HOW DOES MEMORY SELF-EFFICACY AFFECT SOURCE MEMORY WITHIN A REALITY MONITORING TASK?

by

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ABSTRACT

The ability to correctly identify the source of a memory is of vital importance to a person's everyday life. According to the source monitoring framework, memories do not contain source labels, and inferences about the source of a memory must be drawn from the quality of a memory itself. Thus, errors in source memory can occur either due to the quality of the memory in question or due to the inference drawn from characteristics of the memory trace. Recent research has shown the effects of beliefs and expectations on memory, including memory self-efficacy, or belief in one's ability to succeed in memory tasks. However, the proposed mechanisms through which memory self-efficacy affects memory vary widely and have not been systematically investigated and compared. The current studies demonstrate that the correlation between self-efficacy and memory ability extends to reality monitoring tasks. However, they yield an overall lack of evidence that self-efficacy increases engagement with reality monitoring tasks during encoding. While some evidence suggests that memory self-efficacy shifts the characteristics used to draw reality monitoring inferences, the effects were relatively small, and the shifts in memory self-efficacy did not impact memory accuracy. These findings suggest investigation of other sources of the memory self-efficacy/performance relationship, such as metacognitive awareness. These results have implications for basic research in memory, as well as for practical applications of memory research, such as memory training interventions and eyewitness testimony.

DEDICATION

This thesis is dedicated to all of the people who helped to make this research possible, including my parents, without whom I would not be the person who I am today, my late grandmother, Louise Russert-Kraemer, who taught me that questioning the world is not only acceptable, but a fantastic way to discover the true wonders in the world around us, my wife Melanie, who has always shown me what is most important in life, my brothers, who inspire me, Dr. Black, who has guided and encouraged me to become the researcher I am today, Dr. McDonough, who helped me formulate this project into what it is, and all of the generous people who donated their time so that this research could be done.

LIST OF ABBREVIATIONS AND SYMBOLS

a	Cronbach's index of internal consistency
df	Degrees of freedom: number of values free to vary after certain restrictions have been placed on the data
F	Fisher's F ratio: A ration of two variances
M	Mean: the sum of a set of measurements divided by the number of measurements in the set
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
r	Pearson product moment correlation
t	Computed value of t-test
χ^2	Computed value of chi-square analysis
$<$	Less than
$=$	Equal to

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1. INTRODUCTION

The ability to accurately remember events can have a large impact on one's daily life. One particularly important type of memory is reality monitoring, or the process of distinguishing memories of events that originate externally (perceptions) from memories of events that originate internally (e.g. imaginations). Reality monitoring is vital to being able to function effectively because errors in this process can have very negative consequences. For example, a person who mistakenly believes that he or she only imagined taking prescribed medication may take more than the prescribed dose and suffer resulting health problems. As another example, a person who mistakenly believes that he or she turned off the stove off may leave the stove on without bothering to double-check it, creating a dangerous situation in their home.

The importance of reality monitoring has been highlighted by a number of studies which have shown that people create false memories more frequently than commonly believed. Rather common activities can facilitate the creation of a false memory. For example, research indicates that vividly imagining an event increases the likelihood that the imagined event will be mistaken for an event that actually occurred (e.g. Gamboz, Brandimonte, & De Vito, 2010; Garry, Manning, Loftus, & Sherman, 1996; Goff & Roediger, 1998; Thomas, Bulevich, & Loftus, 2003). These findings reveal not only that participants' ratings of confidence in an events' occurrence rise after imagining the event, but also that some events that were only imagined are later confidently rated as having actually happened (Goff & Roediger, 1998). Despite most engagements in reality monitoring for recent events being successful (e.g. in the lab, Goff &

Roediger reported that only 5-10% of imagined tasks were rated by participants as having actually been performed), errors in reality monitoring are nonetheless consistently reproducible, difficult to self-detect, and common enough to be of frequent concern given the number of tasks performed in a day. Thus, whether in familial disagreements, eyewitness testimony, or any number of other situations, factors that may influence reality monitoring could have wide-reaching and important consequences for people's lives.

The current study investigates the impact of a particular subjective belief, memory self-efficacy, on memory performance in an intentional reality monitoring task. Through several experiments, I provide evidence establishing this relationship, and I investigate multiple mechanisms through which self-efficacy may impact memory. Most prominently, I examine whether participants' beliefs about their memories influence encoding through engagement processes, as well as whether these beliefs influence retrieval through altered expectations of memory contents.

The Source Monitoring Framework

The process of reality monitoring can be understood through the source monitoring framework (Johnson, Hashtroudi, & Lindsay, 1993). This framework proposes that memories are composed of individual elements that are stored disparately within the brain, and the act of remembering involves the reconstruction of these individual elements. Under this framework, the source of a memory has no specific label—rather, decisions about whether a memory was originally external or imagined must be made based upon the mental experience that occurs as a result of memory reconstruction. For example, a memory with many perceptual details is more likely to be classified as real and having originated externally. Alternatively, a memory with many associated thoughts and cognitive operations (such as would be necessary to produce an imagination) is more likely to be classified as originating internally through imagination. Because the source of memories is inferred rather than directly labeled within the brain, accurate source memory depends not only on the quality and depth of characteristics of the memory, but also the criteria used to classify the memory. That is, the decision to classify a memory as originating from an imagination or a perceptual experience may change depending upon the type of evidence and the amount of evidence required for a specific classification (Johnson, 2006).

Importantly, this conceptualization of memory is able to capture the effects of seemingly subjective factors that commonly affect memory, including the social and cultural context within which memory exists, as well as the diverse array of knowledge, beliefs, motivations, expectations, and biases possessed by different individuals. In characterizing how source memory may err, Johnson (2006) specifically cites factors such as reduced motivation for engagement in cognitive processes related to memory and individuals setting a low criterion due to a personal interest in a specific conclusion. The ability of the source monitoring framework to account for these factors is paramount, given the rising body of evidence that memory is influenced by factors such as social context (Edelson, Sharot, Dolan, & Dudai, 2011; Gabbert, Memon, & Allan, 2003; Wright, Self, & Justice, 2000), individual motivations (Castel, Benjamin, Craik, & Watkins, 2002; Miendlarzewska, Bavelier, & Schwartz, 2016; Sharman & Calacouris, 2010; Waldum & Sahakyan, 2012), and personal beliefs (Deffler, Leary, & Hoyle, 2016; Lachman & Andreoletti, 2006; Paddock, Terranova, Kwok, & Halpern, 2000). A further understanding of how memory can be impacted by these factors is also important because these factors frequently can be altered fairly simply through experience (for examples, see Bandura, 1977; Hong, Chiu, Dweck, Lin, & Wan, 1999); thus, optimizing motivations and beliefs for memory performance may be a cost-efficient method for improving memory.

Reality Monitoring and Self-Efficacy

The current study focuses on self-efficacy, one of the subjective beliefs most heavily researched regarding memory. Self-efficacy refers to one's belief about his/her personal likelihood of succeeding in a given task or domain (Bandura, 1977). Self-efficacy is commonly related to motivation and persistence for a given task, as individuals with a higher belief in their ability to succeed in a task tend to expend more effort and/or persist longer on that task (for examples, see Brookhart, Walsh, & Zientarski, 2006; George, 1994; Hackett & Campbell, 1987; Lyman, Prentice-Dunn, Wilson, & Bonfilio, 1984). Researchers have found that memory self-efficacy (i.e. self-efficacy for tasks within the domain of memory) bears a small, but consistent, positive relationship to memory performance (for a meta-analysis, see Beaudoin & Desrichard, 2011), and has even been related to training gains made during memory training interventions (Carretti, Borella, Zavagnin, & De Beni, 2011). Furthermore, due to the consistent relationship between memory self-efficacy and memory performance, many memory training interventions have been designed around the idea of improving memory self-efficacy (Aben, Heijenbrok-Kal, Ponds, Rudolf W H M, Busschbach, & Ribbers, 2014; McDougall, 2009; West, Bagwell, & Dark-Freudeman, 2008). Thus, understanding the full ramifications of alterations in memory self-efficacy is greatly important to these types of training efforts.

Although the correlation between high self-efficacy and good memory performance has been readily established, and many researchers seem to consider memory self-efficacy as affecting memory performance rather than vice-versa, this relationship has primarily been investigated using correlational methods. While a 2011 meta-analysis used 107 studies showing a correlational relationship between MSE and memory performance, only a handful of studies have performed research informing the directionality of this relationship (Beaudoin &

Desrichard, 2017; Beaudoin, 2018; Iacullo, Marucci, & Mazzoni, 2016; Klein, Loftus, & Fricker, 1994; Mazzoni, 1998; Strickland-Hughes, West, Smith, & Ebner, 2017). Confirming the direction of this effect should be of interest not only to those in basic research within memory (given that any subject tested possesses some level of memory self-efficacy), but also to researchers who have made memory self-efficacy a focus of their interventions (Aben et al., 2013; McDougall, 2009; West et al., 2008).

One prominent study examining the direction of self-efficacy's relationship with memory was conducted by Iacullo, Marrucci, and Mazzoni, and it revealed that memory self-efficacy for vocabulary impacted the generation of false memories in a Deese-Roediger-McDermott paradigm (Iacullo et al., 2016). In this paradigm, participants are presented sequentially with a list of words that are all semantically related to one non-presented word. Afterward, many participants indicate a false memory by recognizing the unpresented word (the critical lure), an error that can be attributed to failed reality monitoring. Beyond demonstrating that participants with higher memory self-efficacy were less likely to falsely recognize an unpresented word, Iacullo and colleagues also successfully manipulated the memory self-efficacy of participants. They provided 2 rounds of feedback, either showing high scores relative to other participants that further increased after subsequent tasks or instead showing low scores relative to other participants that further decreased after subsequent tasks. This method is consistent with Bandura's self-efficacy theory, which considers both feedback from performance and verbal persuasion to be valid sources of self-efficacy (Bandura, 1977). Iacullo and colleagues found a significant difference in performance between those led to believe that their ability in this task was good versus those led to believe that their ability in this task was poor. Those who were in the high memory self-efficacy group were less likely to falsely recognize the lure words and showed overall better memory accuracy than those who were given negative feedback. These results suggest that self-efficacy directly led to the change in memory accuracy. The authors proposed that this feedback affected motivation and effort during subsequent tasks, ultimately leading to differences in performance.

Although the Iacullo et al. (2016) study is consistent with another study which indicated that self-efficacy manipulations can alter memory performance (Klein et al., 1994), at least one study failed to find an effect after a manipulation of self-efficacy (Gardiner, Luszcz, & Bryan, 1997). In this study, participants completed a second recall task that they were informed was either the same as or harder than a previous task. Though participants' self-efficacy was lower when informed that the subsequent list would be harder, their recall performance did not significantly differ. Ultimately, the researchers concluded that either the self-efficacy decline was not sufficient to impact performance or self-efficacy changes themselves do not impact memory performance. While the methodological differences in this particular manipulation of self-efficacy may have led to the null results, this study nevertheless draws attention to the fact that more replications of the effect of a manipulation on self-efficacy on memory are needed. Furthermore, an investigation of the effect of self-efficacy on different stages of memory may clarify why an effect may or may not be seen in varying circumstances, and conducting this investigation within a reality monitoring memory task may provide particular insight into how self-efficacy might impact memory within daily life. The current study seeks both to examine any causal effects of memory self-efficacy upon memory accuracy and to determine the cognitive mechanisms through which such effects occurs. This investigation could prove useful both to the design of memory interventions based on self-efficacy, and to the understanding of how this belief relates to memory from the perspective of the source monitoring framework.

The cognitive mechanisms underlying an effect of self-efficacy upon memory can be understood through the source monitoring framework. Under the source monitoring framework (Johnson et al., 1993), memory errors may result primarily from sources that can be divided into two categories: factors that affect the characteristics of a memory itself (e.g. amount of perceptual detail, number of cognitive operations, etc.), and factors that affect the source attribution drawn from those characteristics. Thus, new studies are needed in order to determine whether self-efficacy changes the quality of memories themselves, the interpretation of a memory’s source based on those qualities, or both. Because such changes could impact a person’s fundamental ability to determine whether an event truly happened, the current study provides such an investigation within a reality monitoring paradigm.

Mechanisms and Timing of Effects Due to Self-Efficacy

In previous literature, researchers have explored the potential mechanisms that underlie the effects of self-efficacy on memory performance. Because self-efficacy has an important relationship with persistence, motivation, and performance outcomes in a large variety of different tasks (for examples, see Brookhart et al., 2006; George, 1994; Geraci & Miller, 2013; Hackett & Campbell, 1987; Lyman et al., 1984), some researchers have contended that memory self-efficacy works by affecting persistence (Beaudoin & Desrichard, 2017; Iacullo et al., 2016; Klein et al., 1994). However, other explanations have also been considered, including the ideas that memory self-efficacy may work by affecting strategy use (Simon & Schmitter-Edgecombe, 2016), or the interpretation of memory contents (Mazzoni, 1998). These different explanations can be broadly grouped into the two categories outlined earlier through the source monitoring framework: factors that affect the quality of a memory vs. factors that affect the interpretation of those qualities.

