of the context section will be a re-statement of the first research question and my hypotheses. Then the discussion will shift to individual differences in memory. That section will begin with a general discussion of why individual differences are important for memory research before narrowing to what is known about individual differences in memory for prior remembering. There will then be specific sub-sections addressing the individual differences of interest: dispositional mindfulness (Brown & Ryan, 2003) and absorption (Tellegen & Atkinson, 1974). The literature review will end with a discussion of the hypotheses related to the individual difference measures.

Making Judgments about Prior Remembering

Memory for prior remembering is one type of metamemory judgment. In this dissertation, the term metamemory refers to judgments that people can make about their

own memory. Metamemory judgments can include predictive judgments of future learning (e.g., Hartwig & Dunlosky, 2017), assessments of whether a memory was previously retrieved or not (e.g., Arnold & Lindsay, 2002), or reports about the quality of a recollection (e.g., Mickes, Seale-Carlisle, & Wixted, 2013). Memory for prior remembering is a metamemory process that involves people making judgments about whether they believe a piece of information they just retrieved was also retrieved at another time in the past. Despite the fact that people frequently make judgments about their prior remembering, researchers have questioned whether metamemory judgments are accurate (e.g., Joslyn, Loftus, McNoughton, & Powers, 2001; Parks, 1999; Pope & Hudson, 1995). Because of the malleable nature of memory and the potential for people to incorporate misinformation into retrieved memories (see Loftus, 2005 for a review), it is important to further understand what factors influence how accurate memory for prior remembering is and why failures of memory for prior remembering occur.

The accuracy of memory for prior remembering has been of interest for over two decades. Parks (1999) explored memory for previous instances of retrieving childhood memories using a two-phase procedure. In the first phase, participants were brought into the laboratory and asked to retrieve memories from their childhood in response to prompts for specific types of events (e.g., “Do you remember your first bicycle?”). Later, in the second phase, participants attempted to recollect some of the same events, as well as new ones. During the second phase, participants were also asked to make judgments about how recently they thought about the events they just recollected. Researchers have demonstrated that participants frequently forget that they had retrieved specific memories in the laboratory. Instead participants think that they had not retrieved those memories

for weeks or years prior to the experiment. Participants can demonstrate that forgetting when the two acts of retrieval are separated by only a few minutes within the same experimental session (Parks, 1999) or when they are separated by as much as two weeks (Merckelbach et al., 2006). Parks proposed that people have inaccurate memory for their prior remembering because of a bias to underestimate how recently a memory has been retrieved.

Schooler (2001) proposed that changes in subjective experience affect memory for prior remembering. Schooler's ideas came following interviews in which people described an experience of forgetting that they previously retrieved a memory for a highly emotional event, specifically instances of childhood sexual abuse. Schooler found people who reported recovering their memories for a past experience of sexual abuse that they believed they had never retrieved before. Despite their reports, evidence was found that those people had previously recollected the abuse to a confidant and had forgotten that previous act of recollection. Schooler posited that the subjective experience associated with the recollection of a memory affects whether that act of recollection is remembered later. The subjective experience of memory retrieval can be defined as the emotional or conceptual interpretation of the memory at the time of retrieval. The emotional and conceptual aspect of a memory may not remain the same over time and changes to those types of interpretations are argued to impair memory for prior remembering.

Schooler suggested that the surprise and distress that occurred from recollecting a memory of abuse in a therapeutic setting was highly distinct from recollecting the same memory with a confidant. People may have felt as though such an emotional response to

a memory should itself be memorable. However, if the memory was previously recollected in a calmer fashion, then that previous recollection may not be salient in the context of the newer, highly emotional response to the more recent retrieval. In other words, a highly emotional act of retrieving an experience of childhood sexual abuse could be unlikely to remind someone that they had previously retrieved the memory before if the previous recollection occurred in a less distressing fashion. Such different experiences could lead a person to forget a prior instance of recollection. In extreme cases, people may even claim to have entirely forgotten that an act of retrieval ever occurred, which Schooler (2001) termed the “forgot-it-all-along effect.” The factors that are currently known to affect the subjective experience of memories in a way that impairs memory for prior remembering are discussed in the following section.

Contextual Features and Memory for Prior Remembering

The following section will address the first of two research questions: Are contextual features other than semantic context associated with memory for prior remembering? Research has demonstrated that changing semantic context impairs memory for prior remembering (Arnold & Lindsay, 2002), but why is that important and what does it tell us about human memory? In particular, this dissertation was designed to test the theory that memory for prior remembering operates on the same principles as memory for stimuli (Arnold & Lindsay, 2002; 2005). That theory is supported by evidence that changes in semantic context affect both memory for prior remembering (e.g., Arnold & Lindsay, 2002) and recognition accuracy (e.g., Tulving & Thomson, 1973). I will first discuss what is known about the relationship between semantic context and memory for prior remembering. Then I will discuss current theorizing about the

roles of subjective experience and encoding specificity in memory for prior remembering. I will end the section by discussing the gap in the literature that can be filled by this dissertation.

Arnold and Lindsay (2002) tested whether changes to semantic context could create a change in subjective experience that would impair memory for prior remembering. They tested that idea using a three-phase procedure. In the study phase of Arnold and Lindsay's paradigm, participants viewed semantically-related cue-target word pairs (e.g., *hand – palm*, *dog – bark*). In each pair, the target was a homograph with two meanings that were established by two distinct cue words (e.g., *palm* could refer to part of your hand or a type of tree). Participants then completed a cued-recall test (referred to as Test 1) for some of the studied words. Critically, some of the words were cued with the same word from study (same-cue targets, e.g., *hand – p _ _ m*), others were cued with a previously unseen word that was also related to a previously studied target (changed-cue targets, e.g., *birch – b _ _ k*), and others were not tested at all during Test 1 (not tested targets). This created a situation in which, during Test 1, the semantic context of some of the targets changed, while it remained the same for others. Participants then completed a second cued-recall test (referred to as Test 2) in which memory for all the targets was tested in the original study context. Memory for prior remembering was tested for each target during Test 2 by asking participants if the target they retrieved was also retrieved during Test 1. It has consistently been found that memory for prior remembering is worse when the context changes between Tests 1 and 2, compared to when it remains the same throughout the experiment (Arnold & Lindsay, 2002; 2005;

Geraerts et al., 2006; Leppanen & Lyle, 2018; Raymaekers, Peters, Smeets, Abidi, & Merckelbach, 2011).

Context change is believed to affect memory for prior remembering because it is assumed that memory for prior remembering follows the encoding specificity principle. The encoding specificity principle states the ability to retrieve a memory is directly related to the amount of overlap between the conditions that are present at retrieval and those that were present at encoding (Tulving & Thomson, 1973). In the memory for prior remembering paradigm, the act of retrieving a target during Test 1 is encoded with the features that are present during that act of retrieval (e.g., the semantic context). Arnold and Lindsay (2002; 2005) showed that remembering an act of retrieval is better when the features present during Test 2 match those from Test 1 (same-context targets) and it is impaired when they differ (changed-context targets). They argued that a change in semantic context led participants to interpret the targets in subjectively different ways across acts of retrieval (e.g., thinking about *palm* as part of your body is distinct from thinking about *palm* as a type of tree).

According to the encoding specificity principle, a change in subjective experience between acts of retrieval would make the Test 2 retrieval context unlikely to cue a memory for the act of Test 1 retrieval. Even though the target remains the same between Test 1 and Test 2, when the conditions surrounding the target change memory for prior remembering is impaired. The subjective experience of a target differs following changes in semantic context because the same word is interpreted in two distinct ways. When the word *palm* is interpreted as being part of the body during Test 2, it would be a poor cue for a previous instance of retrieving *palm* as a type of tree because of a violation

of the encoding specificity principle. Such a distinction is not present for same-context targets because it is assumed that no change in subjective experience occurs when the semantic context remains the same across tests.

Further support for the role of encoding specificity in memory for prior remembering comes from an experiment which explored the role of response format in memory for prior remembering. Padilla-Walker and Poole (2002) had participants listen to a list of recorded sentences that were all similar in structure (i.e., all of the sentences included a subject, verb, and action). Following study, participants were asked to freely recall as many sentences as they could. After participants heard a second list of distractor sentences and completed other distractor tasks, they were either asked to freely recall as many sentences from the first list as they could or were given a recognition test containing all of the original sentences as well as novel sentences that were not heard in the experiment. Following that second recall attempt, participants were also asked to indicate whether they had retrieved the sentences during their first recall attempt or not. Participants were more likely to falsely indicate that a sentence was not previously retrieved following a recognition test than a second free recall test. The authors argued that free recall tests and recognition tests may lead participants to think about the information they are recalling differently.

Padilla-Walker and Poole's (2002) argument supports Arnold and Lindsay's (2002) idea that memory for prior remembering operates on the same principles as memory for stimuli. The way in which participants retrieve information affects both memory for prior remembering (Padilla-Walker and Poole, 2002) and memory for stimuli (e.g., the accuracy of eye witness memory reports; Evans & Fisher, 2011). In the

memory for prior remembering paradigm, the response format can act as a to-be-remembered cognitive operation and changes in how that operation is processed impair memory for prior remembering. In contrast, the effect of response format on memory for stimuli is on the amount and type of information that is offered (Evans & Fisher, 2011). Despite supporting Arnold and Lindsay's (2002) idea that changes in subjective experience across tests can impair memory for prior remembering, Padilla-Walker and Poole argued that future research could benefit by identifying what types of change can cause participants to forget their previous recollections.

Other than understanding what factors impair memory for prior remembering, attempts have also been made to determine whether the impairment caused by changes in subjective experience can be alleviated. Leppanen and Lyle (2018) had participants either retrieve or view study cues after retrieving targets during Test 1. In separate experiments, participants were given one of three instructions: to overtly retrieve the study cue paired with the previous target, to copy the study cue paired with a given target after viewing it, or to overtly retrieve the study cue paired with the previous target while being told whether that target was a changed-context target or a same-context target. Leppanen and Lyle found that memory for prior remembering of changed-context targets was equivalent to that of same-context targets when participants overtly retrieved study cues, but not when they copied a presented study cue.

Leppanen and Lyle (2018) suggested that the benefit to memory for prior remembering was the result of participants being reminded of the study context during Test 1. They argued that being reminded of the previous context for a given target allowed participants to associate the Test 1 retrieval context with the study context

(which subsequently became the Test 2 retrieval context). Such an association would create a scenario in which the Test 1 retrieval context could be brought to mind by the Test 2 retrieval context when it usually is not. While reminding benefited memory for prior remembering of changed-context in all three experiments, the greatest improvement in the accuracy of memory for prior remembering followed overt memory retrieval. The difference in the efficacy between what was termed reminding-via-retrieval and reminding-via-presentation was attributed to the benefit of retrieving information over re-studying it (for a recent meta-analytic review, see Rowland, 2014). In previous studies, participants were never asked to think about the study context during Test 1 (e.g., Arnold & Lindsay, 2002), yet it is likely that some participants did. Leppanen and Lyle argued that individual differences in what they termed “spontaneous reminding” could underlie differences in memory for prior remembering. People who are more frequently reminded of the context in which an experience occurred should be more likely to remember their prior retrievals by having a greater number of associations with the act of memory retrieval. Therefore, a second goal of this dissertation was to explore individual differences in personality traits that could be associated with how people attend to their own cognitions, which could influence levels of spontaneous reminding. Individual differences in memory for prior remembering will be discussed in the Individual Differences in Memory for Prior Remembering section.

The relationship between encoding specificity and memory for prior remembering can be further elucidated if it is assumed that memory for cognitive operations generally follows the same principles as memory for stimuli. Arnold and Lindsay (2005) argued for that possibility by relating their findings to those of recognition failure paradigms

(Tulving & Thomson, 1973). Recognition failure occurs when a target is cued with a different word at study than at test and is subsequently endorsed as a new target, rather than being recognized as old. Recognition failure is tied to the act of learning a specific cue-target pairing, rather than any pre-experimental associations between a given cue-target pairing. For example, when the word *light* is studied with the word *head* (a word weakly-associated with *light*), it is typically easier to recall *light* when it is again presented with *head* than it is to recognize *light* when it is paired with *dark* (a word strongly-associated with *light*).

Memory for prior remembering and memory for stimuli are also similarly affected differences in the detail of encoded information. Stimuli that are encoded with greater detail, and subjectively experienced as more vivid, are remembered better than stimuli that are encoded in less detail. For example, negatively valenced words have been shown to be encoded in more detail than neutral words and were subsequently remembered better (Kensinger & Corkin, 2003). Similarly, acts of recollection that are rated as more vivid, have been shown to be more likely to be remembered than those that are rated as less vivid (Merckelbach et al., 2006).

Despite what is currently known, it is my argument that prior research has yet to fully support the assumption that memory for prior remembering operates on the same principles as memory for stimuli. Arnold and Lindsay (2005, p. 547) stated that “[their] findings suggest that remembering a prior episode of recollection is equivalent to remembering other sorts of prior episodes. Hence, retrieval of evidence of prior remembering follows the same principles that govern retrieval of evidence of other sorts of episodic memories”. In other words, memory for prior remembering should follow all

of the same principles as memory for stimuli. Currently, that argument is only supported by evidence that changes in semantic context or retrieval method affect the accuracy of memory for prior remembering and memory for stimuli. To provide more evidence for whether memory for prior remembering follows the same principles as memory for stimuli, other types of contextual features should be tested for associations with memory for prior remembering.

Content versus Context of Memories

Before discussing the specific types of context that were used in this dissertation to provide further support for Arnold and Lindsay's (2002; 2005) ideas, it is necessary to have a clearer understanding of what context is and why it is important for encoding specificity. Memories are often separated into their content and context (e.g., Bookbinder & Brainerd, 2016). Content refers to the to-be-remembered information (e.g., a word pair, a picture, the topic of a conversation with a friend) and context is a broad term used to describe aspects of the environment in which content learning takes place. For the purposes of this dissertation, context is defined as the spatiotemporal (e.g., where and when), perceptual (e.g., color), and internally generated (e.g., emotions) information that is associated with a stimulus as it is being learned (Skinner & Fernandes, 2009). For example, when students attend a lecture, the facts that are being learned in the lecture are the content of their memory, but the classroom in which the lecture is taught is a contextual feature that can later be associated with the topic of the lecture. The association of context with content is important because it helps to distinguish highly similar experiences with the same stimulus (for a similar interpretation of the role of context, see Brinegar, Lehman, & Malmberg, 2013). As another example, you may have

a memory of seeing a tiger at the zoo. That experience would be considered the content of the memory in this example. The context surrounding that content could be the zoo you were visiting, the weather that day, or how you felt about seeing the tiger. It is possible that you have multiple experiences with seeing a tiger (e.g., in the zoo, in photographs). You may have seen one tiger at the Louisville Zoo and another at the San Diego Zoo. If someone asks you to recall your experience at the Louisville Zoo, you are able to separate that experience from the memory about the San Diego Zoo because the two experiences occurred in different contexts (e.g., locations).

In the literature, many different contextual features have been associated with the accuracy of memory retrieval. When memory retrieval is impaired by changes to a particular contextual feature, that finding can be used as evidence that the encoding specificity principle generalizes across types of contextual features. For example, when the physical location in which participants learn a list of words differs from the location in which they are tested for those words, recall is typically impaired (e.g., Godden & Baddeley, 1975). As mentioned previously, changing the semantic context of cue-target word pairs between study and a recognition test impairs recognition accuracy (Tulving & Thomson, 1973). Participants have been shown to have worse recall performance when learning in an inebriated state and being tested sober than when learning and test occur in the same state, whether the same state is inebriated or sober (Goodwin, Powell, Bremer, Hoine, & Stern, 1969). When the emotional state that a person is in when they generate autobiographical memories is the same as that on a subsequent test, memory for the previously generated events is better than when the emotional state differs between acts of retrieval (Eich, Macaulay, & Ryan, 1994). As can be seen from these examples,

context can include many different features that, when changed, have an effect on the ability to remember stimuli. Those effects are critical for extending the encoding specificity principle to memory for prior remembering.

Many contextual features affect memory performance, but they are not all considered to have the same relationship with the content of our memories. Different features can have different effects depending on the paradigm being used. Changes in location affect recall accuracy, but they are oftentimes found to have no effect on recognition performance (e.g., Godden & Baddeley, 1980). Researchers account for those types of disparities by grouping contextual features into categories with similar relationships to memory content. It is impossible to discuss all possible methods of categorization in this dissertation and, as such, only three predominant theories will be briefly discussed. First, one proposed method of categorizing contextual features is to use a local versus global categorization scheme (Dalton, 1993). Local contextual features are those that are bound to one, or very few, items (e.g., semantic context) and global contextual features are bound to many different items (e.g., locations, emotions). Second, other researchers separate contextual features into verbal and environmental categories (Franco-Watkins & Daugherty, 2006). Verbal context is applied to contextual features that are described predominantly through the usage of words (i.e., equivalent to semantic context) and environmental context refers to everything else about the learning environment that does not require a verbal label to be processed (e.g., colors, locations). Third, others use intrinsic and extrinsic labels for different types of contextual features (Godden & Baddeley, 1980). Intrinsic contextual features of stimuli are perceived and processed as a stimulus is being learned (e.g., semantic context, color), but extrinsic

contextual features are often encoded incidentally (e.g., location). Based on the categorization scheme being used, different predictions can be made for how different features will be associated with memory content.

Arnold and Lindsay (2005) have endorsed the distinction between global and local contextual features. They discussed how item-level (local) context had different effects on memory for prior remembering than global contextual features have on output monitoring (Marsh & Hicks, 2001). Output monitoring, like memory for prior remembering, is a metamemory judgment about whether information has been recollected previously. Output monitoring and memory for prior remembering are both measured using three-phase procedures. A typical output monitoring procedure would begin with blocks of two alternating phases. In the first of the two phases, participants are given a list of words to remember. In the second phase, participants attempt to freely recall the list they just studied. After a set number of lists, a third phase begins in which participants are given the output monitoring recognition test. In the output monitoring recognition test, participants must indicate which items were targets they had previously retrieved, which were targets they had not retrieved, and which items were new. The effects of global context on output monitoring have been assessed using Deese-Roediger-McDermott (DRM) word lists (Roediger & McDermott, 1995). A DRM word list includes semantically-related words (e.g., nurse, hospital, stethoscope) that all have high associative strength with one extra-list word (e.g., doctor) that is never studied, known as the critical lure. It has been shown that people have trouble accurately monitoring their output of critical lures and often report previously retrieving critical lures, regardless of whether they have or not (Marsh & Hicks, 2001).

Arnold and Lindsay (2005) compared their findings to those of Marsh and Hicks (2001) by arguing that item-level semantic context has different effects on memory for prior remembering than global semantic context (established by DRM word lists) has on output monitoring. Item-level contextual changes impaired memory for prior remembering, but list-wide semantic context increased the endorsement of critical lures. In both cases, metamemory judgments about prior retrieval are inaccurate. The important distinction is that forgetting a prior instance of memory retrieval is an error of omission and endorsing a non-retrieved critical lure as previously retrieved is an error of commission. When local contextual features change there is forgetting of prior remembering, but when items are learned in a consistent global context participants appear to adopt a more liberal response criterion and instead endorse items as previously remembered that were related to items they had actually remembered. It remains to be tested how the two types of contextual features affect metamemory judgments using the same paradigm. As such, aside from merely generalizing Arnold and Lindsay's (2002) findings to new types of contextual features, it is of interest to specifically test whether changing global contextual features in the memory for prior remembering paradigm will have the same impairing effect as changing local contextual features.

The present dissertation was designed to create a within-experiment comparison between the effect of changing a local contextual feature (semantic context) and the effects of changing global contextual features (background color and screen location) on memory for prior remembering. It will be argued that changing background color and screen location may also lead to distinct representations of cue-target pairs because both features have previously been associated with memory for stimuli (as will be described

next). If memory for prior remembering operates on the same principles as memory for events, then such associations should also impact the accuracy of memory for prior remembering. In particular when those features are changed there should be impaired memory for prior remembering. Further, if memory for prior remembering follows the encoding specificity principle, then the results of this dissertation would provide evidence for whether background color and screen location affect the probability of Test 2 target retrieval cueing Test 1 target retrieval.

Background Color Context Effects

The first contextual feature which was used to extend Arnold and Lindsay's (2002) findings was background color. The effects of background color on memory for stimuli have been of interest to psychologists for nearly 90 years. The earliest examinations looked at the effects of displaying target stimuli on colored cards. Researchers have shown that cued-recall of cue-target pairs made up of nonsense syllables was better when the color of the card on which pairs were presented remained the same between study and test compared to when the background changed. That effect was strongest when a given color was paired with only one cue-target pair (Dulsky, 1935). In other words, background color had the strongest association with the content of a memory when it acted as a local contextual feature. Later research demonstrated that participants took fewer trials to learn a set of cue-target word pairs when the pairs were presented on colored cards compared to when the cue-target pairs were presented on uniform gray backgrounds (Weiss & Margolious, 1954). Dulsky's (1935) findings were later extended from cued-recall to free recall by Isarida and Isarida (2007) who showed that recall of Japanese characters was better for those which were tested on the same

background they were studied on than those which were studied on a different color background. Other researchers, however, have failed to find an association between background color and memory for prose when only one color was used (Pointer & Bond, 1998).

It has been suggested that the effects of background color on memory are determined by whether background color is encoded as a local contextual feature or a global contextual feature (Sakai, Isarida, & Isarida, 2010). How background color is encoded is likely determined by how many stimulus items are paired with a given color and the frequency at which the color changes. Color could be encoded locally if few items are paired with a given color and the color changes frequently, but color would instead be encoded globally if many items are paired with the same color and the color rarely changes. Despite the mixed findings of previous research, there is greater empirical support for the idea that background color is in fact encoded with cue-target word pairs. As such, changing background color between instances of retrieving cue-target pairs may lead to distinct representations of the same target items and have an effect on memory for prior remembering.

Screen Location Context Effects

The second contextual feature that was used in this dissertation was screen location. Location is often studied as the physical environment in which learning occurs (e.g., a classroom with a chalkboard, desks, and maps on the walls). It has frequently been shown that changes in physical location between study and test impair memory retrieval compared to when study and test occur in the same location (e.g., Godden & Baddeley, 1975). Interestingly, a change in location can be used to reduce the

interference that normally occurs when two word lists are learned back-to-back in the same location (e.g., Brinegar, et al., 2013). Up to this point location has meant the general spatial location in which information is being learned. However, location can also refer to the relative location of a stimulus within the environment (e.g., the relative location of items on a computer screen). For example, it has been shown that changing the location of items that were learned in specific locations of a 4 x 4 grid on a computer screen slows down recognition responses and lowers identification accuracy compared to when the items remain in the same location (Murphy, Wynne, O'Rourke, Commins, & Roche, 2009). It has also been shown that participants are able to use the position of a stimulus on screen, irrespective of any other visual landmarks, as a retrieval cue to speed responding when making judgments about whether an item was previously studied (Wang, Johnson, Zhang, & Wang, 2002). Given these effects of screen location on memory performance, it is plausible that the location on screen in which cue-target word pairs are learned, and subsequently retrieved, will be associated with those word pairs and have an effect on memory for prior remembering.

In conclusion, this section focused on context and the impact it has on memory. Previous theorizing has suggested that memory for prior remembering operates on the same principles as memory for stimuli and is similarly affected by contextual change (e.g., Arnold & Lindsay, 2002). The predominant theoretical framework for researching memory for prior remembering focuses on the encoding specificity principle. Yet, the evidence supporting the theory that memory for prior remembering follows the encoding specificity principle is limited. This dissertation was designed to address that gap in understanding and to provide further support for the idea that memory for prior

remembering follows the encoding specificity principle. Specifically, background color and screen location were used to test whether global contextual features have a similar effect on memory for prior remembering as local contextual features.

Context Effect Hypotheses

As a reminder, the specific research question being asked is whether contextual features other than semantic context are associated with the accuracy of memory for prior remembering. To answer the proposed research question, the memory for prior remembering paradigm used by Leppanen and Lyle (2018) was adapted to include changes to different contextual features across Tests 1 and 2. In this paradigm, participants studied cue-target pairings and were subsequently given two cued-recall tests for the targets. Critically, during the second cued-recall test, participants were also asked to make a judgment about whether they previously retrieved each target on Test 1. The novel contribution of this dissertation was to compare the effects of changing semantic context on memory for prior remembering and the effects of changing background color and screen location. Those comparisons were made in a between-subjects fashion across conditions in which only one contextual feature was changed between Test 1 and Test 2. The to-be-remembered stimuli were equated across conditions by using the same cue-target pairings. The dependent measure of interest was the accuracy of participants' memory for their prior remembering. Full details of the procedure are provided in Chapter II.

This design allowed for three between-condition comparisons on the effects of contextual change on memory for prior remembering. Those comparisons were between the effects of semantic context, background color context, and screen location context on

memory for prior remembering. According to the encoding specificity principle and the ideas of Arnold and Lindsay (2002), contextual features that are associated with memory for stimuli should also be associated with memory for prior remembering. Therefore, it was hypothesized that a similar pattern of results would be found across all three conditions. Memory for prior remembering of same-context targets was expected to be better than that of changed-context targets in all three conditions. Alternatively, it must be acknowledged that changes to background color and screen location may not affect the qualitative interpretation of the retrieved targets. Previous research suggests that qualitative changes are required to impair the accuracy of memory for prior remembering (e.g. Arnold & Lindsay, 2002; Schooler, 2001). If background color and screen location do not affect the subjective experience of cue-target word pairs, then judgments of prior remembering for changed-context targets would only be impaired in the semantic change condition. It has also been suggested that local contextual features may have different effects on memory for prior remembering than global contextual features (Arnold and Lindsay, 2005). The distinction between local and global contextual features would be supported by any finding that demonstrates the contextual features in this dissertation have different effects on memory for prior remembering.

Individual Differences and Memory for Prior Remembering

The following section will address the second of the two research questions: Are individual differences in internally-focused attention associated with the accuracy of memory for prior remembering? Generally speaking, individual differences research attempts to describe how the ways people differ affect behavior. As with any measurement of cognitive performance, people differ in how accurately they remember

previous instances of memory retrieval. Those differences in accuracy are likely to be associated with individual differences in other measurable traits. However, which individual differences are related to performance on the memory for prior remembering task are poorly understood. This section will first focus on a general discussion of individual differences research, before narrowing to some of the known individual differences in memory. Then, the extent to which individual differences have been associated with memory for prior remembering will be discussed. After that, the discussion will focus on how internal processing of information may underlie performance on the memory for prior remembering task. There will then will two subsections which focus on the individual differences that were measured in this dissertation – dispositional mindfulness and absorption – before ending with a summary of the research hypotheses. Exploring which individual differences affect memory for prior remembering will allow for a more informed discussion about the potential cognitive mechanisms that underlie performance on the memory for prior remembering task developed by Arnold and Lindsay (2002).

For the purposes of this dissertation, the discussion will focus on individual differences that have been associated with memory. Individual differences in personality traits (e.g., anxiety; Krans, de Bree, & Bryant, 2014), brain morphology (e.g., hippocampal volume; Maguire, Woollett, & Spiers, 2006), and cognitive abilities (e.g., working memory ability; Unsworth, Brewer, & Spillers, 2013) are just some of the categories of individual differences which have been shown to affect memory for stimuli. With so many individual differences associated with memory for stimuli, there are many possible approaches to identifying the underlying processes that affect memory for prior

remembering. Arnold and Lindsay (2002; 2005) proposed that memory for prior remembering operates on the same principles as memory for stimuli. Therefore, if a given individual difference is associated with memory for stimuli, it should also be associated with memory for prior remembering.

To my knowledge, only one study has been conducted that attempted to measure individual differences in memory for prior remembering. Raymaekers et al. (2011) compared participants' scores on a variety of questionnaires to their performance on the memory for prior remembering paradigm developed by Arnold and Lindsay (2002). Scores on the Cognitive Failures Questionnaire (CFQ, Broadbent, Cooper, Fitzgerald, & Parkes, 1982), the Creative Experiences Questionnaire (Merckelbach, Horselenberg, & Muris, 2001), and the Dissociative Experiences Questionnaire (Bernstein & Putnam, 1986) were correlated with a single measure of memory for prior remembering performance. In their experiment, memory for prior remembering was measured using a difference score. As was stated in the introduction, there are two main dependent variables in the memory for prior remembering paradigm: the proportions of same- and changed-context targets correctly judged during Test 2 as having been previously retrieved during Test 1. Raymaekers et al. (2011) subtracted the proportion of correct judgments of prior remembering for changed-cue targets from that of same-cue targets. Using the difference score, only one significant result was found. Scores on the CFQ were negatively correlated with memory for prior remembering. The authors argued that lower scores on the CFQ reflect a positive view of one's own memory ability. Participants who are low in self-reported cognitive failures may believe that if they had

previously retrieved a target during Test 1 that they would clearly remember the experience, because of their belief that they have good memory.

People who are low in cognitive failures could be likely to adopt a conservative estimate of their prior remembering. Using a conservative response criterion, participants could reject a changed-context target as being previously retrieved because they do not have a strong memory for the prior recollection following the change in context. The same pattern would not apply to same-context targets, which are already consistently endorsed as previously retrieved. Such a pattern of conservative responding would lead to a smaller difference score. Raymaekers and colleagues' use of a difference score, however, makes it impossible to properly interpret why difference scores are smaller in those who endorse high amounts of cognitive failures.

The issue with Raymaekers et al. (2011) using a difference score is the reduction of two dependent variables into one variable. Whether a particular difference is exhibited in same-context or changed-context performance could have important implications for the underlying mechanisms of memory for prior remembering. Currently, it is unknown what the relationship is between scores on the CFQ and the different cue types that would have led to smaller difference scores. The explanation given by Raymaekers et al. (2011) suggests that response criteria underlie their findings. People are more or less likely to endorse a previous memory as retrieved depending on how accurate they think their own remembering is. People who report fewer cognitive failures may think that they are more accurate. Because changed-context targets are often found to be endorsed as being previously retrieved less often than same-context targets (e.g., Arnold & Lindsay, 2002; Leppanen & Lyle, 2018), it would be informative to know how confidence in one's own

memory affects the different kinds of targets individually. Did participants who scored high in cognitive failures have worse memory for prior remembering of same-context targets or better memory for prior remembering of changed-context targets? Either outcome would result in smaller difference scores, but would have distinct theoretical interpretations. In one instance, there is a detriment to memory for prior remembering that does not involve contextual shifts, while in the other there is an improvement in memory for prior remembering despite contextual shifts. Even though the results from the Raymaekers et al. (2011) experiment are difficult to interpret, they provide a theoretical starting point for future research.

As discussed in the previous section, the underlying assumption of the present dissertation is that memory for prior remembering follows the same principles as memory for stimuli. In particular, memory for prior remembering has been shown to follow the encoding specificity principle (Arnold & Lindsay, 2002; 2005; Padilla-Walker & Poole, 2002). It follows that individual differences which are associated with the encoding and retrieval of stimuli should also be associated with the encoding and retrieval of a cognitive operation like memory. Much like the ability to remember a stimulus, the ability to remember an act of memory retrieval should be affected by the cognitive processing that occurs during learning.

How deeply people process their own cognitions could potentially affect how well they remember those cognitions. Some people may choose to think about their cognitions deeply, but others may notice them and move on from them, and yet others may actively try to suppress their own cognitions. It will be argued that these different approaches have downstream effects on how well cognitions are remembered at a later

point in time. I describe these preferences to process cognitions in distinct ways as types of internal focus on cognition. Individual differences in internally-focused cognition could be related to how people allocate their attention. The allocation of attention directly affects memory. Greater attentional focus during learning improves later recall, while divided attention leads to memory impairment (e.g., Baddeley, Lewis, Eldridge, & Thomson, 1984). Attentional resources can be directed to cognitive processes or external stimuli which could subsequently affect what types of information people choose to elaborate on and subsequently remember.