One way to assess these differences is to differentially investigate the impact of self-efficacy at different stages of memory in a reality monitoring paradigm. Theoretically, self-efficacy could affect different stages of memory, such as encoding (the acquisition and processing of a memory from the initial experience), consolidation (the solidification of a memory after acquisition), or retrieval (the accessing of contents of a stored memory). Deducing the nature of self-efficacy's influence at different points in the memory process may then inform whether a memory's qualities or its interpretation are primarily affected. For instance, if altering self-efficacy at encoding improves memory, then there is a good chance that self-efficacy alters the initial quality of the memory by invoking additional engagement or altering mnemonic strategies. In contrast, if self-efficacy primarily impacts memory at retrieval, then some support may be given to the hypothesis that self-efficacy alters the retrieval criteria used to classify a memory as either truly experienced or imagined. This approach is in line with a previous review of the false memory literature, which specifically called for integrative studies investigating all stages of the memory process when investigating memory distortions (Straube, 2012). This approach is vital, because the stages of memory are fully inter-connected, and thus studies that have investigated only one stage of memory at a time are inherently unable to rule out a variety of alternative explanations for the results.

Furthermore, resulting knowledge from a systematic investigation may help people in many realms of society identify situations in which memory is particularly likely or unlikely to be accurate. For instance, those dealing with eyewitness testimony may be particularly interested in the effects of self-efficacy at retrieval, isolated from the other stages. Moreover, knowledge about the specific mechanisms through which our beliefs impact memory may be used to optimize memory training and memory intervention programs for at-risk populations such as older adults, who have increased difficulty with reality monitoring (Gallo, Korthauer, McDonough, Teshale, & Johnson, 2011; McDaniel, Lyle, Butler, & Dornburg, 2008; McDonough & Gallo, 2013). In the following sections, I will discuss the ways in which self-efficacy is most likely to affect the different phases of the memory process.

Encoding. From the perspective of the source monitoring framework, encoding affects an ultimate memory product through the original processing of a memory's qualities. At retrieval, those qualities will be used to differentiate memories of different sources. For instance, memories that originate from external perceptions tend to be rich in perceptual detail, while memories that originate internally, such as memories of imaginations, tend to produce a large amount of thoughts associated with the memory, termed cognitive operations (Johnson & Raye, 1981; Johnson, Foley, Suengas, & Raye, 1988). As a result, people tend to use these perceptual details to identify memories of true perceptions. In fact, when people activate regions of their brain associated with visual imagery during their imaginations, they are more likely to later confuse that imagination with a memory of a true perception (Gonsalves et al., 2004). Furthermore, people who have more vivid perceptions within their imaginations as measured by the Creative Imagination Scale are more likely to confuse those imaginations with memories of true perceptions (Hyman & Billings, 1998). Thus, to the extent that qualities of a memory, such as perceptual detail or cognitive operations, change with practices at encoding, a person's later ability to distinguish the source of that memory may also be altered.

One factor that has been repeatedly shown to affect the quality of an encoded memory is attention. Dividing attention at encoding has been shown to produce decrements in source memory ability (Troyer & Craik, 2000), and people who are incentivized to focus their attention on certain words during encoding remember those words better at retrieval (Castel et al., 2002).

In fact, across multiple studies Jacoby (Jacoby, Woloshyn, & Kelley, 1989; Jennings & Jacoby, 1993) has found that individuals with greater attentional resources at encoding perform better at reality monitoring than individuals with less attentional resources at encoding. That is, individuals who are able to fully attend to the context at encoding are better able to remember the context under which they learned the information than individuals who are not. Together, these findings attest to the assertion that attention during encoding is the basis of rich memory for phenomenological memory characteristics (Johnson et al., 1993). As a result, attention also has been credited as the mechanism through which many factors impact memory, including emotion (For a review, see Kensinger, 2009) and reward (Fallon & Cools, 2014; Miendlarzewska et al., 2016).

For the effect of self-efficacy on memory, most of the potential mechanisms previously considered at encoding relate to attention through self-efficacy's impact on motivation. The core component of self-efficacy theory is the idea that an increased belief in one's ability coincides with increased motivation, due to the expectation that task success is attainable (Bandura, 1977). Notably, this mechanism would require that participants be aware of the memory task during encoding. That is, persistence because of a belief in likely success at a memory task is only applicable when a person is aware that the task they are completing is a memory task. Thus, while intentional memory tasks would reveal this effect, it would be absent during an incidental memory task. To reveal all possible mechanisms of effect for self-efficacy, the current study utilizes an intentional reality monitoring paradigm.

During the encoding phase of memory, raised motivation could result in a variety of changes in the quality of the memory by altering attention in several potential ways. Beaudoin and colleagues showed that the relationship between self-efficacy and memory recall was mediated by study time, indicating that longer attention to the items being encoded likely led to the increase in memory ability (Beaudoin & Desrichard, 2017). However, even within a set amount of study time, high self-efficacy may still impact attention during encoding, given that motivation affects people's tendency to engage in task unrelated thoughts (Seli, Cheyne, Xu, Purdon, & Smilek, 2015). This possibility is underscored by Beaudoin's findings that manipulating self-efficacy can affect processing efficiency (2018). From the perspective of the source monitoring framework, additional attention during encoding should lead to more differentiable qualities of memories from different sources. Thus, additional effort encoding a memory of an external perception should result in enhanced perceptual detail, while additional effort during imagination should result in more prominent or numerous cognitive operations. Because these qualities are used to distinguish between memories at retrieval, self-efficacy could effectively improve reality monitoring by enhancing qualities that are used to distinguish the source of these memories. Thus, in the current study, I assess how these qualities relate to memory self-efficacy, in order to assess this mechanism of action.

Motivation induced by self-efficacy could also influence memory through strategy use. Previous research found that a concept similar to self-efficacy, locus of control, (see Judge, Erez, Bono, & Thoresen, 2002 for more information about the relationship between these constructs) was related to higher use of an effective memory strategy (chunking), which likely occurred at encoding (Lachman & Andreoletti, 2006).

Although a variety of studies propose that a high opinion of one's memory ability has been associated with factors such as higher effort, activity level, and strategy use for memory tasks (Cavanaugh, 2000; Dixon, Rust, Feltmate & See 2007; Shaw & Zerr 2003), occasionally, high memory self-efficacy has been associated with a relative decrease in the use of compensatory strategies (see Simon & Schmitter-Edgecombe, 2016). Because self-efficacy theory would not predict this type of decrease, the current study also includes a measure of implicit theories of memory (see Dweck, 1999; Plaks & Chasteen, 2013). Dweck's research on mindset proposes that individuals differ in the degree to which they believe that a characteristic may be changed, and that these differences have meaningful implications for how the individual responds to negative feedback. Those who believe that a characteristic (such as intelligence or moral character) cannot fundamentally change due to practice or effort are referred to as having an entity or "fixed" mindset, while those who believe the characteristic can change due to practice or effort are referred to as having an incremental or "growth" mindset. Generally, those with a fixed mindset respond to failure at a task as an indictment of their permanent ability level, leading them to avoid potentially challenging tasks. In contrast, those with a growth mindset respond to failure as an indictment only of their current ability level, and they seek out potentially challenging tasks that they believe will improve their abilities (Dweck, 1999). If a decrease in effort is detected within high self-efficacy individuals, this may be due to a high percentage of individuals with an entity/fixed mindset. That is, those with a fixed mindset may reserve their effort on the task in order to boost their own conception of their memory ability, or to protect their own conception of their memory ability from future negative feedback.

Retrieval. Reality monitoring may also be affected by self-efficacy at retrieval—the next most common stage of memory proposed to be affected. This suggestion garners support from a history of memory being subject to influence at retrieval. For instance, when estimating their personal actions and beliefs from the past, people frequently retrieve their current actions/beliefs and shift their memories based upon their personal theories about how likely they are to have changed (Ross, 1989). In a process similarly dependent upon retrieval, a person's motivation can lead to an increased willingness to believe that a false event actually happened. For example, people reporting higher achievement motivation were more willing to believe that false achievement-related events had happened to them (Sharman & Calacouris, 2010).

Many of the explanations given for effects of self-efficacy at retrieval overlap with the attention-based explanations previously mentioned regarding encoding. For instance, the effect might occur due to increased engagement in effortful search and monitoring processes at retrieval (Klein et al., 1994). This explanation would be consistent with previous research on source monitoring, indicating that with increased time to respond, people are able to make more accurate source memory decisions (Johnson, Kounios, & Reeder, 1994), likely due to the retrieval of additional features, such as perceptual detail, associated with the memory. Interestingly, many studies focusing on an increase in engagement as a function of self-efficacy have not determined the memory stage in which engagement has its effect. (Desrichard & Köpetz, 2005; Iacullo et al., 2016; Lachman & Andreoletti, 2006). Thus, self-efficacy could produce richer representations at retrieval, either through more effortful search processes, initiative for effective retrieval strategies, or through reduced distraction at retrieval.

Other explanations for the effects of self-efficacy on memory at retrieval focus on altering expectations or source-categorization criteria (Mazzoni, 1998) for making a reality monitoring attribution (internal vs. external). That is, a person with high memory self-efficacy may expect many perceptual details from an event that was perceived rather than imagined, causing them to label a memory differently than a person with low memory self-efficacy. In other words, individuals with high self-efficacy may set a higher threshold (i.e., require more perceptual details) for deciding that a memory trace originated from an observed versus an imagined event. Such expectations for ease-of-retrieval have been proposed to explain categorization shifts in words labeled as "high-value" in an experiment (McDonough, Bui, Friedman, & Castel, 2015), as well as words presented in large font (McDonough & Gallo, 2012). Self-efficacy and related concepts have also been shown to influence susceptibility to the misinformation effect, whereby people may come to believe that they experienced things that did not actually occur. Specifically, people with low memory self-efficacy were more likely to accept misleading information as true (Bruck & Melnyk, 2004; Liebman et al., 2002; Mazzoni, 1998, but see Searcy et al., 2000). These studies suggest that people with low memory self-efficacy may possess lower criteria for classifying a remembered event as a true memory.

Importantly, an alteration in the classification criteria for source memory (such as requiring fewer perceptual details to identify a memory as true) should be detectable—such an alteration would likely be marked by a bias in memory response. Bias, in signal detection theory, refers to the tendency to lean toward a "yes/detect" response or a "no" response, overall, in a way that is not necessarily related to the (memory) signal itself (Stanislaw & Todorov, 1999). That is, if a person requires fewer perceptual details to identify a memory as true, then more memories should meet that criteria and ultimately be identified as true, leading to an overall increase in recognition responses of "yes", and therefore a shift in bias would be seen. At the same time, a shift in bias alone should not yield differences in reported memory qualities (i.e., perceptual details, cognitive operations, etc.). Because classification criteria would be affected during retrieval, an experiment that manipulated memory self-efficacy separately at encoding and retrieval could reveal whether memory self-efficacy primarily affects a memory's qualities or the classification criteria used to determine a memory's source.

Alternate Mechanisms. Generally, explanations regarding the effects of self-efficacy on memory offered by current researchers have focused on encoding or retrieval and have not considered alternate mechanisms, such as consolidation or re-consolidation. This may be at least partially because of the gradual nature of consolidation, which can make it more difficult to study. The current study, in line with the explanations offered in prior literature, focuses on encoding and retrieval; nevertheless, a need exists within the false memory literature for investigations that consider all stages of the memory process (Straube, 2012). This consideration is important because although memory self-efficacy itself has not been explored for a relationship with memory consolidation, memory consolidation has been shown to be altered by other factors of subjective experience (e.g. reward, see Patil, Murty, Dunsmoor, Phelps, & Davachi, 2017), resulting in memory changes. Thus, any investigation fully omitting considerations of potential effects at consolidation could unknowingly misattribute these effects to separate processes at encoding or retrieval. Although the current study does not study memory consolidation directly, the investigation is chronologically designed to yield some limited inferences about an effect (or lack thereof) of memory self-efficacy outside of the stages of encoding and retrieval.

Furthermore, factors of subjective experience, including beliefs and motivations, may impact memory during none of the traditional memory stages, but instead during the updating of existing memories—which would occur after encoding but prior to retrieval. That is, memories are occasionally re-activated and re-experienced, a process that involves additional encoding. Thus, updating can occur during the same time-period as consolidation, and can edit an existing memory. This phase of memory has been shown to have important effects when misinformation is involved. If new, related information is presented during the consolidation of previous information, these memories may interfere with one another and result in memory distortions (Straube, 2012) and reality monitoring errors. Self-efficacy may be particularly relevant in this capacity, given that self-efficacy has been shown to impact susceptibility for misinformation (Mazzoni, 1998; Searcy, Bartlett, & Memon, 2000).

Because there are a number of different stages at which self-efficacy might have an impact on reality monitoring, the current study examines the impact of self-efficacy on reality monitoring at encoding, directly after encoding, and at retrieval. Generally, this investigation can yield new information about the mechanisms through which beliefs may impact memory, lending a deeper understanding of factors that are constantly altering memory within laboratory studies. More specifically, we may gain information about how individual differences unrelated to the core ability of memory may nevertheless influence the conclusions drawn from a person's memory. Practically, this study informs researchers and practitioners who emphasize memory self-efficacy within memory training interventions (McDougall, 2009; West et al., 2008), and it can also provide interested parties with concrete information about the circumstances in which memory may be impacted by beliefs. For instance, if I discover that high memory self-efficacy improves the quality of memory at retrieval through persistence, law enforcement might be encouraged to increase the self-efficacy of their witnesses before interviewing them. In contrast, if high memory self-efficacy improves the quality of memory only at encoding through increased engagement, then law enforcement would not gain any advantage from improving the self-efficacy of witnesses prior to an interview, because the event about which they are attempting to glean information would have already been encoded.