As an example, say you have an interaction with your neighbor's dog. During that experience you may think back to previous experiences you had with that same dog, to experiences you have had with the same breed of dog, or you may even think about an experience you had with your mother's cat (because dogs and cats are both types of pets). All of those possibilities involve an internal focus on previous memories. However, if you are focused on your current interaction with your neighbor's dog you may not think about any of those other experiences at all and the current interaction will be what you focus on, which is instead a focus on external stimulation.

In the memory for prior remembering paradigm, people likely differ in how they attend to Test 1 and the change in retrieval context. Participants who naturally attend to, and elaborate on, the Test 1 retrieval context may come across an association with the learning context and naturally form an association between the two. Such an association is believed to benefit memory for prior remembering (Leppanen & Lyle, 2018). That theory could be tested by inferring the extent to which individuals both attend to, and elaborate on, their own cognitions using individual differences measures. Measuring

individual differences in dispositional mindfulness (Brown & Ryan, 2003) and absorption (Tellegen & Atkinson, 1974) would be appropriate because both traits are theorized to involve differing levels of internal focus on cognition, which will be explained in greater detail in the subsections to follow.

Whether focus is drawn to internal thoughts or to external stimulation can affect how well an experience becomes integrated into our prior knowledge and the associations that can be made to previous experiences. The integration of a new experience into prior knowledge can occur through elaboration, which is a process that has been found to benefit memory. The effects of elaboration are often studied using the levels-of-processing framework. Craik and Lockhart (1972) proposed the levels of processing theory to account for research evidence that processing information deeply (e.g., thinking about a word's meaning) can lead to better memory for that information than shallow processing (e.g., counting the number of vowels in a word). Similar evidence was found in an experiment in which Warren, Hughes, and Tobias (1985) asked participants to remember a list of adjectives. Participants who elaborated on the list of adjectives during study (e.g., thinking about how the adjective relates to a specific memory) were found to remember more of those adjectives than participants who merely rated the pleasantness of the adjectives. The researchers argued that elaboration led to a larger network of associations between the adjectives and previous autobiographical memories, which increased the number of possible retrieval cues for the studied items.

It would be predicted that greater internal focus on an act of memory retrieval would lead to more accurate memory for prior remembering. It could be that participants who focus more on their internal cognitions will elaborate on them and thus create more

associations between a given act of memory retrieval and other experiences from their lives (or even within the experiment). Findings from our laboratory have shown that being reminded of the learning context (which subsequently becomes the Test 2 retrieval context) during Test 1 improves memory for prior remembering of changed-context targets (Leppanen & Lyle, 2018). We argued that this improvement was the result of an association being formed between the learning context, the Test 1 retrieval context, and the target. Associating all three of those pieces of information would make the Test 2 retrieval context more likely to cue Test 1 target retrieval. Such an association could be formed by elaborative processing and would be particularly beneficial for remembering prior retrieval of changed-context targets. It could also be the case that deeper elaboration of an act of retrieval simply leads to stronger learning of the act of memory retrieval through extra-experimental associations, which could also lead to more accurate memory for prior remembering.

It is also important to theorize about whether a lack of internal focus could harm memory for prior remembering. It has been argued that mindful attention involves an awareness of individual items of attention and the shifting of attention away from those items prevents elaboration of the attended information (Bishop et al., 2004). In the memory for prior remembering paradigm, participants who focus too much attention on current retrieval contexts could be less likely to think about any other context in which the stimuli may have been experienced (i.e., they may not think back to the study context). If highly focused attention to individual items reduces elaboration of those items, then participants with more focused attention would have less accurate memory for

prior remembering in the face of contextual change where an ability to elaborate across contexts is important.

As a reminder, the second research question being asked is whether individual differences in internally-guided attention are associated with the accuracy of memory for prior remembering. That question was explored by associating the accuracy of memory for prior remembering with attention using two well-researched personality traits that are related to memory and internally-guided attention: mindfulness and absorption. As will be described next, both traits describe a person's tendency to focus attention on present-moment circumstances. Mindfulness involves the tendency for people to focus their attention on sensations and feelings in a nonjudgmental manner (Kabat-Zinn, 2003), which is different from how absorption involves a heightened focus and allocation of perceptual resources on individual objects of attention (Tellegen & Atkinson, 1974). The following two subsections will focus the discussion on mindfulness and absorption separately, but will involve similar argumentative structure. Each subsection will begin with a general description of what mindfulness and absorption are. Then, evidence will be provided that mindfulness and absorption are related to memory retrieval and attention. That will be followed with a discussion of the theoretical associations between a given trait and memory for prior remembering. After discussing both mindfulness and absorption the section will end with a general summary and a description of the research hypotheses.

Mindfulness

Mindfulness is a trait that has received considerable attention in the literature. Mindfulness has been defined as a state of being attentive to and aware of current

experience (Brown & Ryan, 2003) and as awareness of present-moment emotions and state of mind (Kabat-Zinn, 2003). Mindfulness is often measured using self-report questionnaires. Two of the most popular are the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) and the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2008). The MAAS measures awareness to the present moment with questions that ask about the frequency of certain mindful experiences (Brown & Ryan, 2003), whereas instead the FFMQ measures behaviors related to observing, describing, acting with awareness, nonjudgment of inner experience, and nonreactivity to inner experience (Baer et al., 2008). Using these questionnaires (and others), mindfulness has been shown to have positive effects on both psychological (Brown & Ryan, 2003) and physical (Monti et al., 2006) well-being. Some of the benefits of being mindful include: reductions in anxiety and increased positive affect (Brown & Ryan, 2003), an improved ability to cope with pain (Cioffi & Holloway, 1993), and an upregulation of the auto-immune response (Davidson et al., 2003).

Mindfulness may also lead to internally-focused attention that improves the accuracy of memory for prior remembering. As a therapeutic technique, with overall quality of life benefits, mindfulness is taught as a strategy which can be used to alter how people focus their attention on their own thoughts and perceptions (Bishop et al., 2004). Altering how people attend to their own thoughts is likely to have an effect on how well they remember those thoughts. Attending to our cognitions and elaborating on them may improve our ability to remember them.

Mindfulness has been argued to both promote and hinder elaboration. For example, researchers have argued that mindfulness promotes non-judgmental elaboration,

reduces response criterion, and widens access to our network of semantic knowledge during retrieval (Rosenstreich, 2016). A widened semantic network would likely counteract the impairment caused by changes in semantic context that typically impair memory for prior remembering by allowing participants easier access to multiple meanings of the target words. Participants with access to a wider semantic network should more likely be cued to previous semantic contexts despite a change in context, compared to participants with a smaller semantic network. According to prior theorizing (e.g., Arnold & Lindsay, 2002), memory for prior remembering should not be impaired if the retrieval context during Test 2 successfully cues that from Test 1. If that were the case, then memory for prior remembering should be positively correlated with dispositional mindfulness. Such a result would also support the claim that increased focus on cognition is associated with better memory for prior remembering.

Conversely, mindfulness may instead hinder elaborative processing. Crawley (2015) theorized that elaboration is affected by whether attention is focused on either internal or external stimuli. Crawley mapped the two focuses of attention onto what are known as the narrative self and the momentary self. The narrative self involves a focus on internal thoughts and elaborations on them, while the momentary self instead involves focusing on moment-to-moment experience without further elaboration. It has been suggested that people naturally bias their attention internally on their narrative self. Mindfulness training and trait mindfulness are both believed to shift that bias toward the momentary self (Farb et al., 2007). Such a shift moves a person's attention away from internal thoughts to perceiving current experience, which may then inhibit elaborative processing of that experience (Crawley, 2015).

Therefore, people who are high in dispositional mindfulness may focus more on perceiving current experience, which can include contextual information, than on their thoughts about that experience. If that were the case, then changes in context would likely be experienced as distinct and one context would be unlikely to cue memory for another. In the current dissertation, if the retrieval context during Test 2 does not cue that from Test 1, then memory for prior remembering should be impaired. Rather than a benefit, mindfulness could instead have a negative association with memory for prior remembering, or no association at all (since the default finding is that memory for prior remembering is impaired by changes in context). The semantic change condition in the present dissertation can be used to elucidate the effects that trait mindfulness has on semantic elaboration. One goal of this dissertation was to explore whether memory for prior remembering operates on similar principles to memory for stimuli and events. Therefore, to better understand which outcome is predicted, it is necessary to understand how mindfulness relates to other factors that affect memory.

There are two important ways in which mindfulness could indirectly impact memory: mindfulness is associated with hippocampal morphology (e.g., size and shape) and mindfulness improves attention. The former is important for understanding how mindfulness affects brain areas that are important for memory formation and the latter reflects why I will argue that mindfulness is a trait that can be associated with attention to cognitions could underlie memory for prior remembering. The discussion will first focus on the relationship between mindfulness and the hippocampus before shifting to attention. Understanding effects on hippocampal morphology is important because the hippocampus is the brain structure that is critically involved in the formation of long-term

memories (Squire, 1992). People who practice mindfulness have been shown to have greater gray matter volume in the right hippocampus compared to non-meditators (Hölzel et al., 2008). It could be argued that the morphological changes in the hippocampus are not associated with the practice of mindfulness meditation, *per se*, but rather that people with larger hippocampi self-select into a mindful lifestyle. This is unlikely, given that left hippocampal volume was found to be greater in a group of middle-aged adults that completed an eight-week mindfulness-based stress reduction course compared to a control group that did not practice meditation over the same period of time (Hölzel et al., 2011). It has also been demonstrated that meditation alters the functional activation of the hippocampus (Lazar et al., 2000). Given that meditation is a key component of mindfulness training (Kabat-Zinn, 2003), it would follow that mindfulness training would also affect hippocampal function in the short-term. These findings taken together suggest that there are both short- and long-term associations between mindfulness and the hippocampus.

A second factor that likely underlies the relationship between mindfulness and memory performance is the association between mindfulness and attentional processes (Jha, Krompinger, & Baime, 2007; Ruocco & Direkoglu, 2013). It is my argument that attention plays a major role in how we process our own cognitions, which I believe then underlies successful memory for prior remembering. In general, greater attention is known to benefit memory performance (see Mulligan, 2008, for a review) and should also benefit memory for prior remembering. Dispositional mindfulness may be one way of testing that argument because it has been associated with improvements in attentional processing (Ruocco & Direkoglu, 2013). It has also been shown that dispositional

mindfulness is associated with better performance on a variety of attentional tasks. For example, dispositional mindfulness, as measured by the MAAS, has been positively correlated with measures of sustained attention on a GO/NOGO task (Mrazek, Smallwood, & Schooler, 2012). GO/NOGO tasks require participants to respond to a frequently occurring stimulus (e.g., the letter “O”) while inhibiting their response to an infrequently occurring stimulus (e.g., the letter “Q”). It has also been shown that mindfulness training improves performance on the emotional Stroop task, in which it is typically more difficult to name the color in which a negative valenced word is written than a neutral word. Improved performance on the emotional Stroop task suggests that mindfulness is associated with heightened attention to primary task demands and that the natural inhibition caused by our highly learned reading behavior becomes less distracting (Lee & Orsillo, 2014).

In other cases, the association between mindfulness and attention is unclear. Higher scores on the observing subscale of the FFMQ predict better alerting scores on the Attention Networks Test and higher scores on the acting with awareness subscale predict slower reaction times and worse orienting scores (Di Francesco, et al., 2017). Those findings suggest that mindfulness can improve the ability to attend to external stimuli, but at the cost of being able to shift attention quickly. That finding fits with Crawley’s (2015) argument that mindfulness is associated with an external attentional bias. However, some experiments have failed to find a relationship between a brief mindfulness training session and performance on an *n*-back working memory task, or the Trail Making Test. Both the *n*-back and Trail Making Task are considered to be measures of attentional processing (Johnson, Gur, David, & Currier, 2015). Given these

relationships between mindfulness and attention, it is my argument that mindfulness can be used as a measure of attentional processing that could predict the efficacy of memory for prior remembering.

Despite the wide-ranging benefits of mindfulness on well-being and the relationships between mindfulness and other factors associated with memory that were just discussed, only recently have researchers begun to directly explore whether a relationship exists between mindfulness and performance on memory tasks. These explorations have typically taken one of two approaches: using mindfulness training programs to directly examine effects of mindfulness on behavior and measuring mindfulness as a dispositional trait that can underlie behavior without training. I will first discuss findings relating mindfulness training to memory before discussing how dispositional mindfulness relates to memory. Researchers have examined the relationship between mindfulness training and memory using paradigms that vary in the duration of training and the type of memory test being used. Mindfulness training often involves teaching participants how to perform directed body scans. During a body scan, participants' attention is drawn to bodily sensations and current thoughts, with instruction to withhold judgment on those perceptions (e.g., Bonamo, Legerski, & Thomas, 2015). This type of mindfulness training can involve as few as three minutes of recorded instructions, which has been shown to reduce false alarm rates on a recognition test, relative to listening to a documentary for the same duration (Lloyd, Szani, Rubenstein, Colgary, & Pereira-Pasarin, 2016). The frequency with which participants can freely recall specific memories in response to emotional cue words on the Autobiographical Memory Test (Williams & Broadbent, 1986) was found to increase from pre- to post-test

following seven-weeks of a mindfulness training program compared to a demographically-matched control group that underwent no training (Heeren, Van Broeck, & Philippot, 2009). Memory specificity refers to whether or not individual experiences can be reported in response to memory cues or if participants report general summaries of past experiences. Specific memories are more detailed and contain more information than general memories. Improved autobiographical memory specificity from pre- to post-test was also found in a population of formerly depressed participants who completed a mindfulness-based cognitive therapy program, while no improvement was found in a non-depressed control sample (Williams, Teasdale, Segal, & Soulsby, 2000).

Mindfulness training has been shown to increase the proportion of remember responses that are scored as hits in the remember/know paradigm and to improve recall of information from a passage relative to a control condition (Brown, Goodman, Ryan, & Anālayo, 2016; but see Watier & Dubois, 2016, for evidence that training did not affect recognition accuracy). Brown et al.'s (2016) results have interesting implications for how participants may perform on the memory for prior remembering task. In a remember/know paradigm participants learn a set of stimuli, before being given a recognition test. In addition to a recognition response, participants are also required to make a judgment about whether they “remember” the stimuli (i.e., they can recall specific details about the learning experience) or “know” that they learned the stimuli but do not have extra details to support that judgment. It has been shown that recollection of contextual details is highly concurrent with the use of remember responses (McCabe, Geraci, Boman, Sensenig, & Rhodes, 2011). As such, the greater number of remember

responses that participants give following mindfulness training seems to reflect better memory for contextual details.

Mindfulness has also been related to with performance on tests of word recall. Memory for Swahili-English word pairs was better following a brief mindfulness training session that occurred immediately prior to recall than for a control group that was tested immediately (Bonamo et al., 2015). Mindfulness training has also been shown to have effects on emotionally-valenced word recall. Mindfulness training has been shown to increase positive word recall from pre- to post-training (Roberts-Wolfe, Sacchet, Hastings, Roth, & Britton, 2012) and others have found a lower proportion of negatively-valenced word recall in a mindfulness training group relative to a control group (Alberts & Thewissen, 2011). In both cases, there were no differences between groups in total recall. It is important to note that mindfulness training can sometimes lead to increased recall of false memories. Mindfulness training has been shown to increase the endorsement of critical lures in the DRM paradigm relative to control groups in multiple experiments (Rosenstreich, 2016; Wilson, Mickes, Stolarz-Fantino, Evrard, & Fantino, 2015).

Researchers have also examined the relationships between mindfulness as a dispositional trait and memory. Dispositional mindfulness is defined as the tendency to behave in a more or less mindful way in everyday life (Brown, Ryan, & Creswell, 2007). Researchers have looked for associations between dispositional mindfulness and memory using mindfulness questionnaires like the MAAS and the FFMQ. In the Bonamo et al. (2015) experiment, mentioned previously, no relationship was found between scores on the FFMQ and recall performance, despite the beneficial effects that mindfulness training

had on recall of English-Swahili word pairs. Other researchers have also failed to find a relationship between scores on the FFMQ and memory. One such study explored how dispositional mindfulness, measured using the FFMQ, was associated with recognition memory. Rosenstreich and Ruderman (2016) compared participants' hit rates to their false alarm rates to assess the association between mindfulness and participants' ability to discriminate between new and old items. In a recognition memory experiment, a hit is a correct identification of a previously studied item as old and a false alarm is an incorrect identification of a new item as old. Rosenstreich and Ruderman (2016) used the term *sensitivity* to describe their measure (though it was calculated the same way as discrimination, d'), which they did not find to be associated with dispositional mindfulness. Their results suggested that dispositional mindfulness does not improve recognition memory performance. The lack of evidence to support a relationship between dispositional mindfulness and memory is in stark contrast to the positive effects that mindfulness training has on memory.

Other evidence suggests that the relationship between mindfulness and memory is less clear. The experiment by Brown et al. (2016), which was mentioned previously, failed to find a relationship between scores on the FFMQ and performance on the remember/know paradigm, but did find a positive association between state mindfulness (measured using the MAAS) and the proportion of remember responses that were scored as hits. In other words, people who were in a mindful state (as a result of training or assessment of current mental state) were shown to have better memory than those who were not in a mindful state. Lykins, Baer, and Gottlieb (2012) found that long-term mindfulness meditators had better recall performance on the California Verbal Learning

Test (CVLT) than a non-meditating control sample. The CVLT is a word list recall test which contains subscales for long- and short-delay retention intervals, as well as free and cued-recall. Even though mindfulness meditators scored higher on the FFMQ than non-meditators, no association was made between scores on the FFMQ and the CVLT.

Dispositional mindfulness, measured using the Freiburg Mindfulness Inventory (Walach, Buchheld, Buttenmuller, Kleinknecht, & Schmidt, 2006), has been found to be negatively correlated with autobiographical memory specificity (Crawley, 2015), but there was a positive correlation between mindfulness and the intensity of emotional recall experiences. The Freiburg Mindfulness Inventory measures mindful actions like presence and acceptance, which are similar to the FFMQ measures of observing and nonjudgment of thoughts and feelings, respectively.

Current research evidence suggests that the relationship between dispositional mindfulness and memory needs to be better defined. In some cases dispositional mindfulness has shown no relationship with memory, in others the relationship is unknown (e.g., free recall, false memory endorsement), and others have found a positive association. It is likely the case that how dispositional mindfulness is being measured underlies any associations with memory. Though the FFMQ and the MAAS both purport to measure mindfulness, the two measures focus on different aspects of the trait and there is a critical distinction between the two. The MAAS focuses on the attentional aspects of mindfulness, while the FFMQ measures mindfulness as a broad set of skills, of which attention is only one aspect of mindfully acting with awareness. Because I am specifically arguing that the role mindfulness plays in memory could be a product of attentional focus, the MAAS was used. By using the MAAS, this dissertation sought to

clarify the association between mindfulness and memory by exploring whether dispositional levels of mindful attention are associated with cued-recall and memory for prior remembering.

Based on the research that has been discussed, it is my argument that individual differences in dispositional mindfulness could be used to measure internally-focused attention on cognition. In particular, focusing on one's own cognitions may improve memory for prior remembering and that focus comes from attentional processing. Focusing attention on either internal thoughts could lead to elaboration and an increase in associations between a current cognition and previous experience. This is a novel application of Crawley's (2015) idea that dispositional mindfulness is related to differences in internal and external attentional control. To find a relationship between mindfulness and memory for prior remembering, it is important to use an appropriate measure of mindfulness.

Currently there are competing theories concerning the relationship between mindfulness and semantic elaboration and this dissertation can provide support for one theory or the other. Finding that higher levels of mindfulness are associated with better memory for prior remembering would support the theory that mindfulness can allow people to have better access to their network of semantic information and, as a result, better memory. Alternatively, finding that mindfulness has no association with memory for prior remembering or is associated with greater impairment would support the theory that mindfulness can manifest as greater external attention to present moment circumstances and an inhibition of internal processing. I tested the association between mindful attention and memory for prior remembering in each of the three conditions

described in the previous section about context change (semantic change, background change, and location change). Mindfulness was assessed using the MAAS, which was given during the retention interval of the memory for prior remembering paradigm adapted from Leppanen and Lyle (2018). To keep the discussion of predicted outcomes for both of the individual difference measures clearer, hypotheses for how dispositional mindfulness was expected to be associated with memory for prior remembering will be discussed in the general summary section.

Absorption

The second individual difference factor that I argue could predict memory for prior remembering is absorption (Tellegen & Atkinson, 1974). Absorption is defined as “a disposition for having episodes of ‘total’ attention that fully engage one’s representational resources” and is most often measured using the Tellegen Absorption Scale (TAS, Tellegen & Atkinson, 1974, p. 268). Measuring participants’ absorption will allow me to further test my idea that individual differences in internally-focused cognition affect memory for prior remembering. Absorption has received considerable attention in the literature for its association with hypnotic susceptibility (e.g., Nadon, Hoyt, Register, & Kihlstrom, 1991; Tellegen & Atkinson, 1974), but it has also been associated with memory and attentional processes. Absorption has also frequently been associated with other personality traits. People who score high on absorption measures also tend to score high on tests of traits like fantasy proneness (see Lynn & Rhue, 1988 for a summary of findings), visual imagery and vividness of visual imagery (Pekala, Wenger, & Levine, 1985), hypnotizability (Tellegen & Atkinson, 1974), fantastical thinking (Barret, 1996), procrastination (Sirois, 2014). Given the associations that

absorption has with other traits that involve high levels of internal focus, it was measured to assess whether internally-guided attention is associated with memory for prior remembering.

Although mindfulness and absorption were both measured in this dissertation to explore whether individual differences in how people focus on their own cognitions affect memory for prior remembering, the two traits may reflect different types of focus. Greater focus on one's cognitions may lead to stronger memory for those cognitions. I argued that mindfulness may play an important role in that process because of the association mindfulness has with attention (e.g., Jha et al., 2007). Similarly, absorption has been shown to be associated with attentional processes. People who score high in absorption also score high on measures of self-focused attention (Perona-Garcelán, et al., 2013), meaning they can become highly focused on themselves, rather than external experiences. In contrast to highly-mindful individuals, people who are high in absorption may focus their attention on elaborating about their own thoughts rather than noticing them and letting them pass. Intense focus on cognitive processing could be why people who are high in absorption are more susceptible to inattention blindness (Richards, Hellgren, & French, 2014), or the failure to notice a stimulus when a concurrent task also demands attention. People who are high in absorption may have their behavior guided less by external attention to stimuli and more by their own internal cognitions. Intense focus on one's cognitions could also be why absorption has been positively correlated with procrastination (Sirois, 2014). Sirois conceptualized procrastination as a focus of attention on present moment happiness with an avoidance of future thought, which

suggests that absorption can manifest as focused attention on current experience without respect to other points in time.

The results just presented support my argument that absorption is associated with periods of highly-focused attention on internal thought, which could impact memory for prior remembering. People who are highly absorbed in their current thoughts about a given task may elaborate more on the stimuli that are being learned and relate them to previous experience. If that were the case, absorption would positively predict memory for prior remembering. Participants who think a lot about changed-context targets may come across the previous thoughts about those targets. It would then be more likely for the Test 2 retrieval context to cue the Test 1 retrieval context and improve memory for prior remembering. Alternatively, as with mindfulness, it could be the case that absorption harms memory for prior remembering. Participants who are high in absorption may instead focus on each individual retrieval context and focus deeply on that specific information without thinking about it relates to their previous experience during Test 1. In that situation, there would instead be a reduced likelihood that the Test 2 retrieval context would cue that from Test 1 and memory for prior remembering and people who are high in absorption would show greater impairment than people who are low in absorption. To have a better understanding of which outcome is more likely, the discussion will now focus on the relationships that have already been found between absorption and memory.

Associations between absorption and memory for stimuli can be used to develop hypotheses about how absorption could affect memory for prior remembering. For example, people who are high in absorption (as measured by the TAS in all of the

following examples) have been shown to have a greater propensity to accept false information about the peripheral details of a staged classroom event than people who are low in absorption (Eisen & Carlson, 1998). It has also been shown that participants who scored higher on absorption were more likely to have a distorted memory for how they learned about a highly publicized event (i.e., the O.J. Simpson trial verdict). In the same sample, no relationship was found between absorption and false retrieval of critical lures on the DRM (Platt, Lacy, Iobst, and Finkelman, 1998). Those two findings suggest that absorption could be associated with embellishing or otherwise accepting new details about autobiographical events, but that same type of updating does not occur with verbal stimuli in a laboratory setting. However, absorption has not always been associated with more frequently reports of false memories. Participants who scored higher and those who scored low in absorption were equally likely to falsely endorse journal entries that they had not written as a previously retrieved memories (Horselenberg, Merckelbach, van Breukelen, & Wessel, 2004). There is also no evidence to suggest that people who are higher in absorption are more likely to create false memories for suggested childhood experiences than participants lower in absorption (Hyman & Billings, 1998). These results demonstrate that further research is needed to clarify the relationship between absorption and false memories.

Absorption has also been associated with memory in people who have highly-superior autobiographical memory (HSAM). People with HSAM have highly detailed memories for autobiographical events. For example, they perform better than control participants on the 10-dates questionnaire, which asks participants to recite which day of the week a specific date fell on and to describe any verifiable, public event that would

have occurred on that date (LePort et al., 2012). It has been proposed that people with HSAM have such good memory because deeper attentional processing of, or absorption in, events allows information to be related to oneself and people with HSAM engage in that form of processing more than the average person (Patihis, 2016). In one study, people with HSAM were found to have higher absorption scores than control participants and people with HSAM were shown to have a higher propensity to accept misinformation than control participants. In that study, controlling for absorption eliminated the difference between people with HSAM and controls in their overall number of reported false memories in a misinformation paradigm (Patihis et al., 2013). Despite having highly accurate autobiographical memory, people with HSAM still attend to and accept misinformation, much like the results of the previously discussed experiments with participants who could be assumed to have average memory ability. Therefore, it seems to be the case that regardless of baseline memory, people who are high in absorption are more accepting of false information into memory.

Absorption has also been associated with memory distortions, which has implications for how absorption may affect memory for prior remembering. A positive correlation has been found between absorption and both the number and frequency of memory distortions (Platt et al., 1998). This is relevant to memory for prior remembering because one way in which memories can be distorted is through the acceptance of new information (e.g., Belli, 1989). It could be the case that a memory distortion caused by the acceptance of new information does not only cause memory distortions, but also allows for new associations to be formed. This idea is relevant to the current discussion because we found in our research that participants being reminded of the learning context

during Test 1 improved their memory for prior remembering of changed-context targets (Leppanen & Lyle, 2018). We argued that this was because reminding allowed participants to form an association between the target, the learning context, and the Test 1 retrieval context. That association could only be formed if information about the learning context was brought back to mind and added to the experience of the Test 1 retrieval context.

Because reminding improves memory for prior remembering, it can be argued that accepting new information into a recently retrieved memory has beneficial effects. If people who are high in absorption are more likely to accept new information, then they may also be more likely to accept a spontaneous reminder of a previous memory into a new experience. In other words, participants who are high in absorption may be more likely to incorporate the study context into their memory for the act of Test 1 retrieval, regardless of a context change. What that would mean, is that for changed-context targets, the Test 2 retrieval context (which is identical to the study context) would be more likely to cue the Test 1 retrieval context and memory for prior remembering would be improved.

This dissertation explored whether absorption can predict memory for prior remembering. Even though previous researchers have frequently used the TAS, I used an updated version of the TAS. The modified Tellegen Absorption Scale (MODTAS, Jamieson, 2005) has stronger inter-scale correlations between the measure's separate subscales than the original TAS and all of the subscales were found to significantly load onto one higher-order factor which represents absorption. Using the MODTAS allowed

me to provide empirical support for whether highly-focused attention on internal thoughts is associated with participants' ability to remember prior instances of memory retrieval.

Conclusions

The previous three sections have discussed the impact of individual differences on cognition, with an emphasis on memory and attentional processes. Currently, little is known about individual differences in the accuracy of memory for prior remembering. The individual differences that were measured in this dissertation were selected to address my idea that individual differences in how people process their own cognitions affect how well those cognitions are remembered. To date, researchers have only shown that cognitive failures (as measured by the CFQ) are positively correlated with a difference score that represents the accuracy of memory for prior remembering. Throughout the previous two sections I have attempted to establish a connection between individual differences that are associated with internally-guided attention and memory for prior remembering. I have argued that attentional processes, which affect the encoding of stimuli, also affect the encoding of instances of memory retrieval. It is also likely that attention paid to cognitive processing can lead to elaboration of that processing which can produce more associations between a given cognitive operation and previous experience. In this dissertation internally-focused attention was measured as dispositional mindfulness and absorption. Both dispositional mindfulness and absorption have been found to have associations with memory and attentional processes. By relating scores on the MAAS and the MODTAS to memory for prior remembering of both same-context and changed-context targets, this dissertation will provide preliminary evidence

for how attention to and elaboration on cognitions can affect later memory for those cognitions.

The second research question of interest was whether individual differences in internally-guided attention, which were measured using the MAAS and the MODTAS, could predict memory for prior remembering. To answer that question, memory for prior remembering was measured using an adapted version of paradigm used by Leppanen and Lyle (2018). The proportion of correct judgments of prior remembering were related to scores on the MAAS and the MODTAS. If you recall, in this paradigm, participants studied cue-target pairings and were subsequently given two cued-recall tests for the targets. Critically, after the second cued-recall test participants were asked to make judgments about their prior remembering. Participants were required to indicate whether they believed they retrieved each target during the first cued-recall test or not. Aside from the context manipulations previously discussed, the second novel contribution of this dissertation was to assess whether scores on the MAAS and the MODTAS could predict memory for prior remembering. If any associations exist between internally-guided attention and memory for prior remembering, the design of this dissertation allowed me to test whether any predictive power could be generalized across multiple types of context (semantic, background color, and screen location) or whether predictive power differs based on the type of contextual change.

Previous researchers have suggested that internally-guided attention can either improve (Rosenstreich, 2016) or impair (Crawley, 2015) the elaboration of stimuli – at least when theories focus on the attentional aspects of mindfulness – which could subsequently affect how well Test 2 retrieval contexts cue Test 1 retrieval contexts. I

hypothesized that memory for prior remembering would be negatively predicted by total MAAS scores following all three types of contextual change. Previous research suggests that participants who focus on present retrieval contexts without respect to past contexts should show poorer memory for prior remembering of changed-context targets than participants who focus more on their own cognitions. I also hypothesized that there will be no association between dispositional mindfulness and memory for prior remembering of same-context targets. Conversely, I hypothesized that memory for prior remembering would be positively predicted by scores on the MODTAS in all three contextual change conditions. If people who are absorbed attend to the stimuli they are learning on a deeper level and relate those stimuli to previous experience, then they would be expected to have access to a wider array of retrieval cues, which would be expected to improve memory for prior remembering. Such a process would only be expected to benefit memory for prior remembering of changed-context targets because memory for prior remembering of same-context targets is typically near ceiling (e.g., Arnold & Lindsay, 2002; Leppanen & Lyle, 2018). As such, I hypothesized that memory for prior remembering of same-context targets would not be predicted by scores on the MODTAS in any condition. It is also of interest whether mindfulness and absorption measure similar constructs or if the two traits represent distinct ways of focusing on experience. As such, scores on the MAAS and the MODTAS were correlated with one another. I hypothesized that scores on the MAAS and the MODTAS would be positively correlated, given that an association between scores on the original TAS and some subscales on the FFMQ has previously been found (Grant et al., 2013).