The Current Study

To examine the nature of self-efficacy's effect on memory, I conducted a series of studies investigating the effects of self-efficacy on reality monitoring during encoding, immediately following encoding, and during retrieval. In the first study, I sought to verify the known effects of self-efficacy on memory in a previously untested domain (i.e., reality monitoring) that is highly ecologically relevant. In particular, people both engage in and plan or imagine any number of tasks every day, and the current study is based on a methodology used in prior autobiographical reality monitoring studies to bring relevant aspects of a typical reality monitoring experience into a controlled study (McDonough & Gallo, 2008; McDonough & Gallo, 2010). Additionally, I aimed to determine the extent to which self-efficacy relates to the perceptual detail and cognitive operations within a person's memories. As indicated earlier, self-efficacy has been proposed to affect memory performance via different mechanisms; this first study examines these potential mechanisms by investigating the perceptual details and cognitive operations reported at encoding and retrieval by participants with varying levels of memory self-efficacy. These relationships help to determine whether the effect of memory self-efficacy is due to changes in the quality of a memory (i.e., details at encoding), or due instead to the interpretation of a memory's qualities at retrieval, or due to a combination of these factors.

In the second and third study, I aimed both to establish a causal link between reality monitoring performance and self-efficacy, and also to assess the nature of mechanisms through which self-efficacy may be impacting memory. Specifically, the second study involved testing a manipulation of memory self-efficacy, and the third study involved using that self-efficacy manipulation at various stages in the memory process (pre-encoding, post-encoding, and pre-retrieval) to examine changes in memory outcomes during reality monitoring.

2. STUDY ONE: MEMORY SELF-EFFICACY AND REALITY MONITORING

In Study 1, participants completed a series of online tasks that included measures of memory self-efficacy, as well as an online version of a reality monitoring memory task used in previous studies (see McDonough & Gallo, 2010; McDonough & Gallo, 2013). For the reality monitoring task, participants were presented with a cue and were either asked to recall an event from the past associated with the cue or to imagine a future event associated with the cue. Later, at retrieval, participants were instructed to recall the event that they associated with the cue in the acquisition phase of the study. This first study aimed to address three main hypotheses. First, consistent with results from other types of memory tasks, I hypothesized that individual differences in self-efficacy would significantly correlate with performance on a reality monitoring task. Second, I hypothesized that self-efficacy would relate to engagement (i.e., allocation of attention) with the task during encoding, leading individuals with higher memory self-efficacy to report superior perceptual detail at encoding for past memories and superior cognitive operations at encoding for imaginations of future events, when compared with individuals with lower memory self-efficacy. Third, I hypothesized that memory self-efficacy would affect source-classification criteria at retrieval, such that individuals with lower memory self-efficacy would classify events with fewer perceptual details as past memories when compared to individuals with higher memory self-efficacy. That is, individuals with low self-efficacy would set a lower threshold for classifying an event as a true past event instead of an imagined event that will occur in the future.

Method

Participants. A total of 539 participants were initially recruited online using the University of Alabama subject pool. Of the 356 participants who completed both parts of the study, 34 were excluded from analyses for failing to follow simple directions during an attention-checking measure at the beginning of the study at least twice consecutively. Fifty-nine additional participants were excluded from analyses for failing to complete part 2 of the study (the retrieval phase) within a 12-to-48-hour window after completing part 1 of the study (the encoding phase). Four participants were excluded for displaying a reality monitoring performance at or below that which would be expected due to chance (Hits – False Alarms $\leq$ 0). Thus, a total of 259 participants were included in the analyses.

Participants were compensated for participation with course credit. Using the G*power software program (Faul, Erdfelder, Lang, & Buchner, 2007), a power analysis revealed that with 259 total participants and an alpha level of .05, the experiment would be able to detect the small (ρ = 0.18) correlation effects that have been previously associated with domain-specific memory performance (Beaudoin & Desrichard, 2011) with a power of 0.84.

Materials. All materials were presented to participants through Qualtrics Survey Software online through the University of Alabama subject pool website. Stimuli consisted of 72 total nouns of common objects, which were used in a previous reality monitoring task (see Experiment 2 of McDonough & Gallo, 2010). Of these words, 54 were presented to participants on Day 1 during encoding (the "study phase"), and then were subsequently presented to participants on Day 2 during memory retrieval (the "test phase"). During the study phase of the experiment (Day 1), 18 words were used for elaboration of a past memory, 18 words were used for elaboration of a future imagination, and 18 words were used in both elaboration conditions.

The remaining 18 words were not presented at study so that they could be used as unstudied lures during the test phase of the experiment. Each set of 18 words was counterbalanced across the four roles (past, future, both, and unstudied).

The test phase of the experiment (Day 2) consisted of two criterial recollection tests. On the past elaboration test, participants were instructed to indicate whether they previously (the day before) generated a memory based on the cue word currently presented. On the future elaboration test, participants were instructed to indicate whether they previously imagined a future event based on a cue word. Participants were informed that words may have previously been presented during past elaboration, future elaboration, both, or neither. Each criterial recollection test contained a total of 36 words (9 each for past, future, both, and new/unstudied) which were counterbalanced across role.

Measures.

Memory Self-Efficacy Questionnaire (MSEQ-4). General memory self-efficacy was assessed using 4 subscales (shopping list, story recall, object location, and names) of the memory self-efficacy questionnaire (MSEQ) developed by Berry, West, and Dennehey (Berry, West, & Dennehey, 1989). In the MSEQ-4, participants answer whether they can remember a specific number of things under very particular circumstances with a percentage of confidence that they could successfully recall the desired information. The MSEQ has good reliability, with a Cronbach's alpha value of .85 for younger adults. In pilot testing for the current study using data from 87 participants, the MSEQ-4 showed strong reliability ($\alpha = .94$). Face and content validity for the MSEQ are high, considering that the MSEQ was developed by taking concepts from existing measures for self-efficacy. The criterion validity even extends to memory performance in daily life ($R_c = .59$), although it does not extend as well to memory performance in a laboratory setting (R_c= .37 and R_c= .50 for self-efficacy level and confidence respectively). However, considering that these are correlations with actual memory performance rather than perceived memory ability, this does not mean that the MSEQ has low validity for a laboratory setting. This measurement of memory self-efficacy was chosen both for its strong psychometric properties and for its compatibility with more task-specific subscales, which relate more strongly to memory ability than general memory self-efficacy measures (Beaudoin & Desrichard, 2011). Please see Appendix A for a full copy of the measure.

Memory Self-Efficacy Questionnaire: Adapted Reality Monitoring Subscale (MSEQ-ARMS). Because self-efficacy theory suggests that more specific measures of self-efficacy will be most effective (Schunk & Pajares, 2009), and past studies have found more specific measures of self-efficacy to show a stronger relationship with performance (Beaudoin & Desrichard, 2011), a newly developed subscale of the MSEQ was used to generate a self-efficacy score more specific to reality monitoring processes. This subscale was adapted from the existing format of the MSEQ. Questions such as "If I heard it twice, I could remember X items on a grocery list," were replaced with items specific to reality monitoring, such as, "If I either thought about or performed 14 small, everyday actions, two weeks later I could remember whether all 14 actions were actually performed or only thought about." Please see Appendix B for a full copy of the measure.

The general format of the questionnaire has been shown to be reliable; Berry, West, and Dennehey (1989) calculated a test-retest reliability of .89 for an alternate questionnaire, the A-MSEQ, which used different questions than the original questionnaire. Additionally, pilot testing of 85 undergraduates completing the MSEQ-4 and MSEQ-ARMS showed that the MSEQ-ARMS has strong internal reliability (α = .96), and correlates with the other MSEQ subscales at rates consistent with their relationship with one another (*r*s > 0.4 and < 0.6). Furthermore, to assess how well the MSEQ-ARMS assessed a unique dimension of memory self-efficacy, pilot data was used to perform a principal components analysis containing both the MSEQ-4 and MSEQ-ARMS. This analysis revealed that each MSEQ subscale, including the MSEQ-ARMS, loaded onto its own factor, while one additional factor was composed of loadings of the last item on each subscale (as well as the second-to-last item on the shopping and story subscales). The MSEQ-ARMS loaded onto the first factor, explaining 46% of the variance in the combined measure.

Memory Accuracy and Bias. To determine appropriate measures of sensitivity and bias, Performance on the reality monitoring task was assessed for normality using a Shapiro-Wilk Test. Because results showed a non-normal distribution for both hits ($p< 0.001$) and false alarms ($p< 0.001$), non-parametric measures for sensitivity (*A'*) and bias (*B''*) were used. The measure *A'* is a statistical measure consistent with signal detection theory which computes accuracy by comparing the amount of correctly identified items with the amount of falsely identified items (Stanislaw & Todorov, 1999). Bias on the reality monitoring task was assessed using *B''*, a statistical measure consistent with signal detection theory which assesses the degree to which a participant prefers to indicate a successful memory signal (Stanislaw & Todorov, 1999). That is, bias indicates the degree to which a participant defaults toward a “yes” response or “no” response, regardless of the memory signal. For both measures, previously unseen “new” items at test, and items that were present in both types of study phases were excluded. Measures of memory accuracy and response bias during reality monitoring were collapsed across both past and future tests.

Post-Experiment Survey. After the completion of the test phase of the experiment on the 2nd day, participants were asked to complete a survey in which they rate various aspects of their experience with the study, including the clarity of the instructions, strategy use during the study and test phases, and the number of hours the participant slept between the study phase and the test phase. For a full list of included questions, please refer to appendix J.

Theories of Memory Scale. Participants were assessed for their endorsement of the belief that memory ability is fixed and unchangeable. The scale was adapted from Carol Dweck's original Theories of Intelligence scale (Dweck, 1999), which has good reliability for both entity (0.885) and incremental (0.898) factors, as analyzed through a confirmatory factor analysis (Park, Callahan, & Ryoo, 2016). Entity, or fixed, mindset refers to the tendency to believe that a characteristic cannot change due to effort or practice, while an incremental, or growth, mindset refers to the tendency to believe that a characteristic can change due to effort or practice. A similar adaptation of this concept applied specifically to memory ability has been used successfully in previous research (Plaks & Chasteen, 2013). Please see Appendix C for a full copy of the measure.

Vividness of Visual Imagery Questionnaire (VVIQ). To assess individual differences in visual imagery ability, participants completed the Vividness of Visual Imagery Questionnaire. Score on the VVIQ has been shown to be related to memory recall for imagery (Marks, 1973). While the VVIQ has been shown to have good internal consistency, some researchers have reported low test-retest reliability (Eton, Gilner, & Munz, 1998; McKelvie, 1995). Please see Appendix H for a full copy of the measure.

Short Grit Scale (Grit-S), Perseverance of Effort Subscale. Participants were assessed for their tendency to achieve long-term goals through perseverance and stick-to-itiveness through the Perseverance of Effort Subscale of the Short Grit Scale. The Short Grit Scale shows strong internal consistency, test-retest reliability, and predictive validity (Duckworth & Quinn, 2009). Please see Appendix E for a full copy of the measure.

***Metamemory Ratings*.** Two types of ratings were used to assess metamemory, or knowledge and awareness of one's own memory ability. Judgments of learning (JOLs) were used during study for each reality monitoring item, by asking participants to rate the likelihood that they would be to recognize that item at a later time on a 1 (extremely unlikely) to 7 (extremely likely) scale. Specifically, participants were asked, "How likely would you be to recognize this word and connect it to the event you just described, if you were to see this word again in 24 hours?". During the test portion of the reality monitoring task, retrospective confidence judgments (RCJs) were used for each reality monitoring item, by asking participants to rate on a 1 (not confident at all) to 7 (extremely confident) scale their confidence in their yes-or-no answer regarding the item. Specifically, participants were asked, "How confident are you that your answer is correct?". Both JOLs and RCJs are commonly used measures of metamemory, which take place at two separate important stages of the memory process (Nelson & Narens, 1990).

***Memory Qualities*.** Perceptual details and cognitive operations were used to assess the nature of each memory at both encoding and at retrieval. The amount of perceptual details was measured at encoding by asking participants, "How much perceptual detail (e.g. imagery, sounds, smells, etc.) did the event you just described contain?", which they responded to on a 1 (low detail) to 7 (high detail) scale. Similarly, at retrieval, participants were asked, "How much perceptual detail (e.g. imagery, sounds, smells, etc.) did the event associated with the word contain?" The amount of cognitive operations was measured at both encoding and retrieval by asking participants, "What amount of personal thoughts and mental processes are associated with this event in your mind?”, which they responded to on a 1 (low amount) to 7 (high amount) scale. Difficulty of retrieving the memory was measured at encoding and retrieval by asking them, “How difficult was it to generate this event in your mind?”, which they responded to on a 1 (very easy) to 7 (very difficult) scale.

Average Detail to a Yes Response—Past (ADYRP). Ratings from 1-7 on the amount of perceptual details to remembered items on the past test were averaged together for each participant. That is, ADYRP represents the average amount of details for items participants classified as a past memory. This measure was used to infer the threshold amount of perceptual details used to classify an item as a past memory.

Procedure. The study took place in two separate parts (one for encoding and one for retrieval) each taking place an average of approximately 24 hours apart. To begin, participants were first informed that the purpose of the study is to determine what factors of memory are different in people of different memory abilities. Afterwards, participants completed demographics measures, a basic attention check, measures of self-efficacy (MSEQ and MSEQ-ARMS), the short Grit scale, the Vividness and Visual Imagery Questionnaire, and the Theories of Memory scale.