CHAPTER II

METHODS

Participants and Design

Undergraduate students ($N = 180$; 117 female; aged 18-30 years, $M = 20$) participated for course credit. Sixty participants were in each of three conditions. All participants completed the MAAS and the MODTAS. This dissertation had a 2 (Test 1 context: same versus changed) \times 3 (Change type: semantic, background, location) mixed-factorial design, with Test 1 context as the between subjects factor and change type as the within-subjects factor. Memory for prior remembering (measured as the proportion of correct judgments of memory for prior remembering for same-context and changed-context targets following in each change condition) was regressed on total scores on the MAAS and total scores on the MODTAS to measure individual difference effects.

Materials

Study materials consisted of 113 homographic target words (selection criteria can be found in Arnold & Lindsay, 2002). Four words served as primacy buffers and four served as recency buffers, leaving 105 critical targets for analysis. Since each target was a homograph, two possible cues were used which corresponded to two possible meanings of the target (e.g., *hand* and *tree* were cues for the target *palm*). Study lists were created by counterbalancing the pairing of each target with each of the two possible cues such that each cue served as the study cue equally often across conditions. Test lists were created by counterbalancing groups of 35 cue-target pairings into each of three Test 1

treatments: tested with the same context as study (same-context targets), tested with the other possible context (changed-context targets), and not tested. The counterbalancing of test lists was based on assigning specific cue-target pairings from the study phase into each treatment. This means that the type of change (semantic, background color, or screen location) did not affect which cue-target pairings were assigned to which treatment. For example, *hand – palm* was a studied cue-target pairing in the same-context treatment, the other context treatment, and the not tested treatment an equal amount of times, irrespective of what type of change occurred. Each target was tested in the study context on Test 2, regardless of Test 1 treatment.

MAAS

Individual differences in dispositional mindfulness were measured using the MAAS (Brown & Ryan, 2003). The MAAS is a 15-item questionnaire which asks participants to rate how often they experience certain events, such as, “I find it difficult to stay focused on what’s happening in the present”, on a 6-point Likert-type scale (1 = *Almost always* to 6 = *Almost Never*). Ratings for all items were averaged together to obtain a mindfulness score which could range from 1 to 6. Higher scores indicated higher levels of dispositional mindfulness.

MODTAS

Individual differences in absorption were assessed using the MODTAS (Jamieson, 2005). The MODTAS is a 34-item questionnaire which asks participants to rate their agreement with a series of statements, such as, “When I listen to music, I get so caught up in it that I don’t notice anything else”, on a 5-point Likert-type scale (0 = *Never* to 4 = *Very Often*). To my knowledge, the precedent in the literature is to measure

absorption as a single construct and not to analyze the individual subscales separately (e.g., Horselenberg, et al., 2004; Platt et al., 1998; Sirois, 2014). As such, ratings for all items were summed together to obtain a single absorption score. Scores could range from 0 to 136, with higher scores indicating higher levels of absorption.

Procedure

The same three-step procedure, modeled after Arnold and Lindsay (2002), was used for each type of contextual change. The first phase of the procedure was the study phase. The second and third phases were both cued-recall tests, separated by a retention interval. Each phase is described in more detail below.

Participants were tested in groups of up to five on individual computers in a laboratory testing room using E-Prime 2.0 software. The procedure used in this dissertation followed that of Leppanen and Lyle (2018), which differed from that of Arnold and Lindsay (2002), in that participants completed the experiment individually on a computer without an experimenter to record recall responses, nor was there auditory recording of responses.

Study Phase

Following informed consent participants began the study phase of the experiment. In each condition, participants read the same study instructions. Participants were asked to attend to each cue-target pairing and learn that they go together. Participants were instructed to study the series of cue-target word pairs because their memory for them would be tested later. In the study phase, participants in all conditions viewed the same 105 critical cue-target word pairs (e.g., *hand-palm*, *dog-bark*), preceded by four primacy buffers, and followed by four recency buffers. During the study phase, each

homographic target was paired with one of two possible cues (e.g., *palm* could be cued by either *hand* or *tree*). Critical cue-target pairs were presented in a new random order for each participant. In the semantic change and background change conditions, each study trial began with a cue-target pairing in the center of a white screen, in black font, for 2000 ms. In the location change condition all of the study pairs were presented at the top of the computer screen (centered, 10% below the top edge of the screen). Cue-target pairs were then replaced with a sentence, in the same location as the cue-target pairing, containing the cue word and three asterisks which represented the point in the sentence in which the target would logically go (e.g., *He used the *** of his hand to swat a fly*, for the target word *palm*). The sentence appeared on the screen alone for 3500 ms and then the target word appeared above the sentence for an additional 1000 ms. As such, each study trial lasted 6500 ms. Study trials were separated by a 1000 ms inter-trial interval.

Test 1 Phase

Immediately following the study phase, participants began the Test 1 phase. Test 1 was a self-paced, cued-recall test. For each Test 1 trial, a cue word and a partially completed target, word consisting of the first and last letters of a studied target separated by dashes (e.g., *hand – p _ _ m*), were presented on the screen. Participants were instructed to type the entire target word rather than typing only the missing letters. During Test 1, targets were assigned to one of three treatments: tested in the study context (same-context targets), tested in a new context (changed-context targets), or not tested (not tested targets). In the semantic change condition, same-context targets were those that were paired with the study cue, while changed-context targets were those that were paired with the other possible cue which was semantically-related to the target, but

had not been studied previously. Unlike the semantic change condition, cue-target pairings in the background and location change conditions remained the same throughout the study. In the background change condition, same-context targets were presented in black font on the same white background as the study phase, while changed-context targets were presented in black font on a yellow background. In the location change condition, same-context targets were presented at the top of the screen, while changed-context targets were presented at the bottom of the screen (centered, 20% from the bottom of the screen to allow for the response box to be located below the stimuli in both treatments). Participants were instructed to respond with a target they remembered viewing during the study phase and to respond with “pass” if they were unable to recall a target from the study phase. Participants were given an example of how to respond. On each trial, participants were given feedback on whether they were correct or incorrect. There was a seven-minute retention interval following Test 1, during which time participants completed the MAAS and the MODTAS. The order in which the two questionnaires were completed was counterbalanced and achieved by stapling the questionnaires in one of the two possible orders.

Test 2 Phase

Test 2 was a second cued-recall test. Participants were informed that all of the words from the study phase would be tested in the same context they were viewed in during the study phase (i.e., original study cues for all targets in the semantic change condition, white background for all targets in the background change condition, and all targets were presented at the top of the screen in the location change condition). Participants were instructed to respond by typing in a target they remembered viewing

during the study phase. Following each cued-recall attempt, participants were also asked to make a judgment of their prior remembering. Participants were asked: “*Did you retrieve this target during the first test? Yes (y) or No (n)*”. Participants were instructed to make their judgment irrespective of the context in which the target appeared during Test 1. If a participant remembered seeing “incorrect” as feedback after attempting to retrieve a target on Test 1, or if they remembered responding with “pass”, they were instructed to make the judgment that the target had not been previously retrieved. After Test 2, participants were debriefed and dismissed.

CHAPTER III

RESULTS

Context Effect Analyses

The first aim of this dissertation was to test whether changing contextual features other than the semantic context would impair memory for prior remembering. Even though the focus of this dissertation is on accuracy of memory for prior remembering, cued-recall performance was also analyzed (e.g., Arnold & Lindsay, 2002; Leppanen & Lyle, 2018).

Context Effects on Cued Recall

Cued-recall performance on Test 1 was calculated as the proportion of correct target retrievals (see Table 1). Performance was analyzed using a 2 (Test 1 context: same or changed) \times 3 (change type: semantic, background, location) mixed-factorial ANOVA, with Test 1 context as the within-subjects variable and change type as the between-subjects variable. The main effect of Test 1 context was significant, showing that cued-recall of targets on Test 1 was greater for same-context targets ($M = .79$) than changed-context targets ($M = .75$), $F(1, 177) = 25.03, p < .001, \eta_p^2 = .124$. There was also a significant main effect of change type, $F(2, 177) = 7.02, p = .001, \eta_p^2 = .074$. Follow-up independent samples t tests revealed that participants in the semantic change condition recalled a significantly lower proportion of targets on Test 1 ($M = .72$) than participants in the background change ($M = .79$) or the location change ($M = .80$) conditions, smallest $t(118) = 3.19, p = .002, d = 4.43$. Test 1 cued-recall did not differ between the

background or location change conditions. The main effects were qualified by a significant interaction, $F(2, 177) = 23.89, p < .001, \eta_p^2 = .213$. The interaction was explored with follow-up paired-samples t tests for each change type separately. In the semantic change condition, same-context target retrieval on Test 1 ($M = .78$) was significantly better than changed-context target retrieval ($M = .66$), $t(59) = 7.39, p < .001, d = .974$. In contrast, same-context target retrieval and changed-context target retrieval on Test 1 did not differ in either the background change or location change condition, smallest $p = .910$ (see Figure 1).

Table 1
Proportion of Targets Recalled Correctly Across Change Type

	Change Type		
	Semantic	Background	Location
Test 1 Same-Context	.78 (.02)	.79 (.02)	.80 (.02)
Test 1 Changed-Context	.66 (.02)	.79 (.02)	.80 (.02)
Test 2 Same-Context	.83 (.02)	.83 (.02)	.84 (.02)
Test 2 Changed-Context	.82 (.02)	.83 (.02)	.84 (.02)
Test 2 Not Tested	.80 (.02)	.80 (.02)	.79 (.02)

Notes: Numbers in parentheses are standard errors of the mean.

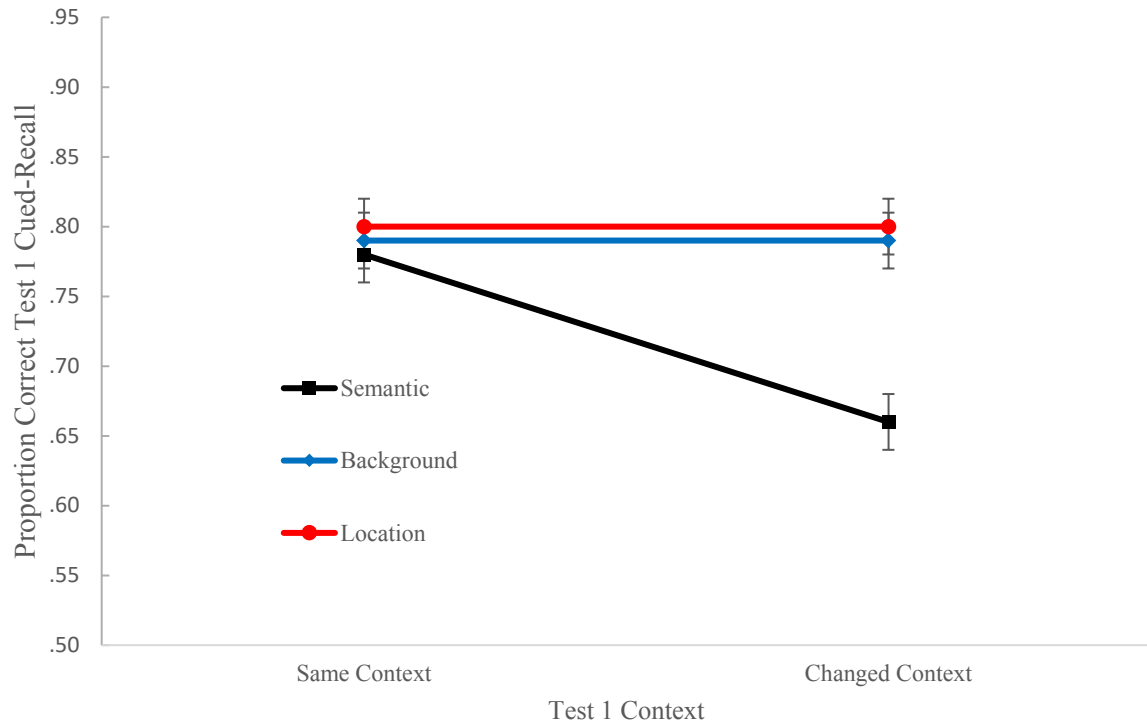


Figure 1. Proportion correct target recall on Test 1. Error bars represent one standard error of the mean.

Cued-recall performance on Test 2 was calculated as the proportion of correct target retrievals. The proportion of targets retrieved correctly was analyzed using a 3 (Test 1 context: same, changed, or not tested) × 3 (change type: semantic, background, location) mixed-factorial ANOVA, with Test 1 context as a within-subjects factor and change type as a between-subjects factor. The main effect of Test 1 context was significant, $F(2, 176) = 21.80, p < .001, \eta_p^2 = .199$. There was no significant interaction between Test 1 context and change type ($p = .666$). The main effect of Test 1 context was explored with follow-up paired-samples t tests comparing the proportion of correct recall of same-, changed-, and not tested targets to each other across the three types of change. Test 2 recall did not differ between same-context targets ($M = .83$) and changed-

context targets ($M = .83$), but not tested targets ($M = .79$) were recalled significantly less often than either previously tested cue type, smallest $t(179) = 5.55, p < .001, d = .32$ (see Figure 2).

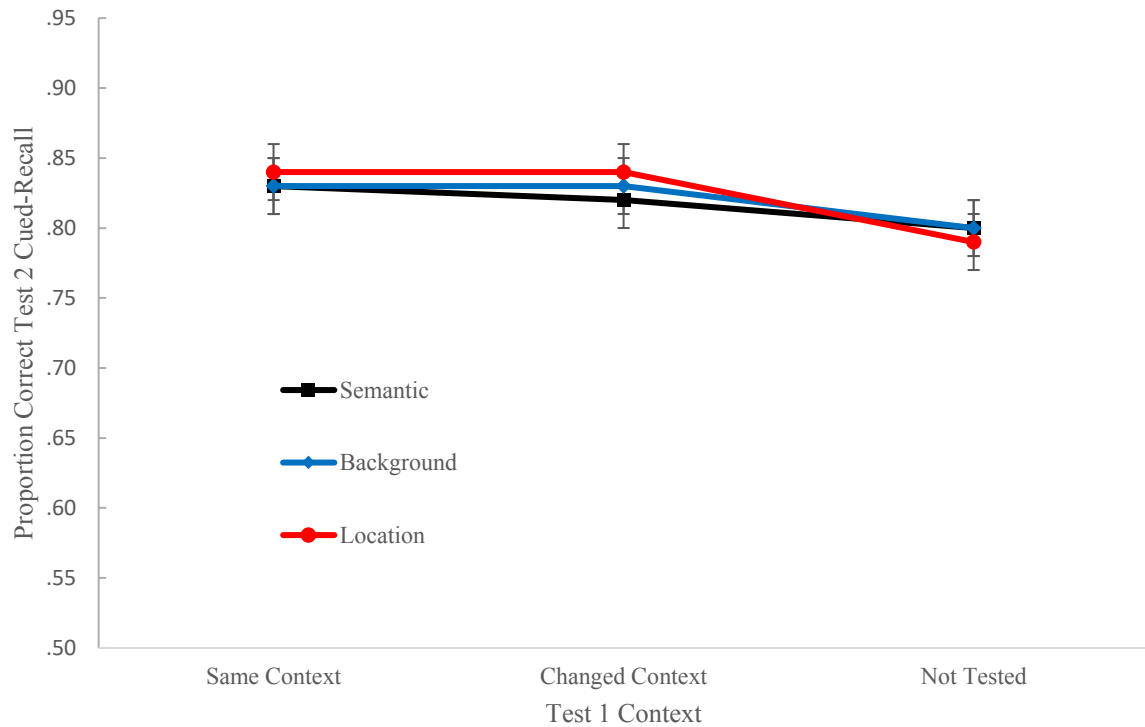


Figure 2. Proportion correct target recall on Test 2. Error bars represent one standard error of the mean.