Next, participants completed the study phase of the online reality monitoring paradigm, patterned after the paradigm described in Experiment 2 of McDonough and Gallo (2010). The study phase consists of two past elaboration blocks alternating with two future elaboration blocks (for a total of four blocks). Participants were first instructed that they will be asked later to recall the event associated with the cue they are presented with. Then, for the past elaboration blocks, participants were presented with a series of cue words, directed to recall a specific, exclusive memory from their past that is related to each word, and instructed to write a brief description of the memory, including what was involved and where it took place. To incentivize active engagement with the task, participants were not able to move on from writing their description until at least 15 seconds had passed. This overall process was designed to associate each cue word with a memory that originates externally.

After each item, participants made a judgment of learning (JOL), and rated the qualities of the memory (amount of perceptual detail in the memory, the difficulty of retrieving the memory, and their memory for thoughts and mental operations in the memory). These ratings encourage depth of processing when recalling each memory, and they were also used during data analysis to draw inferences about the mechanism of the effect of self-efficacy on source memory.

Completion of the future elaboration blocks was similar to the past elaboration blocks. For future imagination blocks, participants were presented with a series of cue words, and were directed to imagine and briefly describe a specific, exclusive future event that is related to each word, including what would be involved and where the event would take place. This process was designed to associate each word with an event that originates internally. As with the past elaboration blocks, after each item, participants were asked how likely they would be to recognize that item at a later time (JOL), and then asked to rate the memory on a 1 to 7 scale for the same memory qualities as the past elaboration blocks.

At the completion of the study phase, participants were reminded to complete Part Two of the study approximately 24 hours after beginning Part One of the study (the study phase). To complete Part Two, participants signed up through the University of Alabama subject pool, and then logged in approximately 24 hours after completing Part 1 in order to perform the test phase of the reality monitoring paradigm, in which participants were asked about memories and imaginations from the previous day. For each cue word presented, participants completed one of two criterial recollection tests to make a judgment about the origin of the event associated with that word. For the past test, participants were presented with a word and asked whether they generated a past memory about that word during the study on the previous day. After responding with a “yes” or “no”, participants made a retrospective confidence judgment (RCJ), and rated memory qualities (perceptual detail, cognitive operations, and difficulty). Participants were instructed to record the lowest level of each rating if they did not recall anything about an event associated with the word. The same procedure was completed for the future test; however, instead of being asked whether they previously generated a past memory about a presented word, they were instead asked whether they previously imagined a future event about the presented word.

To ensure that participants were able to correctly understand and follow all of the instructions, participants were asked about the clarity of the instructions both immediately after a practice item in the study phase, and in the post-experiment survey after the test phase is completed. The post-experiment survey also asks participants about other aspects of their experience, including strategy usage for both the study phase and the test phase, as well as the amount of sleep they received during the intervening period between Part One and Part Two. After the study, participants received online debriefing, which thanked them and provided specific detail about the study’s purpose.

Results

Data Analysis Plan. To gain information about the study’s first question (whether self-efficacy relates to reality monitoring performance), I planned to use a Pearson correlation to determine the relationship of individual differences in self-efficacy with memory accuracy. While I originally planned to use *d’* as the measure of accuracy, a lack of normality necessitated the use of *A'* instead (see Stanislaw & Todorov, 1999). Based upon the relationship between memory self-efficacy and other forms of memory (Beaudoin & Desrichard, 2011), I hypothesized that there would be a significant small-to-moderate positive relationship between self-efficacy and memory accuracy during reality monitoring.

To address the second hypothesis (whether self-efficacy relates to engagement at encoding), I planned to use Pearson correlations between memory self-efficacy and two measures of engagement during encoding, as well as with two measures of engagement-related memory qualities during encoding. For engagement during encoding, I sought to examine MSE's relationship with the length of the response to the cue word, and the elapsed time before a typed response to the cue word. For engagement-related memory qualities, I sought to examine MSE's relationship with the amount of perceptual details that participants rate after the study phase for true past memories, and with the amount of cognitive operations that participants rate after the study phase for imaginations of future events. I hypothesized that these would all be positive relationships.

To test the third hypothesis (whether self-efficacy relates to source-classification criteria at retrieval), I planned Pearson correlations between MSE and two measures: 1) response bias and 2) Average Detail to a Yes Response—Past (ADYRP), which is each participant's average 1-7 rating on perceptual details for items he/she responded "yes" to on the past test. While I originally planned to use *c* as the measure of response bias (default tendency to respond "yes" or "no"), a lack of normality necessitated the use of *B''* instead (see Stanislaw & Todorov, 1999). In testing whether individual self-efficacy is associated with response bias for memory responses during retrieval, I expected to find that higher self-efficacy would be positively related to *B''*, indicating a bias toward "no" responses, as participants who expect themselves to successfully remember their experiences should have a higher expectation, and thus a higher threshold, for their memory signal. This stricter interpretation, operating in isolation, should result in both fewer hits and fewer false alarms. In testing whether MSE is related to ADYRP, participants with high self-efficacy should require more perceptual details to classify an event as a past memory, the items to which they responded “Yes” on the past test should possess more corresponding perceptual details. Thus, I expected to find a positive relationship, verifying that self-efficacy affects the level of perceptual details used to classify an event as a memory or an imagination.

Descriptive Statistics. Descriptive statistics were first obtained to assess consistency with previous uses of this reality monitoring paradigm and address potential differences due to online administration of the study. Descriptive statistics of performance in the reality monitoring task can be found in Table 1. The average number of hours between completing Part 1 and starting Part 2 was approximately 24 hours (M=23.62, $S.D.$=6.27), as directed by the study procedure. It is important that time between sessions was similar because performance on the reality monitoring task, as measured by A', did decrease when participants took longer, $r(257) = -.327$, $p<.001$. As with past studies utilizing criterial recollection tests, a reality monitoring asymmetry was observed, such that participants showed significantly fewer false alarms on the test which asked participants whether the cue was previously associated with a future imagination (the “future test”; FA = 0.30) relative to the test which asked participants whether the cue was previously associated with a memory from the past (the “past test”; FA = 0.36), $F(1,258)=11.437$, $p = .001$, (McDonough & Gallo, 2010; McDonough & Gallo, 2013).

MSEQ-ARMS. Several analyses examined the reliability and validity of the newly developed subtest of the MSEQ which specifically assesses self-efficacy for reality monitoring ability. As in pilot testing, results showed strong internal reliability ($\alpha = .96$), and the MSEQ-ARMS correlated with the other MSEQ subscales. However, in contrast with the pilot data, the correlation for the MSEQ-ARMS subscale was a little lower than the correlations amongst the other measures (average MSEQ-ARMS, r =.40; average of other subscales, r =.53). We once again assessed how well the MSEQ-ARMS assessed a unique dimension of memory self-efficacy, by performing a principal components analysis containing both the MSEQ-4 and MSEQ-ARMS. As in the analysis of the pilot data, this analysis revealed that each MSEQ subscale, including the MSEQ-ARMS, loaded onto its own factor, while one additional factor was composed of loadings of the last item on each subscale, (this factor also contained loadings from the second-to-last item on the shopping, names, and object-location memory subscales, but did not contain the last item from the MSEQ-ARMS). The MSEQ-ARMS loaded onto the first factor, explaining 18% of the variance in the combined measure.

Self-Efficacy and Reality Monitoring Performance. To address the study's first hypothesis (that self-efficacy relates to reality monitoring performance), I used a Pearson correlation to determine the relationship of individual differences in self-efficacy (MSEQ-4) with memory accuracy as measured by *A'*. As predicted, I found a significant, positive relationship between general memory self-efficacy and memory accuracy in the reality monitoring task, $r(257) = .190$, p=0.002. The size of this relationship is similar to that reported between memory self-efficacy and other forms of memory (see Beaudoin & Desrichard, 2011). Thus, the first hypothesis was supported. Follow-up analyses revealed that the association of high self-efficacy with superior accuracy was most likely due to a reduction in false alarms, $r(257) = -.162$, p=0.009, rather than an associated change within hits, $r(257) = .087$, p=0.165.

Next, I used a Pearson correlation to examine this same relationship using the new, reality-monitoring-task subtest of the MSEQ that I developed, known as the MSEQ-ARMS. While previous research found that more task-specific measures of self-efficacy related more strongly to memory performance (Beaudoin et al., 2011), no significant relationship was found between this new task-specific MSE measure and actual reality monitoring performance, $r(257) = .077$, $p=0.22$. The lack of a significant relationship suggests a disconnect between performance on the reality monitoring task and the aspects of self-efficacy being measured by the newly developed MSEQ-ARMS. Due to this lack of a relationship, and the relative novelty of the measure, proceeding analyses investigating self-efficacy utilized the more established measure of the MSEQ-4.

To further probe this relationship, participants were separately analyzed according to their mindset (1-3.49 = Entity/Fixed Mindset; 3.5 – 6 = Incremental/Growth Mindset). For those with a fixed mindset, the relationship between self-efficacy and reality monitoring ability was stronger, $r(114) = 0.253$, $p=0.006$, driven by a positive relationship with hits, $r(114) = .229$, $p=0.013$, and a non-significant negative relationship with false alarms $r(114) = -.150$, $p=0.107$. For those with a growth mindset, no significant relationship was found between memory self-efficacy and reality monitoring performance, $r(141) = .123$, $p=0.14$. While for this group, higher self-efficacy was associated with a reduction in false alarms, $r(141) = -.177$, $p=0.034$, it was also non-significantly associated with reduction in hits, $r(141) = -.086$, $p=0.306$.

This pattern fits with an extensive pattern of prior research which suggests that those with a fixed mindset may reserve their effort on tasks they believe they may fail at in order to boost their own conception of their ability, or to protect their own conception of their ability from future negative feedback (Dweck, 1999). Because effort yields better performance in memory tasks (Castel et al., 2002; Hyde & Jenkins, 1973), this means that, for fixed mindset individuals, low expectations of success (MSE) may lead to low memory performance, while those with growth mindset would not be expected to exhibit this pattern to the same extent.

Self-Efficacy and Engagement. To address the second hypothesis (that self-efficacy relates to engagement at encoding), I ran a series of Pearson correlations between general self-efficacy (MSEQ-4) and measures of engagement. To first verify adequate task engagement, I examined the length of the responses participants gave when prompted. The average response during encoding was approximately 90 characters (M=88.77, $S.D.$=43.42), which is a reasonable length for providing details such as when and where an event took/will take place. Consistent with the idea that engagement enhances memory, response length at encoding was found to be related to A', $r(257) = .388$, $p<0.001$; however, no other measures of engagement at encoding (time-to-first click, cognitive operations for future imaginations, perceptual detail for past memories) were related to *A'*(all *p*s>0.05).

Contrary to the second hypothesis, no significant correlation was found between general self-efficacy and the length of participants' written response to the cue word, $r(257) = .081$, p=0.195, nor the amount of time passing between receiving a cue and generating an event, $r(257) = .084$, p=0.195, nor the amount of cognitive operations generated at encoding when imagining future events, $r(257) = .10$, p=0.108. However, general memory self-efficacy did marginally correlate with the perceptual detail participants reported at encoding for past events, $r(231) = .127$, p=0.053. Generally, these findings do not support the idea that self-efficacy impacts memory performance by increasing engagement at encoding.

Exploratory analyses also failed to find evidence supporting a relationship between memory self-efficacy and increase engagement during encoding. MSEQ-4 was unrelated to measures of perceptual detail and cognitive operations at retrieval as well, regardless of whether the item was studied as a past memory or future imagination, and regardless of whether the test asked for recall as a past memory or future imagination (all *p*s >0.05). Furthermore, when assessing reality-monitoring-specific self-efficacy, no significant correlations were found between MSEQ-ARMS and any measures of engagement (all ps>0.05).

Follow-up exploratory analyses, however, did show a relationship between MSEQ-4 and two measures of engagement-related memory qualities for the subset of individuals with fixed mindset (cognitive operations reported at encoding for future imaginations, $r(114) = .230$, $p=0.013$; perceptual detail reported at encoding for past memories, $r(114) = .193$, $p=0.049$). For those with growth mindset, these same measures of engagement showed no relationship with MSEQ-4 (cognitive operations reported at encoding for future imaginations, $r(141) = -.008$, $p=0.921$; perceptual detail reported at encoding for past memories, $r(124) = .073$, $p=0.42$). Neither group showed any relationship between MSEQ-4 and response length, nor between MSEQ-4 and time-to-response (all ps>0.05). Again, these subgroup analyses fit a broader pattern, suggesting that those with low MSE may be particularly prone to a lack of effort when they hold a fixed mindset.

Self-Efficacy and Source Decision at Retrieval. To test the third hypothesis (that self-efficacy relates to source-classification criteria at retrieval), I first conducted a Pearson correlation between general memory self-efficacy and response bias as measured by *B''*. Essentially, *B''* measures the degree to which a participant has a default tendency to respond "yes" or "no" (for full calculation formula, see (Stanislaw & Todorov, 1999)). Contrary to my hypothesis, no significant relationship was found between bias and self-efficacy, $r(253) = -.000$, $p = .998$. Next, I examined whether a relationship existed between general self-efficacy and the average perceptual detail reported at retrieval for items that participants responded “yes” to on the past test (ADYRP). Although I hypothesized that individuals with high self-efficacy would set a higher “threshold” for identifying an event as a memory from the past, I found no significant correlation between the variables, $r(257) = .051$, $p=0.418$. These analyses fail to support the hypothesis that memory self-efficacy alters decision-making criteria about memories at retrieval.