Context Effects on Memory for Prior Remembering

Memory for prior remembering analyses were run contingent upon correct target retrieval on both Test 1 and Test 2 (e.g., Arnold & Lindsay, 2002; Leppanen & Lyle, 2018). Accurate memory for prior remembering was defined as a “yes” judgment to the memory for prior remembering probe following cued-recall attempts on Test 2 (“*Did you retrieve this target on the first test?*”). Tables 2-4 show the proportion (and raw number) of targets judged to have been previously retrieved on Test 1 in response to the memory

for prior remembering probe on Test 2. The proportion of correct judgments of memory for prior remembering was analyzed using a 2 (Test 1 context: same or changed) X 3 (change type: semantic, background, location) mixed-factorial ANOVA, with Test 1 context as a within-subjects factor and change type as a between-subjects factor. The main effect of Test 1 context (see Figure 3) was significant, $F(1, 177) = 85.20, p < .001, \eta_p^2 = .325$. A follow-up paired-samples t test revealed that the accuracy of memory for prior remembering of same-context targets ($M = .91$) was significantly higher than that of changed-context targets ($M = .82$), $t(179) = 6.50, p < .001, d = .48$. However, this main effect was qualified by a significant interaction with change type, $F(2, 177) = 91.97, p < .001, \eta_p^2 = .510$. To explore the interaction, separate paired-samples t tests were run for each change type separately (semantic, background, location). In the semantic change condition, accuracy of memory for prior remembering of same-context targets ($M = .91$) was significantly higher than that of changed-context targets ($M = .63$), $t(59) = 10.33, p < .001, d = 1.47$. In the background change condition, accuracy of memory for prior remembering of same-context targets ($M = .92$) did not significantly differ from that of changed-context targets ($M = .91$), $p = .124$. In the location change condition, the pattern of results was opposite that of the semantic change condition. Accuracy of memory for prior remembering of changed-context targets ($M = .92$) was significantly higher than that of same-context targets ($M = .90$), $t(59) = 2.00, p = .05, d = .22$.

Table 2

Mean Number of Targets and Mean Proportion of Targets Judged as “recalled” as a Function of Recall Status on Test 1 for the Semantic Change Condition

Test 1/Test 2 Recall Status	Number of Targets	Proportion Judged as “recalled” on Test 1
Same cue*		
Recalled/Recalled	26.27	.91 (.01)
Recalled/Not Recalled	1.15	.61 (.07)
Not Recalled/Not Recalled	4.93	.22 (.04)
Not Recalled/Recalled	2.65	.53 (.06)
Changed cue*		
Recalled/Recalled	20.25	.63 (.03)
Recalled/Not Recalled	2.78	.33 (.06)
Not Recalled/Not Recalled	3.43	.21 (.04)
Not Recalled/Recalled	8.43	.37 (.05)
Not tested*		
NA/Recalled	27.88	.36 (.04)
NA/Not Recalled	7.12	.15 (.03)

NA = Not applicable. * Test 1 context. Numbers in parentheses are standard errors of the mean. Lines in bold are those for which statistical analyses are reported in the text.

Table 3

Mean Number of Targets and Mean Proportion of Targets Judged as “recalled” as a Function of Recall Status on Test 1 for the Background Change Condition

Test 1/Test 2 Recall Status	Number of Targets	Proportion Judged as “recalled” on Test 1
Same cue*		
Recalled/Recalled	26.57	.92 (.01)
Recalled/Not Recalled	1.18	.66 (.07)
Not Recalled/Not Recalled	4.73	.28 (.05)
Not Recalled/Recalled	2.52	.53 (.05)
Changed cue*		
Recalled/Recalled	26.68	.91 (.01)
Recalled/Not Recalled	1.03	.52 (.08)
Not Recalled/Not Recalled	4.90	.27 (.05)
Not Recalled/Recalled	2.38	.55 (.06)
Not tested*		
NA/Recalled	27.83	.34 (.04)
NA/Not Recalled	7.17	.15 (.03)

NA = Not applicable. * Test 1 context. Numbers in parentheses are standard errors of the mean. Lines in bold are those for which statistical analyses are reported in the text.

Table 4

Mean Number of Targets and Mean Proportion of Targets Judged as “recalled” as a Function of Recall Status on Test 1 for the Location Change Condition

Test 1/Test 2 Recall Status	Number of Targets	Proportion Judged as “recalled” on Test 1
Same cue*		
Recalled/Recalled	26.90	.90 (.01)
Recalled/Not Recalled	1.05	.55 (.07)
Not Recalled/Not Recalled	4.60	.21 (.04)
Not Recalled/Recalled	2.45	.44 (.05)
Changed cue*		
Recalled/Recalled	26.83	.92 (.01)
Recalled/Not Recalled	1.07	.56 (.07)
Not Recalled/Not Recalled	4.63	.23 (.04)
Not Recalled/Recalled	2.47	.54 (.05)
Not tested*		
NA/Recalled	27.63	.34 (.04)
NA/Not Recalled	7.37	.13 (.03)

NA = Not applicable. * Test 1 context. Numbers in parentheses are standard errors of the mean. Lines in bold are those for which statistical analyses are reported in the text.

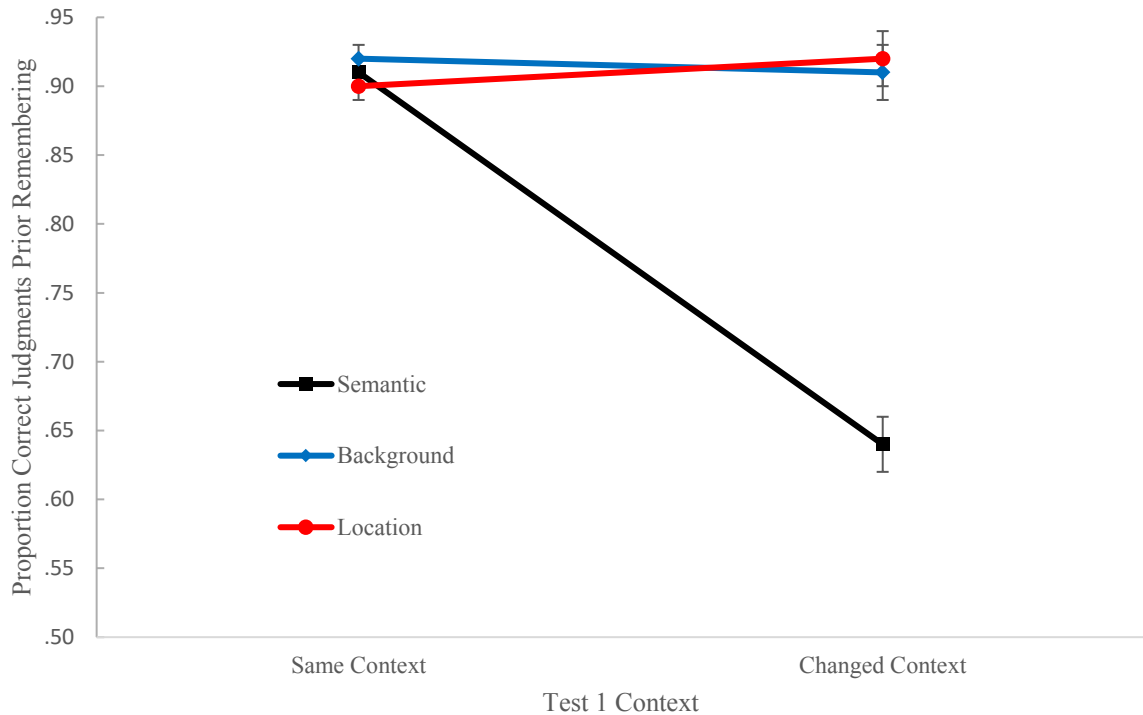


Figure 3. Proportion correct judgments of memory for prior remembering across the three change types. Judgments were only analyzed for targets which were correctly retrieved on both Test 1 and Test 2. Errors bars represent one standard error of the mean.

I also examined if the accuracy of memory for prior remembering of changed-context targets differed between the three change types. Independent-samples *t* tests revealed that accuracy of memory for prior remembering of changed-context targets was significantly worse following a change in semantic context ($M = .63$), than following either of the other two change types ($M_s = .91$ and $.92$, for the background change and location change conditions, respectively), smallest $t(118) = 8.04, p < .001, d = 1.52$. Accuracy of memory for prior remembering of changed-context targets did not significantly differ between the background change and location change conditions, $p = .372$.

Individual Difference Analyses

The second aim of this dissertation was to explore if dispositional mindfulness and absorption could predict memory for prior remembering. Neither scores on the MAAS, nor scores on the MODTAS differed as a function of questionnaire order, smallest $p = .293$, and as such, all analyses were collapsed across order. The correlation between scores on the MAAS ($M = 53.3$) and scores on the MODTAS ($M = 60.8$) did not reach the cutoff of statistical significance, $r = -.14$, $p = .063$.

Correlations between Cued Recall, Memory for Prior Remembering, scores on the MAAS, and scores on the MODTAS

Pearson's correlations were calculated between the individual difference measures (MAAS and MODTAS scores) and the dependent variables. From Test 1, the proportion of correct same- and changed-context target retrieval were included. From Test 2, the proportion of correct same- and changed-context target retrieval, and the proportion of correct not tested target retrieval were included. The proportion of correct judgments of memory for prior remembering for same- and changed-context targets were also included. Finally, a contextual change difference score was added to the correlation analyses. Contextual change difference scores were calculated by subtracting the proportion of correct judgments of memory for prior remembering for changed-context targets from that of same-context targets. Contextual change difference scores were added to assess the effect of contextual change on memory for prior remembering while accounting for baseline memory performance. Full correlation matrices can be found in the in Tables 5-7.

Across all three types of change, an expected positive correlation was found between all of the cued-recall measures, smallest $r = .35, p = .007$. The only significant correlation between cued-recall and memory for prior remembering was found in the background color condition. In the background condition, the proportion of changed-context targets that were retrieved on Test 1 was negatively correlated with the contextual change difference score, $r = -.27, p = .041$. There were also significant positive correlations between the proportion of correct judgments of memory for prior remembering for same- and changed-context targets in all three conditions, smallest $r = .61, p < .001$. The only significant correlations between the individual difference measures and accuracy of memory for prior remembering were found in the semantic change condition. In the semantic change condition, there was a significant positive correlation between MODTAS scores and the proportion of correct memory for prior remembering judgments of same-context targets, $r = .29, p = .026$. There was also a significant positive correlation between MODTAS scores and the proportion of correct memory for prior remembering judgments of changed-context targets, $r = .27, p = .035$.

Table 5Correlation Matrix for the Semantic Change Condition

Variable	Correlations									
	1	2	3	4	5	6	7	8	9	10
1 Total MAAS	–									
2 Total MODTAS	.05	–								
3 Test 1 Same-Context Cued Recall	-.11	-.12	–							
4 Test 1 Changed-Context Cued Recall	.07	-.06	.47***	–						
5 Test 2 Same-Context Cued Recall	-.18	.09	.85***	.42***	–					
6 Test 2 Changed-Context Cued Recall	-.12	.01	.66***	.46***	.69***	–				
7 Test 2 Not Tested Cued Recall	-.32*	.14	.57***	.35**	.69***	.78***	–			
8 Same-context MPR	.06	.29*	.13	.02	.24	.09	.07	–		
9 Changed-Context MPR	.07	.27*	.01	-.04	.05	-.11	-.09	.61***	–	
10 Contextual Change Difference Score	-.06	-.20	.05	.05	.04	.17	.14	-.30*	-.94***	–

Note: MPR = proportion correct judgments of memory for prior remembering. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 6Correlation Matrix for the Background Color Change Condition

Variable	Correlations										
	1	2	3	4	5	6	7	8	9	10	
1 Total MAAS	–										
2 Total MODTAS	-.31	–									
3 Test 1 Same-Context Cued Recall	.06	-.08	–								
4 Test 1 Changed-Context Cued Recall	-.06	-.11	.73***	–							
5 Test 2 Same-Context Cued Recall	-.06	-.10	.90***	.72***	–						
6 Test 2 Changed-Context Cued Recall	.01	-.12	.66***	.89***	.69***	–					
7 Test 2 Not Tested Cued Recall	.05	-.27*	.72***	.75**	.74***	.74***	–				
8 Same-context MPR	-.05	.07	-.04	-.2	-.08	-.18	-.23	–			
9 Changed-Context MPR	-.11	-.03	.08	< .01	.06	.06	-.06	.73***	–		
10 Contextual Change Difference Score	.08	.14	-.17	-.27*	-.19	-.31*	-.21	.28*	-.46***	–	

Note: MPR = proportion correct judgments of memory for prior remembering. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 7Correlation Matrix for the Screen Location Change Condition

		Correlations									
Variable	1	2	3	4	5	6	7	8	9	10	
1 Total MAAS	–										
2 Total MODTAS	-.14	–									
3 Test 1 Same-Context Cued Recall	-.02	-.22	–								
4 Test 1 Changed-Context Cued Recall	.04	-.20	.75***	–							
5 Test 2 Same-Context Cued Recall	.09	-.16	.91***	.77***	–						
6 Test 2 Changed-Context Cued Recall	.11	-.17	.70***	.92***	.76***	–					
7 Test 2 Not Tested Cued Recall	.10	-.13	.73***	.76**	.79***	.78***	–				
8 Same-context MPR	.10	.06	.14	.01	.12	-.04	.09	–			
9 Changed-Context MPR	.12	.07	-.02	-.03	< .01	-.08	-.08	.66***	–		
10 Contextual Change Difference Score	< -.01	< .01	.20	.05	.16	.04	.20	.50*	-.32***	–	

Note: MPR = proportion correct judgments of memory for prior remembering. * $p < .05$, ** $p < .01$, *** $p < .001$

Predictive Power of the MAAS and the MODTAS on Cued-Recall Performance

For each type of change (semantic, background, location), seven multiple linear regression analyses were run. Separate multiple linear regressions were run to predict Test 1 cued-recall performance (total, same-context, and changed-context) and Test 2 cued-recall performance (total, same-context, changed-context, not tested). Each multiple linear regression analysis consisted of two steps. In the first step, scores on the MAAS and scores on the MODTAS were entered as predictor variables, in stepwise fashion, with a significance cutoff of $p = .05$ for inclusion in the model. In the second step, an interaction term (calculated by mean-centering each participant's MAAS and MODTAS scores before multiplying them together) was entered, in a stepwise fashion, with a significance cutoff of $p = .05$ for inclusion in the model. In the semantic change condition, cued-recall of not tested targets on Test 2 was significantly predicted by MAAS scores (see Table 8), $F(1, 59) = 6.57, p = .013$. In the background change condition, cued-recall of not tested targets on Test 2 was significantly predicted by MODTAS scores (see Table 9), $F(1, 59) = 4.63, p = .036$. No other regressions revealed significant predictors of cued-recall performance.

Table 8

Multiple Linear Regression Results When Predicting Cued Recall of Not Tested Targets on Test 2 Following a Change in Semantic Context

Predictor	β	R^2	t	p
MAAS	-.003	.102	-2.56	.013
MODTAS	--	--	1.28	.203
MAAS x MODTAS	--	--	-.57	.569

Table 9

Multiple Linear Regression Results When Predicting Cued Recall of Not Tested Targets on Test 2 Following a Change in Background Context

Predictor	β	R^2	t	p
MODTAS	-.001	.074	-2.15	.036
MAAS	--	--	-.29	.772
MAAS x MODTAS	--	--	-.05	.963

Predictive Power of the MAAS and the MODTAS on Memory for Prior Remembering

For each condition (semantic change, background change, location change), three multiple linear regression analyses were run. Separate multiple linear regressions were run to predict the proportion of correct memory for prior remembering judgments for same-context targets, the proportion of correct memory for prior remembering judgments for changed-context targets, and contextual change difference scores. Each multiple

linear regression analysis consisted of two steps. In the first step, scores on the MAAS and scores on the MODTAS were entered as predictor variables, in stepwise fashion, with a significance cutoff of $p = .05$ for inclusion in the model. In the second step, an interaction term (calculated by mean-centering each participant's MAAS and MODTAS scores before multiplying them together) was entered, in stepwise fashion, with a significance cutoff of $p = .05$ for inclusion in the model. The only significant predictors were found in the semantic change condition. Scores on the MODTAS significantly predicted accuracy of memory for prior remembering judgments for same-context targets, $F(1, 59) = 5.21, R^2 = .082, p = .026$, and changed-context targets, $F(1, 59) = 4.66, R^2 = .074, p = .035$. Tables 10 and 11 display the beta weights, R^2 values, t statistic, and significance for the models with significant predictors. Scores on the MODTAS, scores on the MAAS, and their interaction term did not significantly predict contextual change difference scores in the semantic change condition.

Table 10

Multiple Linear Regression Results When Predicting Same-context Memory for Prior Remembering in the Semantic Context Condition

Predictor	β	R^2	t	p
MODTAS	.001	.082	2.28	.026
MAAS	--	--	.36	.719
MAAS x MODTAS	--	--	.81	.423

Table 11

Multiple Linear Regression Results When Predicting Changed-context Memory for Prior Remembering in the Semantic Change Condition

Predictor	β	R^2	t	p
MODTAS	.003	.074	2.16	.035
MAAS	--	--	.47	.641
MAAS x MODTAS	--	--	.65	.518

CHAPTER IV

DISCUSSION

The purpose of this dissertation was to explore factors affecting memory for prior remembering. Specifically, two factors that influence the accuracy of memory for prior remembering were explored by adapting a paradigm that was originally developed by Arnold and Lindsay (2002) and later used by Leppanen and Lyle (2018). The two factors were context change and individual differences. The discussion will first focus on the findings related to context change before moving on to a discussion of the individual differences findings.

Context and Memory for Prior Remembering

First, three different context changes were examined to test what types of contextual changes affect memory for prior remembering. The effects of changing semantic, background, and screen location contexts on the accuracy of memory for prior remembering were compared. I hypothesized that changing any contextual feature between instances of memory retrieval would impair memory for prior remembering of changed-context targets. Participants learned a series of cue-target pairs and were asked to retrieve them twice. On Test 1, participants retrieved targets in one of two contexts. In the same-context condition, cued-recall occurred in the same context throughout the course of the experiment. In other words, the cue, background color, or location on screen of same-context targets never changed. In the changed-context condition, cued-recall occurred with one contextual feature being different (e.g., the cue changed in the

semantic condition) between Test 1 and Test 2. Consistent with previous research (e.g., Arnold & Lindsay, 2002; Leppanen & Lyle, 2018), changing the semantic context in which targets were retrieved impaired memory for prior remembering. In contrast, there was no impairment caused by changes in background color context or screen location context. In fact, memory for prior remembering improved following a change in screen location.

This dissertation tested Arnold and Lindsay's (2002; 2005) idea that memory for cognitive operations (e.g., an act of memory retrieval) operates on the same principles as memory for stimuli. The current findings provided support for the idea that specific types of context change affect memory for stimuli and memory for prior remembering in the same fashion. Cued-recall of changed-context targets on Test 1 was worse than that of same-context targets in the semantic change condition, but not in the background color or location change conditions. A similar pattern was found when examining memory for prior remembering. The difference was that memory for prior remembering of changed-context targets was improved by a change in screen location rather than being unaffected by the change. Therefore, it was shown that recall of targets and recall of previous acts of retrieval were similarly affected or unaffected by changes to specific types of contextual features.

As was discussed in the introduction, researchers have suggested that contextual features can be categorized based on their associations with performance in different memory paradigms (e.g., cued-recall versus recognition). One such categorization scheme separates contextual features into local and global feature categories (Dalton, 1993). Local contextual features are those that are associated with one, or very few items

in memory (e.g., the semantic condition in this dissertation), whereas global contextual features can be associated with many items in memory (e.g., the background and location conditions). Previous research has shown that changing local contextual features between study and retrieval is associated with contextual change effects (e.g., Dalton, 1993). A contextual change effect is found when memory retrieval is impaired by retrieving an item in a different context than it was studied in. Conversely, changing global contextual features between study and retrieval has inconsistent effects on memory retrieval (e.g., Smith, 1986). For example, changing the physical location between study and test impairs free recall performance, but not recognition performance (Godden & Baddeley, 1980). The present results suggest that contextual features should be separated into local and global categories when discussing effects of context change on memory for prior remembering. The present dissertation utilized semantic context as an example of a local contextual feature, whereas both background color and screen location acted as global contextual features. Changing a local contextual feature had an impairing effect on both cued-recall and memory for prior remembering, but changing global contextual features had inconsistent effects. Cued-recall was not impaired by changing background color or screen location of the cue-target pairs, while memory for prior remembering was not affected by a change in background color and was improved by a change in screen location.

The results may also be interpreted as a demonstration that changes to memory content impair memory for prior remembering, but changes to context do not. Why may that be the case? When you see the word *bark*, you may think about how that word represents the sound a dog makes or part of a tree. Under those circumstances, the

meaning of the words could be interpreted as the stimulus being learned, rather than as a contextual feature. At no point in this dissertation were participants asked to make the background color or the visual location of a stimulus the to-be-remembered information. Rather, they were instructed that the information would be present during retrieval. While semantic context is more focal to the stimuli being learned, I would nonetheless contend that the changes in this dissertation were to semantic context and not the content of the stimuli being learned. Franco-Watkins and Dougherty (2006) defined semantic context as one word acting as the context for another word. In this dissertation, participants learned homographic targets, which means each target could have multiple words that act as appropriate context. That is a critical feature of the design because participants were tested on whether they had seen particular orthographic forms during the study phase and word meaning is not necessary to complete that task. Without any semantic information acting as a retrieval context during Test 1 or Test 2, participants could still complete the cued-recall tests with the letters of a word they saw during the study phase. So while it may seem as though the semantic information is necessary for successful cued-recall performance, the task can also be completed without it. Semantic information is likely to make retrieving orthographic forms easier, but that benefit is derived from an association between the orthographic form of the stimulus (i.e., the content) and the semantic context of that stimulus.

Background color may have had no effects on cued-recall or memory for prior remembering because of how global contextual features become associated with the content of memories. I hypothesized that changing the background color would impair memory performance, given that alternating two background colors paired with verbal

stimuli has been shown to lead to context effects (Isarida & Isarida, 2007). However, that hypothesis was not supported by the present results. Neither cued-recall nor memory for prior remembering were impaired by a change in background color. It may be that too many targets were paired with the same color context, which could have led to cue overload (Rutherford, 2004). Cue overload can occur when a specific contextual feature no longer serves as an effective retrieval cue because many stimulus items are paired with that same context. Cue overload has been shown with as few as 20 items paired with one background color context (Isarida & Isarida, 2007). This dissertation paired 35 items during Test 1 with either the white background context or the yellow background context, which could have led to cue overload and the background color becoming an uninformative retrieval cue. If background color became irrelevant, then participants may have habituated to that particular feature and no longer attended to it (e.g., Turatto, Bonetti, & Pascucci, 2017; Wagner, 1979). Habituation occurs when a stimulus that previously elicited a response from an organism ceases to do so. If participants became habituated to the yellow background, they would no longer process it and it would no longer be associated with the cue-target pairs. If the background color was never associated with the cue-target pairs during Test 1, then Test 1 and Test 2 would have had identical retrieval contexts. Under those circumstances, changed-context targets would have been treated identically to same-context targets and memory for prior remembering would not be impaired. That result was exactly what was found.

Although cue overload and habituation can account for the null effect of background change on memory for prior remembering, it is less clear why changing the screen location *improved* memory for prior remembering in this dissertation. Although

the effect was numerically small (a difference in accuracy of less than 2 percent), it was unexpected and bears consideration. One possibility is that participants encoded the oculomotor response that they made to cue-target pairs at the bottom of the screen as an action that was associated with particular cue-target pairs. Participants would then have had access to a greater number of retrieval cues for changed-context targets than same-context targets when making their memory for prior remembering judgments. In the same-context condition, cue-target pairs remained at the top of the screen (where they would have been expected to be up to that point in the experiment) and, as such, no additional oculomotor movements needed to be made to process the test pair. However, in the changed-context condition, participants needed to actively shift their gaze to the bottom of the screen, adding an additional action that could subsequently be remembered. This idea could be tested using eye-tracking methodology to see if participants shift their gaze to the bottom of the screen during retrieval of changed-context targets during Test 2, despite the target no longer being presented there.

Researchers have suggested that oculomotor responses are implicitly encoded as a type of spatial cue that can improve recognition memory (Bradley, Cuthbert, & Lang, 1988). Bradley et al. (1988) demonstrated that participants recognize words embedded in a string of digits faster when the oculomotor response made while viewing the stimuli is the same between study and test compared to when it differs, but with no benefit to accuracy. It has also been shown that participants make saccades to empty areas of a computer screen where a visual stimulus was previously paired with auditory presentation of factual information when retrieving a memory for the fact which was heard (Richardson & Spivey, 2000). Despite such a response, a reinstated oculomotor

response did not benefit recall accuracy compared to trials in which no saccades were made to the previous location of the visual stimulus. Previous findings suggest that oculomotor responses can be implicitly encoded along with memory for a stimulus, but the binding of an oculomotor response to a stimulus does not benefit later retrieval of that stimulus. Currently it is unknown whether implicitly-encoded oculomotor responses are associated with memory for prior remembering. It would instead be advantageous to focus on the lack of any impairment caused by the change in screen location, which may have been caused by cue overload, as suggested previously for the background change condition.

The likelihood that participants would endorse non-retrieved changed-context targets as previously retrieved differed across the three contextual change conditions (Not recalled/Recalled in Tables 2-4). In the semantic change condition, relative to the background and location change conditions, participants were less likely to endorse changed-context targets they had just retrieved on Test 2 as also having been retrieved on Test 1. This finding could be related to differences in the subjective experience of retrieving targets across different contexts, as suggested by Arnold and Lindsay (2002). Participants in the semantic change condition had subjectively different experiences when retrieving changed-context targets on Test 1 compared to when they attempted to retrieve them again in the original context on Test 2. The change in subjective experience is believed to reduce the likelihood that the Test 2 retrieval context cues a memory for Test 1.

The results of this dissertation suggest that those in the background and location change conditions did not process any difference in subjective experience across tests,

regardless of the Test 1 context. That means that Test 2 would be more likely to cue a memory for Test 1, which could result in targets feeling like they were retrieved before when they were really cued but not retrieved. A stronger feeling of experiencing a target during Test 1 could then result in the endorsement of the target as being previously retrieved, when in fact it was not. However, in the semantic change condition, regardless of whether a participant successfully or unsuccessfully retrieved a target on Test 1, a change in subjective experience between the two tests would mean that the Test 2 retrieval context would be unlikely to cue a memory for Test 1 at all. That means that successful recall of a target on Test 2 would not cue participants to Test 1 as often, regardless of Test 1 retrieval success. This argument is supported by the finding that, in the semantic change condition, the endorsement of same-context targets that were not previously retrieved on Test 1 as retrieved was higher than that of changed-context targets. The endorsement of a not previously retrieved target as retrieved was essentially equivalent between same-context targets in the semantic change condition and that of changed-context targets in the background and location change conditions. Under those three circumstances, the subjective experiences of Test 1 and Test 2 were likely similar and it was under those circumstances that merely being cued to retrieve a target was most likely to be misconstrued as successful retrieval.

The argument that subjective experience has an impact on memory for prior remembering is also supported by the finding that there was no difference between the three conditions in the endorsement of not tested targets as previously retrieved. As discussed, participants may partially make their memory for prior remembering judgments based on whether they believe they were cued for a given target during Test 1.

Participants could have been more likely to have that belief when Test 2 felt subjectively the same as Test 1. For participants in the background and location change conditions, compared to those in the semantic change condition, the Test 2 retrieval context was more likely to cue a memory for both retrieval success and failure during Test 1. Therefore, a difference in subjective experience was more likely to affect responding in the semantic condition than in the background or location conditions. Such an effect of subjective experience could only be found with targets that participants attempted to retrieve on Test 1. That is exactly what was found in this dissertation. A change in context between Test 1 and Test 2 only affected memory for prior remembering judgments when there was an act of retrieval to be cued in the first place. For not tested targets, there could be no association between those targets and any previous retrieval context, which would result in a similar subjective experience of those targets regardless of any context change.

Individual Differences in Memory for Prior Remembering

The second factor that was explored in the present dissertation was individual differences. The specific question was whether dispositional mindfulness and absorption could be found to predict the accuracy of participants' memory for prior remembering. Using multiple regression analyses, it was found that scores on the MODTAS significantly predicted the accuracy of memory for prior remembering of both same- and changed-context targets, but only in the semantic change condition. Higher absorption scores were associated with better memory for prior remembering. In contrast, scores on the MAAS were not found to predict the accuracy of memory for prior remembering in any condition.

There was some predictive power of absorption on memory performance, but that predictive power was specific to few circumstances. Following a change in semantic context, absorption significantly predicted memory for prior remembering of both same- and changed-context targets. However, absorption did not generally predict memory performance. If absorption provided an overall mnemonic benefit, then it should have significantly predicted performance across all of the memory measures in this dissertation (i.e., cued-recall and memory for prior remembering across all three types of change). Instead, absorption did not predict the accuracy of memory for prior remembering in the background or location change conditions. In fact, the only other measure significantly predicted by absorption was cued-recall of not tested targets in the background change condition.

Given that combination of findings, the predictive power of absorption may be specific to experimental task demands. In the semantic change condition, the task requires that participants process the same targets with two different meanings, designed to create two distinct ways to subjectively experience each target. Participants who are high in absorption may notice the difficulty of the task and shift their focus to thinking deeply about each target to try and remember how they thought about it. That shift in attention could lead participants to elaborate on what a given target means, which could coincidentally bring the original study context to mind (which later becomes the Test 2 retrieval context). Under those circumstances, an association could be formed between the study context and the act of retrieval during Test 1, reducing the disparity in subjective experience between the two meanings of a word by associating them together. That association could then be brought to mind during Test 2 and memory for prior

remembering would be improved. In contrast, there may be no subjective difference between same- and changed-context targets on Test 1 in the background and location conditions. In those conditions, participants who were high in absorption may not have experienced any task demands that would influence the focus of their attention on anything other than the immediate retrieval of targets. The present results suggest that people who are high in absorption are better able to remember their internal cognitions, but they do not differ in their ability to remember external events. Furthermore, absorption may only benefit memory for internal cognitions in situations in which attention is drawn to internal processing.

Previous research has found mindfulness to be associated with better memory (e.g., Bonamo et al., 2015; Roberts-Wolfe et al., 2012), but the findings of this dissertation are inconsistent with that pattern. In this dissertation mindfulness only significantly predicted cued-recall of not tested targets following a change in screen location. Previous research has found that mindfulness training benefits cued-recall of Swahili-English word pairs (Bonamo et al., 2015) but dispositional mindfulness did not predict cued-recall of same- or changed-context targets on either Test 1 or Test 2 in this dissertation. The beneficial effects of mindfulness on memory have been generalized to recognition memory (e.g., Lloyd et al., 2016) and free recall of specific autobiographical details (Heeren et al., 2009), but they did not generalize to memory for prior remembering. Mindfulness may not have predicted memory for prior remembering because of a reduction in elaborative processing (Crawley, 2015). Typically, memory benefits from elaborating on a stimulus and creating stronger associations between that stimulus and other experiences (Craik & Tulving, 1975). As such, it would be expected

that memory for prior remembering should benefit from elaboration (specifically, elaboration on internal cognitive processing), as well. Elaborating on the cue-target pairs during Test 1 would be expected to create more associative links between the act of memory retrieval and previous experience. Increasing the number of associations with the act of Test 1 cued-recall should increase the likelihood that a memory for Test 1 is retrieved later. Because mindfulness practice is designed to teach people to notice internal thoughts and feelings before moving on from them (e.g., Kabat-Zinn, 2003) people who are naturally mindful may not spend much time elaborating on their own thoughts. It may also be the case that mindful attention is related to the amount of effort needed to complete a task (Jensen, Vangkilde, Frokjaer, & Hasselbalch, 2012) and the conditions in the present dissertation may not have required more mindful participants to fully utilize their attentional resources. Participants who are more mindful would attend to their internal cognitions, but may devote less effort to their attending to those cognitions which would reduce the likelihood of any elaboration on those cognitions. In such a situation, mindfulness would not be expected to benefit memory for prior remembering, but it would not cause impairment either. The present results do not support previous findings that mindfulness has general benefits to memory performance because mindfulness did not have an effect on memory for prior remembering.