Exploratory analyses examined these same relationships using reality-monitoring-specific measure of self-efficacy; however no significant correlations were found between MSEQ-ARMS and bias, $r(253) = .091$, $p = .147$, or MSEQ-ARMS and detail-threshold for past memories, $r(253) = .101$, $p = .104$. The only evidence, even from exploratory analyses, which seemed to indicate altered decision-making criteria at retrieval, was a negative relationship between MSEQ-4 and cognitive operations at retrieval for items that were not initially studied, $r(257) = -.14$, $p=.02$). While this relationship is weak, it may suggest a slight change the way that memory qualities are interpreted at retrieval. Because the actual cognitive operations should be effectively non-existent on average for items that were never presented, a relationship between MSE and this quality may suggest that those with low MSE are more liberal with their ratings of cognitive operations.

Supplemental Analyses. Supplemental analyses showed significant positive correlations between general memory self-efficacy and confidence at retrieval, $r(257) = .291$, $p<0.00$, as well as between general memory self-efficacy and judgment of learning (JOL) at encoding, $r(257) = .318$, $p<.001$. These relationships help to establish that the general memory self-efficacy reported by participants bears a direct relationship with the individual memory judgments made during the reality monitoring task. Furthermore, just as general MSE correlated with *A’*, so did confidence at retrieval, $r(257) = .250$, $p < 0.001$, and JOLs made during encoding, $r(257) = .126$, $p = .042$.

Investigations of the effect of strategy use showed that participants who expressed that they had used a particular strategy during encoding showed lower reality monitoring accuracy compared with those who did not use any strategy, $F(1, 125.79) = 5.42$, $p=0.021$. Strategy use at retrieval trended in the same direction but showed no significant difference, $F(1, 99.498) = 2.647$, $p=0.107$. MSEQ-4 showed no relationship with indications of strategy use at encoding, $F(1, 257) = 0.432$, $p=0.51$, or retrieval, $F(1, 257) = 1.15$, $p=0.28$. No subgroup analyses revealed any of these relationships to be significant when specifically examining those with fixed mindset or those with growth mindset (all *p*s>0.05).

Discussion

While prior studies demonstrated a weak, but a significant positive relationship between memory self-efficacy and memory performance for a variety of memory tasks (Beaudoin & Desrichard, 2011), the current results demonstrate the extension of this relationship to include source memory tasks such as the current reality monitoring paradigm. Although the large variety of memory tasks to which memory self-efficacy positively relates (Beaudoin & Desrichard, 2011) would suggest that this relationship exists, until the present study, this relationship with reality monitoring had yet to be formally demonstrated. This finding is particularly important because reality monitoring is a type of memory task with a high level of ecological validity, and it has vital implications for the fields of eyewitness testimony, medicine, and care of older adults. While the current type of reality monitoring task had not previously been conducted using online data collection, the reality monitoring asymmetry seen in previous lab-based versions of the paradigm (McDonough & Gallo, 2010; McDonough & Gallo, 2013) was replicated online, suggesting a consistency between the two methods.

MSEQ-ARMS Measure. The current study further sought to establish the reliability and validity of the MSEQ-ARMS measure for measuring the self-efficacy of reality monitoring tasks. The measure showed high internal consistency, and a series of analyses revealed a consistent relationship between the MSEQ-ARMS and other MSEQ subtests. However, while the MSEQ-4 showed a significant relationship with actual reality monitoring performance (A'), the MSEQ-ARMS did not. There are several potential explanations for the lack of a relationship between reality monitoring performance and score on the MSEQ-ARMS.

One possibility is that, while people largely possess some accuracy in predicting their general memory ability, they may have less accuracy in predicting their reality monitoring ability. One difference that may lead to this difference in accuracy is that, while the general MSEQ subtests conceptualize memory ability as the opposite of forgetting, the MSEQ-ARMS involves a judgment about the personal prevalence of false memories. This may be more difficult for many people who are unaware of the prevalence of false memories. Using telephone and internet surveys comprising about 2500 American adults, Simons and Chabris found that around 50% of Americans believe memory works like a video recording, between 30-40% of Americans believe that memories do not change after you form them, and about 45% of Americans believe that hypnosis actually helps eyewitnesses more accurately recall details of crimes they have seen (Simons & Chabris, 2011; Simons & Chabris, 2012). A different explanation for the lack of a relationship between the MSEQ-ARMS and reality monitoring performance may be due to the measure itself. While people can commonly relate to trying to remember names or follow a story, it is possible that participants were less able to clearly understand the judgments they were being asked to make during the MSEQ-ARMS. However, in such a case, it might be typical to default to one's general memory self-efficacy when completing the measure, so one might still reasonably expect to see a relationship between MSEQ-ARMS and reality monitoring performance.

Mechanisms of Effect. While it is important to establish the presence of this important relationship in a reality monitoring paradigm, the current investigation also sought relationships that might explain how self-efficacy could lead to improved memory performance. Substantial evidence was not found supporting either individual mechanism by which I proposed self-efficacy may be impacting memory performance. If memory self-efficacy were related to engagement in encoding during the study phase of a reality monitoring task, we would expect to see it relate to the cognitive operations reported by participants for future imaginations, to the response length given by participants, and/or to the time required before providing a response—none of which were found. Although a small, marginal relationship was found between memory self-efficacy and perceptual detail reported for past events, by itself this cannot serve as evidence of a relationship with engagement, because the past memories had been previously established prior to the current study. That is, without the evidence of a relationship with other measures of engagement, this correlation could as easily be explained by a high level of detail impacting self-efficacy as otherwise. Furthermore, I found no evidence of memory self-efficacy relating to changes in decision-making criteria at retrieval. Specifically, memory self-efficacy was unrelated to bias towards a "yes" response during retrieval and was also unrelated to the threshold of perceptual detail associated with participants "remember" responses.

These findings suggest caution in the interpretation of the cause of the relationship between memory self-efficacy and memory performance. For example, When Iacullo and colleagues found that manipulating self-efficacy led to differences in false memory rates in a DRM paradigm, they attributed this finding to memory self-efficacy's hypothetical effect on engagement and coping strategies (2016). When Klein and colleagues found that manipulating self-efficacy increased performance on a recognition memory task, they attributed their finding to self-efficacy's effect on persistence and motivation (1994). And generally, at least within an older adult population, authors regularly espouse the idea that memory self-efficacy affects motivation and effort (e.g. Dixon, Rust, Feltmate & See 2007).

These attributions are common despite mixed findings among the few studies that actually measure the relationship between memory self-efficacy and engagement. For example, while Beaudoin and Desrichard found a small relationship between memory self-efficacy and the time participants devoted to studying, they failed to find the relationship they expected between memory self-efficacy and strategy use (2017). Wells and Esopenko, on the other hand, found no relationship of memory self-efficacy with either persistence or strategy use (2008).

As posited by Beaudoin and Desrichard (2011), MSE may be less strongly related to persistence in memory tasks when compared to other types of self-efficacy and their corresponding tasks. The authors propose that this may be due to low motivation, related to laboratory memory tasks typically having little impact on a participant's life, particularly when the memory tasks do not correspond to everyday memory activities. An additional possibility may be that, at least for memory tasks requiring long periods of sustained attention, which is by nature limited, persistence may generally "level out", leaving little room for memory self-efficacy to modulate engagement levels.

Of course, under the source monitoring framework, (Johnson et al., 1993), increased engagement would be thought to improve memory performance through changes in the quality of memories. However, scant evidence was found for this, as MSE showed no relationship with our measure of cognitive operations at encoding for imagined future events, and only a weak, marginal relationship with perceptual detail at encoding (r =.13) for remembered past events.

Potential Alternate Explanations. Because self-efficacy does not appear to be related to increased engagement nor to changed memory judgments at retrieval, alternate explanations must be considered. While some might propose that increased self-efficacy could enhance performance through increasing strategy use, evidence for this outcome was not clearly demonstrated. That is, strategy use was unrelated to memory self-efficacy and inversely related to memory performance. While at least one study found an effect of locus of control on strategy use (Lachman & Andreoletti, 2006), several studies have failed to find a relationship between strategy use and memory self-efficacy (Beaudoin & Desrichard, 2017; Wells & Esopenko, 2008), and one even found a negative relationship between the two concepts (Simon & Schmitter-Edgecombe, 2016).

Another potential explanation might be that changes in engagement, strategy use, and/or judgments at retrieval are caused by high self-efficacy, but only for a subset of individuals such as those with a belief that effort can improve memory ability. In the current study, some evidence supports this line of thinking. For example, I found a moderating effect of mindset on the relationship between self-efficacy and memory performance, such that there was a stronger relationship for individuals expressing a fixed/entity mindset regarding memory. I also found a moderating effect of mindset on the relationship between self-efficacy and memory qualities (cognitive operations and perceptual detail), but no moderating effect of mindset on response length, which is arguably the most effective measure of task engagement due to its correlation with A'. Nor was any moderating effect of mindset found on the relationship between self-efficacy and timing to first click, strategy use, or bias against lures at retrieval. Due to this mixture of findings, Study 3 may serve as a replication that can shed light on the reliability of these conditional, exploratory findings.

Given the lack of evidence supporting the main hypothesized mechanisms, some consideration must also be given to the hypothesis that a large majority of the relationship between memory self-efficacy and memory performance may be explained through metacognitive awareness rather than through any causal impact of self-efficacy on memory performance. That is, a significant correlation between self-efficacy and memory performance may not be a result of the impact of self-efficacy on memory, but instead may be a result of people gauging their own memory ability with relative accuracy. As previously mentioned, very few studies have found a direct causal effect of memory self-efficacy on memory performance (Iacullo et al., 2016; Klein et al., 1994; but see Gardiner, Luszcz, & Bryan, 1997). In contrast, a 2011 meta-analysis cited 107 studies on the correlational relationship between MSE and memory performance. This type of finding leaves open the possibility that, rather than self-efficacy causing changes in memory performance, the opposite effect takes place throughout an individual's lifetime. In other words, as a person's memory performance affects the feedback they receive throughout their lifetime, this may affect their memory self-efficacy. Indeed, from as early as Bandura's first explanations of the concept of self-efficacy, performance feedback has been considered a primary calibrator of an individual's level of self-efficacy (Bandura, 1977). Although the hypothesis that metacognitive awareness is primarily responsible for the relationship between memory self-efficacy and memory performance has not been empirically investigated in this particular study, a lack of discovery of alternative mechanisms suggests that future studies should more heavily consider whether memory performance may affect self-efficacy rather than vice-versa.

As limited information about these causal relationships may be determined from a correlational study, for Studies 2 and 3 I sought to establish a method of altering self-efficacy experimentally (Study 2) and to implement this method to determine causal effects of self-efficacy on engagement, retrieval judgments, and reality monitoring performance (Study 3).

3. STUDY TWO: TESTING A MEMORY SELF-EFFICACY MANIPULATION

The purpose of Study 2 was to establish a manipulation for memory self-efficacy that may be applied later (in Study 3) within a reality monitoring paradigm. Thus, Study 2 involved manipulating memory self-efficacy by providing positive or negative feedback after memory-based tasks, in a procedure adapted from Iacullo et. al (2016). I hypothesized that participants who received a positive-feedback manipulation intended to improve their memory self-efficacy (high MSE group; feedback indicated high memory performance of approximately the 75th - 80th percentile) would show significantly higher scores on the MSEQ-4 and MSEQ-ARMS than participants who received a negative-feedback manipulation intended to lower their memory self-efficacy (low MSE group; feedback indicated high memory performance of approximately 20th – 25th percentile). To address this hypothesis, participants completed a series of short memory tasks and subsequently received pre-selected feedback on their performance, before completing measures of self-efficacy.

Methods

Participants. Two hundred and ninety-three participants were recruited using the University of Alabama subject pool. Participants were compensated for participation with course credit. Of all 293 who completed the study, 85 were excluded for failing to follow simple directions during an attention-checking measure at the beginning of the study. Another 19 participants were excluded for failure to accurately recall the feedback they were presented during the study, when they were asked during the post-study survey (e.g. they received feedback informing them that they were in the 20th percentile and they indicated remembering a percentage outside the $10^{th} – 30^{th}$ range; or they received feedback informing them they were in the 80^{th} percentile and they indicated remembering a percentage outside the $70^{th} – 90^{th}$ percentile range). Another 2 participants were excluded for responding on the post-study survey that they did not clearly understand the instructions at all (1 on a 7-point clarity of understanding instructions scale). Additionally, five participants who completed the online procedure in the unreasonably quick time frame of under 15 minutes were excluded from the analyses. This rate was determined as a conservative minimum due to the length of the study in question, which requires about 10 minutes to complete even if one reads nothing and simply selects a random answer for every question. Accuracy of the MSEQ-4 is particularly important to the study, and this piece of the study alone requires approximately 20 minutes if instructions are read and properly followed. In total, 182 participants were included in the study.

Materials. Stimuli for the short memory task were 60 words presented in a variety of colors (red, blue, green, purple, black), sizes (small, medium, large), and locations on a 9-cell grid (various combinations of top/middle/bottom and left/middle/ right). Words were presented in 4 blocks of 15 words, with each block followed by 10 questions asking about various aspects (presence, color, size, and location) of the words just presented.

Measures. Participants were asked to complete the MSEQ-4, MSEQ-ARMS, and the Theories of Memory Scale. For a full description of these measures, please refer to Study 1; for a full copy of these measures, see Appendices A-C. Participants were also asked to complete a new post-experiment survey, which asks participants about the clarity of the instructions, whether they thought the feedback they received indicated that their memory performance was good or bad, whether the feedback was encouraging or disappointing based upon the participant's own personal standards, whether they thought the feedback was accurate, and whether the participant doubted the authenticity of the feedback.

Procedure. Participants first answered a few basic demographics questions before engaging in the memory tasks. Memory tasks consisted of sequential 3-second presentations of 15 different words. Afterwards, participants were asked a series of 10 questions about the presence, size, color, and location of the words that were presented. This process was repeated for four total blocks of memory tasks. Participants received an abbreviated "practice" version of the task before beginning. To manipulate self-efficacy, performance feedback was given twice throughout the procedure; this feedback procedure was adapted from the successful self-efficacy manipulation reported in Iacullo, Marucci, and Mazzoni (2016). Feedback was given according to condition after the second and fourth blocks. In the high memory self-efficacy (MSE) condition, participants were informed that they performed better than 75.3% of other participants after two blocks and better than 79.7% after four blocks. In the low MSE condition, participants were informed that they performed better than only 25.7% of other participants after the second block and better than only 20.3% after the fourth block. After the fourth block of memory tasks, participants were asked to complete memory self-efficacy measures (MSEQ-4 and MSEQ-ARMS).

After completing the self-efficacy measures, participants completed the post-experiment survey, which asks various questions about the participants' reaction to the performance feedback. Then, they were taken through the online debriefing. This debriefing emphasizes that the feedback shown to participants during the study was not actually related to their performance, and instead they were assigned the feedback randomly. Participants are further provided with an explanation for the necessity of this method, in order to determine how beliefs about memory affect memory ability.

Results

Analysis of the post-experiment survey questions showed participants clearly understood the instructions (M = 6.64 on a 7-point scale), correctly interpreted the feedback (Low MSE, M = 2.17; High MSE, M = 4.02, on a 5-point perceived-performance scale), and that the false results were believed to be legitimate in a large majority of cases (91%). However, many participants may have personally disagreed with the results that they saw, as they only tepidly agreed that the results accurately reflected their ability in the task (M = 3.6 on a 5-point scale), and did not express high agreement that their results accurately reflected their overall memory ability (Low MSE, M = 2.9; High MSE, M = 3.6 on a 5-point scale).

Overall, the task was perceived to be highly difficult (M=6.08 on a 7-point scale). Among the participants whose results were excluded due to skepticism of the feedback received, qualitative responses included several mentions of not believing in the *positive* feedback—that is, some participants could not believe that they had performed so well, given the difficulty of the task. Furthermore, while only 4% of those in the group that received negative feedback disbelieved that their results were actually generated from their performance, 15% of those in the group that received positive feedback disbelieved their results. An examination of actual performance on the short memory task on which participants received their feedback may explain the source of this perception. While actual performance greatly varied as intended (range = 10% - 83%), the average participant correctly answered only 46% of the questions asked, on a series of 40 multiple-choice questions with an average of around 5 response options per question. To students who may have been likely to compare their perceived performance to the grading scales of their university, this type of performance may have seemed particularly low, leading them to classify the task as highly difficult.

To determine the effectiveness of the self-efficacy manipulation, two one-way ANOVAs were used to compare scores on the self-efficacy measures between the high MSE condition and the low MSE condition. The 17 participants who reported disbelief in the feedback given were excluded from this analysis. While memory self-efficacy condition did not have a significant effect on either MSEQ-4, $F(1, 162) = .235$, $p = .629$ or MSEQ-ARMS, $F(1, 165) = 1.445$, $p = .231$, both trended in the expected direction (MSEQ-ARMS, High = 56.55, Low = 51.27; MSEQ-4, High = 67.55, Low = 66.25).

Using the G*power software program (Faul, Erdfelder, Lang, & Buchner, 2007), a power analysis revealed that with 165 total participants and an alpha level of .05 (corrected to .025 to account for multiple comparisons using a Bonferroni correction), the experiment should be able to detect a medium effect in a one-way ANOVA with a power of 0.83. A medium effect was used for this power analysis, as a similar manipulation previously yielded a medium-to-large effect size (Iacullo et al., 2016).

Effect of Mindset. Due to the finding in Study 1 that some differences may be related to mindset, the effectiveness of the original manipulation was compared across mindset (entity vs. incremental). However, no significant differences were found for either subgroup (all *p*s > 0.05).

Revision of Self-Efficacy Manipulation. In response to the non-significant difference in MSEQ between the two groups, several variations of this procedure were run using a variety of changes, in order to enhance the efficacy of the manipulation. First, to enhance legitimacy of the task, the introductory “practice” portion of the task was supplemented with accurate feedback and correct answers provided for each practice question. To further enhance legitimacy of the task, the manipulation was given a backstory as a task “commonly used to assess a person’s general memory ability”, and the results were described as being generated from comparison with “norms established through a national database of subject pools at large research universities” (see Appendix L).

Second, attempts were made to diminish perceived task difficulty, which previously may have limited the effectiveness of the manipulation. Perceived task difficulty was addressed by a) removing the “size” dimension from the questions and instructions, in order to make encoding seem easier, and b) emphasizing the struggles of past participants in the task instructions, so as to create a lower bar for participants to reach in order to feel that they performed “well”. New pilot data from variations of the experiment with and without these changes were assessed, and effect sizes were compared (see Table 2). The collapsed variations showed larger effect sizes in the predicted direction when the new alterations to perceived difficulty were included. Thus, a variation of the manipulation that included both of these changes was imported into Study 3 to be used as the manipulation of self-efficacy.

Discussion

The current study investigated the believability of the self-efficacy manipulation and was used to develop a workable manipulation for inclusion in a reality monitoring task, to investigate the direct impact of self-efficacy on reality monitoring in Study 3. The initial manipulation did not show a significant effect of the manipulation on a global measure of self-efficacy. This may have been due to a high level of task difficulty, which was originally intended to provide an ambiguous personal sense of performance, and thus enhance the effectiveness of the feedback. However, the non-significant difference may indicate that high level of task difficulty decreased the effectiveness of the positive feedback. Nevertheless, it should be noted that the individual subscale for reality monitoring did trend in the predicted direction. Furthermore, in prior literature, the few successful manipulations of memory self-efficacy affected only specific subtests and were not reported to significantly change global measures of MSE. Particularly, Iacullo and colleagues reported an effect of a feedback manipulation on a MSE words subtest and a MSE numbers subtest. Klein and colleagues, by contrast, measured MSE by using a custom 7-point scale to predict performance on the study's particular memory task. Thus, while an effect of a manipulation was sometimes found in previous literature, differences in measurement of MSE may contribute to the differences between the current results and previous studies.

Nevertheless, the manipulation procedure was revised in various ways and retested. Assessments of the revised manipulation showed consistently higher means for High MSE participants than for Low MSE participants. Furthermore, versions of the manipulation incorporating planned revisions showed an approximately medium effect size (d = .34 - .42), which is consistent with past literature (Iacullo, Marucci, & Mazzoni, 2016). Thus, the revised manipulation procedure, rather than the original procedure, was utilized to manipulate self-efficacy in Study 3.

4. STUDY THREE: MANIPULATION EFFECTS ON REALITY MONITORING

In Study 3, I sought to determine the effect of manipulating self-efficacy on memory performance during a reality monitoring task. By manipulating self-efficacy at different stages of the process (pre-encoding, post-encoding, and pre-retrieval), I aimed both to assess the potential causal role of memory self-efficacy on memory accuracy and to investigate the specific mechanisms through which self-efficacy may impact memory. The study addressed three main hypotheses. First, I hypothesized that participants who receive an increasing self-efficacy manipulation (High MSE group) specifically administered either before encoding or approximately 24 hours later before retrieval would show increased memory accuracy compared to participants who received a decreasing self-efficacy manipulation (Low MSE group) at the same step. In contrast, the self-efficacy manipulation would not yield differences in memory accuracy when it is received right after the encoding phase is already completed (approximately 24 hours prior to retrieval). Second, I hypothesized that participants who receive an increasing self-efficacy manipulation (High MSE group) before encoding would show increased engagement compared to participants who receive a decreasing self-efficacy manipulation (Low MSE group), causing the High MSE group to rate their past memories as containing more perceptual detail and rate their imaginations of future events as containing more cognitive operations. Third, I hypothesized that participants receiving an increasing self-efficacy manipulation directly before retrieval would possess a raised signal threshold for recognition, showing a change in bias to respond “yes” that items are remembered, as well as tendency to only respond "yes" to items with more perceptual details, relative to participants receiving a decreasing self-efficacy manipulation. To accomplish these goals, participants will complete a reality monitoring task, as in Study 1. However, at specific time points during this process, participants will receive either positive or negative feedback about their memory ability in order to alter their self-efficacy.

Method

Design. The current study investigated the impact of self-efficacy at various stages of memory using a 2 (feedback: High MSE vs. Low MSE) x 3 (timing: pre-encoding vs. post-encoding vs. pre-retrieval) between-subjects design. Thus, each subject received one of two different forms of feedback impacting self-efficacy, and this feedback was given to each participant at one of three different points during the study, depending upon condition.

Participants. A total of 424 participants were initially recruited online using the University of Alabama subject pool. Of the 263 participants who completed both parts of the study, fifteen were excluded from analyses for failing to follow simple directions during an attention-checking measure at the beginning of the study at least twice consecutively. Fifty additional participants were excluded from analyses for failing to complete part 2 of the study (the retrieval phase) within a 12-to-48-hour window after completing part 1 of the study (the encoding phase). Thirteen participants were excluded for displaying a reality monitoring performance at or below that which would be expected due to chance (Hits – False Alarms $\leq$ 0). Thus, a total of 185 participants were included in subsequent analyses. Participants were compensated for participation with course credit.

Materials. Stimuli for the current study were imported from the previous two studies. For the reality monitoring portion of the study, the same cue words were used that were referred to in Study 1. For the self-efficacy manipulation portion of the study, the same procedure was used as in the revised manipulation described in Study 2—short memory tasks contained words presented in a variety of colors (red, blue, green, purple, black), and locations (various combinations of top/middle/bottom and left/middle/ right). However, in addition to the 60 words used in Study 2, Study 3 used an additional 60 words for a total of 120 words. Words were presented in 8 blocks of 15 words, with each block followed by 10 questions asking about various aspects (presence, color, and location) of the words just presented.

Measures. Participants were asked to complete the VVIQ, Short Grit Scale, MSEQ-4, MSEQ-ARMS, and the Theories of Memory Scale. For a full description of these measures, please refer to Study 1; for a full copy of these measures, see Appendices A, B, E, and H. Participants were also asked to complete a more detailed post-experiment survey, which included the questions regarding the reality monitoring task from the post-experiment survey in Study 1 (regarding strategy use, sleep, clarity of instructions, etc.) as well as questions regarding the self-efficacy manipulation from the post-experiment survey in Study 2 (see Appendices I - K).

Procedure. Please refer to Figure 1 for a visual depiction of the order of events during the study, as well as the placement of feedback (i.e. the self-efficacy manipulation) for each condition. Broadly, the procedure involved a reality monitoring test with short memory tasks also given throughout various stages of that process (specifically, before encoding, after encoding, and before retrieval). Having these short memory tasks throughout created consistency for all conditions but allowed for feedback to be given on the short memory tasks at different places throughout the study. The study took place in two separate parts (one for encoding and one for retrieval) each taking place an average of approximately 24 hours apart.

For Part One, participants were first informed that the purpose of the study is to determine what factors of memory are different in people of different memory abilities. Participants then filled out a few brief demographics questions, the VVIQ, the short grit scale, the theories of memory scale, and the MSEQ-4 and MSEQ_ARMS (all as described in the materials section of Study 1) before engaging in four blocks of short memory tasks (same materials and procedure as in Study 2). Next, participants completed the study phase of the reality monitoring paradigm (same procedure as Study 1), in which they were presented with cue words and had to either recall a memory associated with the word or imagine a future scenario associated with the word. Afterwards, participants completed two more blocks of short memory tasks, concluding Part One. Participants were then instructed to complete the Part Two portion of activities as close as possible to 24 hours later. For Part Two, participants first completed 2 more blocks of short memory tasks and then completed the test phase of the reality monitoring paradigm. Afterwards, they filled out the MSEQ-4 and MSEQ-ARMS once more, as well as the post-experiment survey before going through the online debriefing that was outlined in Study 2. The post-experiment survey questions included those from Study 1 regarding the reality monitoring task, as well as those from Study 2 regarding the feedback manipulation.

Depending upon the condition of the participant (pre-encoding/ post-encoding/pre-retrieval), participants were presented with feedback at different points during the experiment. Encoding, or the initial processing of information, takes place during the study phase of the reality monitoring task. Thus, participants in the pre-encoding condition were presented with feedback before the 3rd and after the 4th blocks of short memory tasks, both of which occur directly before the study phase of the reality monitoring task. In contrast, participants in the post-encoding condition were presented with feedback before the 5th and after the 6th block of memory tasks, both of which occur directly after the study phase of the reality monitoring task. Thus, post-encoding feedback could affect memory consolidation, but could not affect encoding. Retrieval takes place during the test phase of the reality monitoring task. Thus, participants in the retrieval condition were presented with feedback before the 7^{th} and after the 8^{th} block of memory tasks, both of which occur on the second day of the study, directly before the test phase of the reality monitoring task.