Effects of absorption and mindfulness on cued-recall performance were less clear. Both absorption and mindfulness predicted Test 2 cued-recall of not tested targets, but in different conditions. Absorption predicted Test 2 cued-recall of not tested targets in the background change condition, whereas mindfulness predicted Test 2 cued-recall of not tested targets in the semantic change condition. It could be the case that, under some

circumstances, participants who focus on the stimuli that they are recalling during Test 1 will create stronger memories for those targets. Later, on Test 2, those stronger memories may interfere with the weaker memory for targets which had not been seen since the study phase. It is unclear, however, why that interference would occur in some conditions and not others.

The results of the present dissertation suggest that absorption and mindfulness are separable constructs. In the introduction, I proposed that both traits represent a person's ability to focus on internal states and thoughts. People who are high in absorption spend their time engrossed in their thoughts and fantasies. In contrast, people who are high in mindfulness focus their attention on bodily sensations and thoughts in a non-judgmental manner before moving on from them. Despite the similar emphasis on internally-focused attention, the two traits seem to represent different forms of attentional processing that affect memory differently.

Mindfulness and absorption were not significantly correlated and were found to have different relationships with memory for prior remembering. It could be that people who are high in absorption and those who are high in mindfulness process information differently with respect to the self. People who are high in absorption may process their thoughts and fantasies in a way that allows them to integrate previous experience into those thoughts more readily. In contrast, people who are high in mindfulness will acknowledge the thoughts and fantasies they are having, but instead pass on from them without integrating previous experiences into those thoughts. In that way, people who are mindful will experience thoughts and feelings moment-to-moment, while people who are high in absorption will experience them as a unified whole that is integrated with

other thoughts and fantasies over time. Such a difference in how people process cognitions could underlie the disparate findings in whether mindfulness and absorption could be used to predict memory for prior remembering. Deeper processing of an act of memory retrieval and elaborating on how it relates to other experiences would likely increase the number of previous experiences associated with that act of retrieval, which would increase the number of available retrieval cues and result in improved memory for prior remembering.

People who are high in absorption may be more likely to be spontaneously reminded of previous contexts when retrieving a memory. Leppanen and Lyle (2018) suggested that higher rates of spontaneous reminding should lead to improved memory for prior remembering. People who are high in absorption are argued to think more about the information they are remembering. While thinking about a given target, someone who is high in absorption could be more likely to spontaneously think about the study context and be better able to associate that context with the Test 1 retrieval context. It could also be the case that people who are high in absorption are spontaneously reminded of the background color and screen location in which cue-target pairs were previously seen. However, because memory for prior remembering in the background color and screen location conditions was near ceiling, there was reduced variability across all participants. Reduced variability inherently makes it more difficult to find individual differences in performance, which could explain why no individual differences were found in either the background color or screen location conditions. Future research should be conducted to see whether people who are high in absorption are better able to remember the study cue of changed-context targets. Given that successful retrieval of

study cues during Test 1 has beneficial effects on memory for prior remembering (Leppanen & Lyle, 2018), absorption may benefit memory for prior remembering because those who are high in absorption are better able to retrieve the study cue for changed-context targets.

Although not the main focus of this dissertation, it is of note that evidence of a testing effect on cued-recall was found. A testing effect is found when practice retrieving information benefits later retrieval of that same information (Karpicke & Roediger, 2008). In all three change conditions of the present dissertation, Test 2 cued-recall of same- and changed-context targets was greater than that of not tested targets. In other words, participants were better at retrieving targets on Test 2 that they had successfully retrieved on Test 1 than targets they had not attempted to retrieve before. This is further evidence that memory retrieval itself is a process that has mnemonic benefits for later retrieval of the same information.

Future Directions and Implications

Because people frequently make judgments about their memory for prior remembering, future research should be conducted that further explores the factors that underlie successful memory for prior remembering. Memory for prior remembering is known to be affected by contextual information and individual differences in personality traits. Future research could determine how context change and individual differences affect memory for prior remembering across the lifespan. It has been shown that older adults have poorer memory for contextual information than younger adults (e.g., Burke & Light, 1981). As such, I would predict that older adults have worse memory for prior remembering than younger adults. Replicating the current dissertation in a sample of

older adults could demonstrate whether memory for prior remembering operates on the same principles across the lifespan. Do local and global contextual features have similar effects on memory for prior remembering in older adults as they do in younger adults? If older adults exhibit a similar pattern to younger adults, then despite overall poorer memory for prior remembering, changes in semantic context (local context) should be more impairing than changes to either background color or screen location context (global contexts).

Studying memory for prior remembering also has implications for improving our understanding of cognitive aging. Older adults are known to have greater difficulty processing contextual information than younger adults (e.g., Chee et al., 2006) and it is known that context plays an important role in memory for prior remembering (e.g., Arnold & Lindsay, 2002). As such, an impaired ability to remember prior remembering could be used as a marker for cognitive aging and lead to the development of cognitive interventions that could help mitigate declines in memory function.

Given that mindfulness training has been shown to have positive effects on memory (e.g., Bonamo et al. 2015), it should be tested whether mindfulness training has an impact on memory for prior remembering. To do so, researchers could implement a brief mindfulness exercise into the retention interval between Test 1 and Test 2 and see whether the typical impairment caused by a change in semantic context persists or is alleviated. Researchers have argued that mindfulness training improves performance on semantic memory tests because mindfulness increases access to a person's network of learned semantic associations (e.g., Heeren et al., 2009). Yet, in the present dissertation, dispositional mindfulness was not associated with performance on a memory test

involving semantic context. The lack of a relationship between dispositional mindfulness and memory for prior remembering may reflect a propensity for mindful people to behave less mindfully under experimental conditions than they do in their everyday lives. If an experimental task requires participants to disregard their mindful tendencies (e.g., demanding working memory tasks like the operation span) then they may perform differently than their trait tendencies would suggest. Mindfulness training may be used to reinstate mindful tendencies and reduce any effects that the context of an experiment may otherwise have on reducing trait mindfulness. That idea is supported by the findings that mindfulness training typically improves memory performance (e.g., Bonamo, et al., 2015; Brown et al., 2016). Therefore, participants may have their mindful tendencies upregulated by mindfulness training and subsequently approach experimental tasks differently. If this were the case, then mindfulness training should improve memory for prior remembering.

The idea that mindfulness and absorption reflect different styles of internal focus on cognition could be further elucidated using a newly developed measure of attention. The Attentional Style Questionnaire (ASQ; Van Calster, D'Argembeau, & Majerus, 2018) was developed to assess the biases that people may have in processing internal versus external information and whether that bias is carried out by the bottom-up or top-down attentional network. The difference between the bottom-up and top-down attentional networks lies in whether attention is being guided by external stimulation (bottom-up) or by volitional control (top-down). Subscales of the ASQ were designed to measure internally-biased attention and externally-biased attention separately. The distinction between internal and external attention is important for understanding whether

people focus on their own thoughts and cognitions or on stimuli in the external world. According to Van Calster et al., a bias toward an internal, bottom-up attentional style reflects poor top-down attentional control over internal cognitions. For instance, a person who has trouble moving on from their own intrusive thoughts is demonstrating an inability to exert top-down cognitive control over their internal attention to intrusive thoughts. To test my idea that mindfulness and absorption reflect differences in internally-guided attention, scores on the ASQ could be associated with those on the MAAS and the MODTAS. I would predict that scores on the MODTAS would be significantly positively correlated with the internal attention subscale of the ASQ and that scores on the MAAS would be significantly positively correlated with scores on the external attention subscale of the ASQ. My idea that differences in internally-guided attention have an effect on memory for prior remembering could be directly tested by associating scores on the ASQ with memory for prior remembering.

Conclusion

In this dissertation, participants completed a three-phase memory for prior remembering procedure (Leppanen & Lyle, 2018) in which three different types of contextual change were made across conditions (semantic, background, location). Participants also completed the MAAS and the MODTAS to measure individual differences in internally-guided attention. Changes in semantic context between Test 1 and Test 2 impaired memory for prior remembering, but no impairment was found in the background and location change conditions. I argued that differences in the association of the contextual features to individual items could be the cause of the disparate findings. Individual differences in absorption, as measured by the MODTAS, were found to predict

the accuracy of memory for prior remembering of both same- and changed-context targets, but only in the semantic change condition. No associations were found between dispositional mindfulness, as measured by the MAAS, and any measure of memory for prior remembering. I argued that individual differences in elaboration of cognitive operations underlies the differential relationships between personality traits and memory for prior remembering. In conclusion, contextual change cannot be assumed to be inherently problematic for memory for prior remembering and that individuals who process their cognitions more deeply may be better at later remembering those cognitions.

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EDUCATION |

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DISSERTATION | My dissertation explored factors that affect our ability to accurately remember a prior instance of memory retrieval (i.e., our memory for prior remembering). My dissertation addressed two main aims: (a) to test the effects of contextual features (specifically, background color and screen location) on the accuracy of memory for prior remembering and (b) to explore individual differences in the accuracy of memory for prior remembering (specifically, whether dispositional mindfulness and absorption are associated with more, or less, accurate memory for prior remembering). Defense date: July 13, 2018

PUBLICATIONS |

Leppanen, M. L., Lyle, K. B., Edlin, F. M., & Schäfke, V. D. (submitted). Is self-report a valid measure of unimanual object-based task performance?

Leppanen, M. L. & Lyle, K. B. (2018). Making remembering more memorable. *Memory*, 26, 960-973. Doi: 10.1080/09658211.2017.1422270

Edlin, J. M., **Leppanen, M. L.**, Fain, R. J., Hackländer, R. P., Hanaver-Torrez, S. D., & Lyle, K. B. (2015). On the use (and misuse?) of the Edinburgh Handedness Inventory. *Brain and Cognition*, 94, 44-51.

Manuscripts in Preparation (data collected)

Leppanen, M. L., Lyle, K. B., Depue, B. E., & Naaz, F. Unimanual dexterity positively predicts children's episodic memory: A joint behavioral and neuroimaging investigation.

POSTERS AND PRESENTATIONS |

Lyle, K. B., **Leppanen, M. L.**, & Depue, B. E. (2017). *Unimanual dexterity positively predicts children's episodic memory: A behavioral and neuroimaging investigation*. Paper presented at the fifty-eight annual meeting of the Psychonomic Society. Vancouver, Canada.

Lyle, K. B., Depue, B. E., Dombroski, B. A., Switala, A. E., Hopkins, R. J., & **Leppanen, M. L.** (2016). *Bimanual coordination positively predicts episodic memory: A joint behavioral and neuroimaging investigation*. Paper presented at the fifty-seventh annual meeting of the Psychonomic Society. Boston, MA.

Leppanen, M. L. & Lyle, K. B. (2015). *Overt retrieval of study context eliminates the forgot-it-all-along effect*. Poster presented at the fifty-sixth annual meeting of the Psychonomic Society. Chicago, IL.

Leppanen, M. L., Fain, R. J., Edlin, J. M., Hackländer, R. P., & Lyle, K. B. (2014). *How do researchers use the Edinburgh Handedness Inventory?* Poster presented at the eighty-sixth annual meeting of the Midwestern Psychological Association. Chicago, IL.

TEACHING EXPERIENCE |

COURSES TAUGHT |

University of Louisville, KY

PSYC-302: Psychological Research Methods (Summer 2018)

Taught students the basics of psychological research methodology. Content covered hypothesis generation, experimental designs, correlational designs, measurement techniques, and statistical tests. Students all completed group research projects, where they conducted a literature review, collected their own data, scored and entered the data they collected, interpreted the results of their experiment, and completed a research paper. Assisted students with completion of ethical research training.

GRADUATE TEACHING ASSISTANT POSITIONS |

University of Louisville, KY

PSYC-302: Research Methods (seven sections, Fall 2016 – Spring 2018)

Responsible for teaching two laboratory sections per semester, with a total of 175 students. Guided students through successful completion of group research projects, where students conducted a literature review, collected their own data,

scored and entered the data they collected, interpreted the results of their experiment, and completed a research paper.

PSYC-321: Introduction to Learning: (four sections, Fall 2015 – Spring 2016)
Responsible for teaching two laboratory sections per semester with a total of 50 students. Instructed students on the use of the *Sniffy the Virtual Rat – Lite* program, which is designed to teach students about the basics of classical, and operant, conditioning using a simulated operant chamber.

PSYC-363: Life-span Development (Fall 2015)
Responsible for grading assignments and assisting students with use of the *My Virtual Child* online program (www.myvirtualchild.com).

GUEST LECTURES |

University of Louisville

- **“Measurement: Describing behavior with numbers”**
PSYC-302: Research Methods — Spring 2018
- **“Measurement: Describing behavior with numbers”**
Online Lecture
PSYC-302: Research Methods — Spring 2018
- **“Survey Research” (1/2 Lecture)**
PSYC-302: Research Methods — Fall 2017 and Spring 2018
- **“Measurement: Describing behavior with numbers”**
PSYC-302: Research Methods — Fall 2017
- **“How to write a methods section”**
PSYC-302: Research Methods — Fall 2016
- **“Classical conditioning: Basic phenomenon & various complexities”**
PSYC-321: Introduction to Learning — Spring 2016
- **“Escape, Avoidance, & Punishment”**
PSYC-321: Introduction to Learning — Fall 2015
- **“Adulthood: Body and mind”**
PSYC-363: Life-span Development — Fall 2015
- **“Adolescence: Body and mind”**
PSYC-363: Life-span Development — Fall 2015

PROFESSIONAL DEVELOPMENT |

- **Grant Writing Academy** (Spring 2017)
A semester-long series of sessions designed to teach knowledge and skills in grant writing through interactive workshops led by experts in the College of Arts and Sciences Office of Research.
- **Graduate Teaching Assistant Academy** (Fall 2015 – Spring 2016)

A year-long series of sessions designed to teach knowledge, skills, and excellence in college teaching through interactive workshops along with faculty mentors selected for their expertise in teaching.

- **More Than a Discussion Board: Best Practices and Effective Applications for Teaching Online** (March 2018)

Two-hour seminar designed to teach participants how to teach an effective online course. Topics included how to engage students, organize course material, and how to design proper activities.

PROFESSIONAL SERVICE AND MENTORING EXPERIENCE |

- **Conference submission reviewer** (December 2017)

Reviewed undergraduate submissions to the ninetieth annual meeting of the Midwestern Psychological Association.

- **Undergraduate mentorship in the Memory and Cognition Lab of Dr. Keith B. Lyle** (Fall 2013 – present)

Co-leader of weekly laboratory meetings for one semester during Dr. Lyle's sabbatical

Trained undergraduate research assistants on how to properly conduct human subjects research

Assisted with the development of undergraduate thesis projects

- **Peer mentorship program: University of Louisville** (Fall 2015 – Spring 2016)

Meetings with a first-year graduate student to assist with acclimation to the city of Louisville and to the Experimental Psychology PhD program.

AWARDS AND MEMBERSHIPS |

- Graduate Student Excellence in Teaching Award – Department of Psychological and Brain Sciences (University of Louisville, 2018)
- Kentucky Academy of Science (2018)
- University of Louisville Fellowship (Summer 2013 – 2015)
- Member of Psi Chi, Psychology Honor Society (Current)
- Golden Key International Honour Society (Current)

MEDIA COVERAGE |

“Improving How We Remember That We Already Remembered an Event” (March 7, 2018). *Brain and Life* (online blog)

RESEARCH EXPERIENCE |

University of Louisville (2013 – present)

Doctoral Candidate in the Memory and Cognition Lab

Principal Investigator: Dr. Keith B. Lyle

University of Wisconsin-Milwaukee (2011 – 2013)

Research assistant in the Greene Cognitive Neuroscience Laboratory
Principal Investigator: Dr. Anthony Greene

Research Assistant in the MINDful of Memory Lab
Principal Investigator: Dr. Deborah Hannula