Due to the differences in feedback procedures, slightly different prompts were given during the introduction to the short memory tasks (see Appendices M-O). As in Study 2, approximately half of the participants (n = 94) were presented with positive/increasing feedback about their performance, while half of the participants (n = 97) were presented with negative/decreasing feedback about their performance.

Results

Descriptive statistics of performance in the reality monitoring task can be found in Table 3. As in Study 1, the average number of hours between completing Part 1 and starting Part 2 was approximately 24 hours (M=23.29, $S.D.$=6.26), and performance on the reality monitoring task (as measured by A') decreased when participants took longer between encoding and retrieval, $r(179) = -.164$, p=0.028, and increased with increased response length from the participants, $r(179) = .321$, p<0.001. Once again, a reality monitoring asymmetry was observed, such that participants showed significantly fewer false alarms to lures (i.e. mistook an imagination for a memory or vice-versa) on the criterial recollection test which asked participants whether the cue was previously associated with a future imagination (the "future test"; FA = 0.35) relative to the test which asked participants whether the cue was previously associated with a memory from the past (the "past test"; FA = .40), $F(1, 184)$=6.793, p = .01, (McDonough & Gallo, 2010).

MSEQ-ARMS. Once again, the MSEQ-ARMS showed strong internal reliability (pre-test, α = .97; post-test, α = .95), and correlated with the other MSEQ subscales (shopping list, story recall, object location, and names). In line with the results from Study 1, the correlation for the MSEQ-ARMS subscale was a little lower than the correlations amongst the other measures for the pre-test (average MSEQ-ARMS, r =.39; average of other subscales, r =.48) but these correlations were right in line with the other subscales for the post-test (average MSEQ-ARMS, r =.58; average of other subscales, r =.58). As a replication of pilot data and assessment of how well the MSEQ-ARMS represents a unique dimension of memory self-efficacy, I performed a principal components analysis containing both the MSEQ-4 and MSEQ-ARMS. For the pre-test, these results closely matched those of Study 1, but for the post-test, the results somewhat differed. For the post-test, the MSEQ-ARMS subscale composed the 3rd factor, explaining 15% of the variance, behind a factor composed of items from the object-location and shopping subscales, and a factor composed of all of the last items from each subscale.

Correlational Results. Before addressing the key hypotheses for Study 3, I sought to verify the validity of the correlational relationships established in Study 1. Baseline MSEQ-4 showed no significant relationship with reality monitoring performance, as measured by *A'*, but the trend was positive, $r(179)$ =.09, p=0.22. This relationship is substantially smaller than in Study 1 and fails to reach significance, suggesting the various feedback manipulations throughout the study may have affected this relationship. No correlation was found between MSEQ-ARMS and A', $r(182)$ = -.099, p=0.184. No correlational relationship was found between MSEQ-4 and any of the measures of engagement (length of response, time to first click, cognitive operations at encoding for future items, and perceptual detail at encoding for past items), all ps > .05. No correlational relationship was found between MSEQ-4 and bias, $r(177)$ =

.058, p = .438. Notably these results are largely consistent with the findings of Study 1. Within exploratory analyses, one correlational finding that differed from Study 1 was that in this study, those with growth mindset, rather than fixed mindset, showed a marginally significant relationship between MSEQ-4 and A' (Growth, $r(70) = .227$, $p = .055$; Fixed, $r(107) = -.038$, $p = .70$). The opposite had been found in Study 1.

Effect of Feedback Manipulation on Self-Efficacy. Examinations of the post-experiment survey questions were used to assess the manipulation of self-efficacy. Participants reported clearly understanding the instructions (M = 6.32 on a 7-point scale), showed correct interpretation of the feedback (Low MSE, M = 2.38; High MSE, M = 3.87, on a 5-point perceived-performance scale), and believed the false results to be legitimate in a large majority of cases (93%). However, many participants may have personally disagreed with the results that they saw, as they only tepidly agreed that the results accurately reflected their ability in the task (M = 3.38 on a 5-point scale), and did not express high agreement that their results accurately reflected their overall memory ability (Low MSE, M = 2.80; High MSE, M = 3.49 on a 5-point scale). Notably, these results are consistent with those seen in Study 2.

A series of ANOVAs were used to determine whether the differential feedback received pre-encoding, post-encoding, and pre-retrieval led to measurable differences in Post-Test MSEQ-4. As a manipulation check, I had participants respond to several key questions about the feedback. For example, participants were instructed to indicate the percentile that approximated their performance based on the feedback given earlier in the study. For analyses focusing on this manipulation, 20 participants who could not accurately approximate the percentile which their feedback placed them in were excluded from this analysis, as were the 11 participants who reported not believing the feedback manipulation to be legitimate were excluded from these analyses. This left a total of 154 participants. Table 4 displays the number of participants in each manipulation category.

Altogether, mean MSEQ-4 decreased from the first measurement to the second, $F(1, 153) = 23.64$, $p<0.001$. However, these decreases were only significant for those receiving Low MSE feedback pre-encoding, $F(1, 24) = 4.61$, $p = .042$, and for those receiving Low MSE feedback pre-retrieval, $F(1, 27) = 12.92$, $p = 0.001$. No other subgroup showed a significant decrease (all *p*s>0.05).

Three separate ANCOVAs were used to examine differences in post-study MSEQ-4 between individuals who received High MSE vs. Low MSE feedback, while controlling for baseline MSEQ-4. No significant differences were found between individuals who received High MSE vs. Low MSE feedback (all ps > 0.05). Similar ANCOVAs found no difference between feedback conditions in MSEQ_ARMS (all *p*s>0.05).

Self-Efficacy and Reality Monitoring Performance. In order to assess the first hypothesis of Study 3 (that self-efficacy can improve memory accuracy at encoding and at retrieval) I performed a 2 (high MSE vs. low MSE) x 3 (pre-encoding vs. post-encoding vs. pre-retrieval) ANOVA on memory accuracy, as measured by *A'*. Memory accuracy was collapsed across past and future tests. Table 5 shows the mean *A'* values for participants in each category. This ANOVA showed that there was no significant interaction between the type of manipulation (High MSE or Low MSE) and when the manipulation was administered, in predicting any effect on overall performance in the reality monitoring task, $F(2, 146) = 0.027$, $p=.974$. Thus, the results failed to support Hypothesis 1, which predicted that self-efficacy manipulations at both pre-encoding and pre-retrieval would affect memory performance, while a manipulation post-encoding would not. Furthermore, the ANOVA revealed no main effect of the self-efficacy manipulation on accuracy, $F(1, 146) = .063$, $p=.802$, nor any main effect of the location of the self-efficacy manipulation on accuracy, $F(2, 146) = 0.733$, $p=.482$.

To investigate the role of the self-efficacy manipulation further, I conducted a series of exploratory analyses. These showed that the expected interaction was not found when isolating hits, $F(2, 148) = .273$, $p=.762$, or false alarms to lures, $F(2, 148) = .882$, $p=.416$ Exploratory simple effects tests were run on A', hits, and false alarms to lures to determine whether the self-efficacy manipulation had any effects on the reality monitoring task when administered pre-encoding, post-encoding, and pre-retrieval respectively. These revealed no significant differences between the two groups for all subtests (all ps>0.05).

Self-Efficacy and Engagement. To address the study's second hypothesis, I ran a series of one-way ANOVAs examining the difference between participants given High MSE and Low MSE feedback pre-encoding in a variety of measures of engagement. No differences were reported according to condition for reported perceptual details of past memories at encoding, $F(1, 39) = .129$, $p = .722$, reported cognitive operations for imaginations at encoding, $F(1, 46) = 1.975$, $p = .167$, response length during encoding, $F(1, 46) = 1.301$, $p = .260$, response latency during encoding, $F(1, 46) = 2.664$, $p = .109$. However, participants in the High MSE condition at encoding did self-report marginally higher engagement during Part 1 of the study (as assessed in the post-test at the end of Part 2), $F(1, 46) = 3.438$, $p = .070$, and this appeared to persist to engagement at retrieval as well, $F(1, 60) = 5.826$, $p = .019$.

Reported strategy use during encoding also did not appear to vary with feedback given pre-encoding, with 48% of Low MSE participants reporting strategy use compared with 43% of High MSE participants, $\chi^2(1) = .099$, $p = .753$. Furthermore, a non-significant trend showed that participants who reported strategy use actually showed lower reality monitoring accuracy, F(1,

150) = .949, *p* = .332. While this trend is not significant, the same trend was significant in Study 1.

Self-Efficacy and Source Decision at Retrieval. Next, I sought to address the study's third hypothesis that positive feedback intended in improve self-efficacy should result in participants' using more stringent criteria when evaluating memory qualities. To test this hypothesis, I used a 2 (Feedback) x 3 (Timing) x 2 (Past-focused test vs. Future-focused test) ANOVA on memory bias, as measured by *B"*. The two different types of criterial recollection test, as described in the materials section of Study 1, are included as a within-subjects factor because memory self-efficacy was not predicted to alter classification criteria for the future imagination test. Thus, when self-efficacy is increased, bias was expected to be higher on the past test than the future test. I expected an interaction such that High MSE participants pre-retrieval show significantly higher *B"* scores (indicating a greater tendency toward "no" responses) than Low MSE participants, but with the same difference not present if feedback is administered pre-encoding or post-encoding. The three-way interaction was not significant $F(2, 116) = .994$, $p = .373$. A main effect was found for past vs. future test, such that there was a stronger bias in favor of "yes" responses on the past test, $F(1, 116) = 5.273$, $p = .023$. No main effect was found for High MSE feedback vs. Low MSE feedback on bias, $F(1, 116) = .083$, $p = .773$, nor for timing of feedback, $F(2, 116) = .1.055$, $p = .351$, nor for the interaction between the two, $F(2, 116) = 2.162$, $p = .120$. There was also no interaction found between past vs. future test and type of feedback, $F(1, 116) = .005$, $p = .945$, nor for past vs. future test and timing of feedback, $F(2, 116) = .790$, $p = .107$.

A weak, marginally significant relationship was found between a participant's MSEQ-4 score at retrieval and their individual threshold for perceptual details (ADYRP), $r(152) = 0.155$, *p*=0.055. When this correlation was examined using the reality-monitoring specific measure of self-efficacy, no correlation was found, $r(152) = 0.047$, $p=.561$, nor was any relationship found when using pre-test measures of the MSEQ-4, $r(152)=.107$, $p=0.185$, or MSEQ-ARMS, $r(152) = 0.114$, $p= 0.158$. However, exploratory analyses did suggest that calibration of memory ratings themselves may be altered at retrieval. In particular, a significant negative relationship was found between MSEQ-4 and cognitive operations at retrieval for items that were not initially studied, $r(152) = -.20$, $p=.014$).

Next, specific subtests were used to assess differences in memory interpretation when feedback was specifically administered pre-retrieval. For participants receiving their feedback right before retrieval, no significant differences were found in bias between High MSE ($M =-.02$, $SD = .51$) and Low MSE ($M = .159$, $SD = .44$), $F(1, 51) = 1.78$, $p=.189$, or in detail-threshold as measured by ADYRP, $F(1, 52) = .501$, $p=.482$. However, when feedback was specifically administered pre-retrieval, participants who received High MSE feedback did report significantly more cognitive operations than participants who received Low MSE feedback. This increase in cognitive operations was consistent across all items—even toward new items that were never encoded. Thus, the self-efficacy manipulation at retrieval appears to have altered calibration of memory ratings themselves. These findings, along with similar trends for perceptual detail, may be seen in Table 6.

Engagement at Retrieval. Several exploratory analyses investigated the possibility that increased engagement at retrieval may contribute to the relationship between memory self-efficacy and memory performance. A one-way ANOVA found no significant difference in self-reported engagement at retrieval between those who received High MSE vs. Low MSE feedback pre-retrieval, $F(1, 51) = .110$, $p=.741$. Baseline MSEQ-4 also did not correlate with memory qualities at retrieval, such as perceptual details or cognitive operations (all *p*s>0.05). Reported strategy use during retrieval also did not appear to vary with feedback given pre-retrieval, with 32% of Low MSE participants reporting strategy use compared with 31% of High MSE participants, $\chi^2(1) = .012$, $p = .914$. Furthermore, no difference was found in reality monitoring accuracy between participants who reported using a strategy during retrieval and those who did not, $F(1, 150) = .020$, $p = .886$.

Supplemental Analyses. Supplemental analyses showed a significant positive correlation between general memory self-efficacy and confidence at retrieval, $r(178) = .150$, $p<0.05$, as well as between general memory self-efficacy and judgment of learning (JOL) at encoding, $r(178) = .280$, $p<.001$. These relationships help to establish that the general memory self-efficacy reported by participants bears a direct relationship with the individual memory judgments made during the reality monitoring task. Notably, these relationships were stronger for those with a growth mindset (MSEQ-4 with JOL, $r(60) = .361$, $p = 0.004$; MSEQ-4 with Confidence, $r(60) = 0.332$, $p=.008$), compared with those with a fixed mindset (MSEQ-4 with JOL, $r(90) = .243$, $p = 0.019$; MSEQ-4 with Confidence, $r(90) = 0.043$, $p=.684$)—a finding that is inverted compared with results of Study 1.

Supplemental analyses were used to investigate the relationship of several variables with reality monitoring ability. Results showed no significant relationship between A' and VVIQ, $r(178) = .02$, $p = .76$, between A' and the Grit subscale $r(178) = .03$, $p = .68$, or between A' and the amount of sleep between encoding and retrieval $r(178) = -.13$, $p = .08$.

Discussion

The current study sought to systematically investigate the causal role of self-efficacy in affecting reality monitoring performance, given that only a handful of studies have directly manipulated self-efficacy in an attempt to affect memory. The results of the study do not support the idea that an acute change in memory self-efficacy results in any meaningful changes to reality monitoring performance. Participants who received positive feedback designed to improve MSE did not show any difference in reality monitoring performance compared with participants who received negative feedback designed to decrease MSE. No effect was found regardless of whether the feedback was administered pre-encoding, post-encoding, or pre-retrieval.

The current study adds to a small number of studies that have directly manipulated self-efficacy in order to determine the causal role it plays in memory tasks. While at least three studies found an effect of manipulating self-efficacy on memory performance (Iacullo et al., 2016; Klein et al, 1994; Strickland-Hughes, West, Smith, & Ebner, 2017), at least one did not (Gardiner, Luszcz, & Bryan, 1997). While previous studies investigated the role of memory self-efficacy in primarily free recall tasks, the current study investigated the role of memory self-efficacy in a source-memory recognition task, which required participants to determine the difference between memories of past events and memories generated as a result of imagining future events. Thus, it is possible that memory self-efficacy plays a different role in different types of memory tasks, and this may account for differing results across studies. For instance, a large meta-analysis found a stronger relationship between memory performance and MSE for recall tasks compared with recognition tasks (Beaudoin, 2011), and when Strickland-Hughes and colleagues (2017) manipulated MSE, they found an effect on recall performance, but not on recognition performance. This would be consistent with Self-Efficacy Theory, which postulates that self-efficacy impacts performance by modulating effort expenditure on tasks which demand cognitive resources. Therefore, the relationship between self-efficacy and memory would be expected to be larger for more resource demanding tasks. However, it should be noted that despite recognition tasks being generally recognized as being less mentally taxing, it is no less important of an ability for everyday life. Source memory and reality monitoring are particularly important abilities for eyewitness testimony, susceptibility to false information, and general daily functioning, particularly for older adults. If changes in memory self-efficacy do lead to changes in performance during lab recall tasks, but do not lead to meaningful changes in source memory and reality monitoring ability, this would be an important distinction to be kept in mind for the application of memory self-efficacy research into daily life purposes.

Mechanisms of Effect. In the results of the current study, support was generally lacking for the suggestion that MSE improves memory accuracy by increasing engagement at encoding. The current study found no direct effect of positive vs. negative performance feedback on memory when feedback was administered pre-encoding. When feedback was administered pre-encoding, a marginal difference in self-reported engagement was found, but the lack of a significant difference in length of response and qualities of the memory itself casts doubt on the idea that memory self-efficacy affects reality monitoring ability through engagement with reality monitoring tasks.

Support was more mixed regarding the suggestion that MSE improves memory accuracy by altering decision-making criteria at retrieval. While manipulations of self-efficacy at retrieval did not alter reality monitoring performance, and memory self-efficacy did not specifically relate to bias in responses, some evidence suggests the possibility of memory self-efficacy affecting interpretation of the memory signal. Specifically, high memory self-efficacy scores during retrieval were related to higher ratings of cognitive operations during retrieval, and participants who received High MSE feedback at retrieval consistently rated their memories as having more cognitive operations than participants who received Low MSE feedback at retrieval. The fact that this trend held true for ratings of events that were never actually encoded may suggest that actual memory qualities are not affected, but rather that the presence of those memory qualities is interpreted more generously by High MSE individuals.

Potential Alternate Explanations. Many alternate explanations were considered as potential explanations for the relationship between memory self-efficacy and memory performance, and a large number of exploratory analyses investigated these possibilities. Largely, these exploratory analyses failed to support the alternate explanations. For example, the current results fail to support the idea that memory self-efficacy may primarily have its effect on memory performance by increasing strategy use, because the self-efficacy manipulation did not lead to any meaningful differences in reported strategy use, and reported strategy use did not relate to memory performance. As another example, the current results muddle the picture regarding the hypothesis that mindset may play an important role in the relationship between memory self-efficacy and memory ability. Although Study 1 found that individuals with fixed mindset showed a larger relationship between these two constructs (i.e., self -efficacy and memory performance) than individuals with growth mindset, the current results showed just the opposite, calling into question the validity of these exploratory analyses from Study 1.

Given the lack of causal evidence supporting altered memory self-efficacy directly impacting reality monitoring ability, as well as weak or non-existent effects on engagement levels or altered response-bias tendencies, I must consider that self-efficacy may be the effect in this relationship rather than the cause. That is, some degree of correlation between actual reality monitoring ability and perceived memory ability would be expected simply due to one's personal experiences. Furthermore, the average of individual metamemory judgments in both Study 1 and Study 3 possessed correlations with memory ability that were roughly similar to the correlation between memory self-efficacy and memory ability.

While the results in this particular study may not necessarily translate to other types of memory tasks, the effect of memory ability on memory self-efficacy should nevertheless be considered for all memory tasks as a potential explanation for the link between MSE and memory ability. Notably, despite lacking any definitive effect of engagement or other mechanisms, MSE nevertheless showed the same strength of relationship with memory ability that is seen, on average, in the broader memory literature (Beaudoin, 2011).

Limitations. Some limitations regarding this study must be taken into consideration. First and foremost, the possibility exists that the feedback manipulation did not actually change self-efficacy levels. This limitation is salient when considering the lack of significance in Study 2 between feedback conditions after revision, and the lack of a pre-test/post-test difference in MSEQ-4 seen in Study 3. However, it should be noted that the effect size for the Study 2 revised procedures was approximately medium and in the expected direction, suggesting that a larger sample size may have been sufficient to produce a significant result. Furthermore, the pre-test/post-test difference in Study 3 MSEQ-4 rating may be limited by 1) Potential carryover effects due to taking the pre-test and post-test only 24 hours apart, and 2) Increased noise due to participation in the reality monitoring memory task, and associated feelings of success or failure. Moreover, composite memory self-efficacy measures such as the MSEQ-4 may be too broad to capture task-specific changes in memory self-efficacy. Notably, even though two prior studies have found an effect of MSE manipulations on small subtests or ad-hoc MSE measures (Iacullo et al., 2016; Klein et al., 1994), These studies did not report changes in established, global measures of memory self-efficacy such as the MSEQ. Nevertheless, these same studies found resulting changes in memory performance that were attributed to their self-efficacy manipulations. The difficulty finding an effect on global MSE measures may be partially related to the stronger observed relationship between task-specific MSE and performance on the corresponding memory task, compared to global measures of MSE (see Beaudoin et al., 2011). In an attempt to account for this, the current study developed the task-specific measure of the MSEQ-ARMS. Unfortunately, however, this new task-specific measure for reality monitoring showed no significant relationship with reality monitoring performance.

Another limitation is that, because the duration of the manipulation’s effects is difficult to fully determine, the study’s capability to addresses memory consolidation is limited. While encoding and retrieval occur acutely (and thus I was able to manipulate self-efficacy directly before these stages take place), consolidation is a very gradual process, and the post-encoding manipulation may not have lasted a sufficient duration to mimic effects that may be present in everyday life with chronic maintenance of self-efficacy at a particularly high or low level. Thus, the post-encoding manipulation of self-efficacy may not be an accurate enough proxy to allow us to draw definitive conclusions about self-efficacy’s effect on the consolidation phase of memory during everyday reality monitoring.

A further limitation relates to participant completion of Study 1 and Study 3. In these studies, a large number of participants who completed the first part of the experiment did not complete the test phase approximately 24 hours later. The possibility exists that these participants who chose not to continue with the experiment left individuals with a restricted range of qualities remaining in the study, limiting the generalizability of the current results.

5. GENERAL DISCUSSION

The current studies provide valuable new information to the study of memory and beliefs. While previous studies have established a consistent relationship between memory self-efficacy and memory performance, the current study is the first to demonstrate this relationship within a reality monitoring paradigm. Understanding the nature of this relationship is particularly important because reality monitoring skills are critical for our daily functioning as human beings, for eyewitness testimony, and for conflicts in autobiographical memory that arise between individuals.

Notably, while the current study found general MSE to relate to reality monitoring ability, a reality-monitoring-specific measure of MSE did not relate to reality monitoring ability, despite possessing psychometric properties similar to the other subscales of the MSEQ-4. One distinguishing characteristic of reality-monitoring-specific MSE is that accuracy requires acknowledgement of false memories, while general MSE does not. Due to a general lack of awareness of false memories among much of the general public (Simons & Chabris, 2011; Simons & Chabris, 2012), individuals may on average possess less awareness of their own reality monitoring ability than other memory abilities such as general memory recall. Furthermore, forgetting generally produces more metacognitive feedback than possessing a false memory, because awareness of the former requires only introspection about what is remembered, while awareness of the latter requires actual evidence of the conflict between what truly happened and the false memory in question. The more regular feedback in recall tasks may calibrate general MSE, explaining why general MSE possesses a consistent relationship with ability while reality-monitoring-specific MSE does not.

Although several studies have found manipulations of self-efficacy to affect memory performance directly (Beaudoin, 2018; Iacullo et al., 2016; Strickland-Hughes et al., 2017; Klein et al., 1994) the current study did not find a direct effect of a self-efficacy manipulation on reality monitoring ability, regardless of whether the manipulation took place prior to encoding, after encoding, or prior to retrieval. A variety of factors may have affected this result. For example, one of the studies finding an effect focused on samples of older adults, rather than younger adults (Beaudoin, 2018), and Geraci and Miller (2013) even found that their manipulation's effectiveness differed according to the age of their participants. However, evidence for differences according to age is mixed (see Strickland-Hughes et al., 2017). Also, nearly all of the studies finding an effect of a manipulation focused on memory recall tasks (Beaudoin, 2018; Klein, 1994), and Strickland-Hughes and colleagues (2017) found that while MSE affected performance on recall tasks, performance on recognition memory tasks was not affected. As far as I am aware, only one study (Iacullo et al., 2016) has shown a significant effect of a self-efficacy manipulation on recognition in adults.

Moreover, while previous studies have hinted at the mechanisms through which memory self-efficacy may impact memory performance, the current study is the first to investigate multiple potential mechanisms of action simultaneously. Overall, evidence suggesting that MSE affects source memory through engagement at encoding was extremely limited. In Study 1, despite finding the expected relationship between MSE and memory, MSE did not significantly relate to any measure of engagement or memory quality. In Study 3, although manipulating MSE before encoding did yield marginal changes in self-reported engagement, actual measures of engagement and memory quality showed no changes. While many of these means and relationships did overall trend in the direction of higher MSE being related to higher engagement, the combined results of these studies call into question whether this effect is strong enough to explain a meaningful portion of the relationship between MSE and source memory. While some prior research on other types of memory tasks have found evidence of a role for task persistence (Beaudoin & Desrichard, 2017), our study adds to those that found no such evidence (see Wells & Esopenko, 2008).

The current study also investigated the possibility that the effect of engagement was muffled because it primarily applied to a subset of participants—those with a fixed mindset who consider memory to be an ability that does not change with effort or practice. While Study 1 seemed to support this suggestion, showing that those with a fixed mindset showed a stronger relationship between MSE and memory, as well as between MSE and memory qualities, these results were not found in Study 3. One reason for this difference may be that Study 3 correlations necessarily collapse across 6 different feedback manipulations, each of which might have affected engagement in a number of ways, increasing the amount of variability within the data and ultimately affecting the results. Regardless, the suggestion that those with fixed mindset may be differentially affected by memory self-efficacy manipulations requires further study.

Evidence suggesting that MSE alters the interpretation of memory qualities at retrieval was also extremely limited. In both Studies 1 and 3, MSE did not relate to bias. Nor did MSE relate to the amount of detail in the memories participants accepted as true past memories, though a weak positive trend was seen. Manipulating MSE before memory retrieval had no effect on either of these criterion-shift measures either, nor did it affect overall memory accuracy. The most compelling evidence for MSE altering the interpretation of memory qualities at retrieval instead came from exploratory analyses showing that the MSE manipulation at retrieval affected ratings of cognitive operations for unstudied items. Because these items were never studied, they should theoretically have no cognitive operations associated with them. Nevertheless, participants given positive feedback about their memories rated these items as possessing more associated cognitive operations compared with participants given negative feedback. However, this shift in the ratings of memory qualities at retrieval could also be a result of increased engagement at retrieval. A large body of research has shown that imagining various events increases their estimated likelihood of reality (e.g. Gamboz, Brandimonte, & De Vito, 2010; Garry, Manning, Loftus, & Sherman, 1996; Goff & Roediger, 1998; Thomas, Bulevich, & Loftus, 2003); therefore, if more engaged participants were more motivated to imagine receiving the word, they may have rated the word with slightly more associated cognitive operations. This possibility is limited, however, by the finding that self-reported engagement at retrieval was not affected by the MSE manipulation.

Conclusion

While the relationship between memory self-efficacy and memory ability appears to extend to reality monitoring tasks, directly manipulating self-efficacy did not produce a direct effect on reality monitoring performance. Furthermore, little evidence was found suggesting that memory self-efficacy relates to reality monitoring ability either through engagement or through interpretation of memory contents at retrieval. Therefore, great consideration must be given to the possibility that the relationship between memory self-efficacy and reality monitoring performance is due to participants commonly possessing a small degree of metacognitive accuracy and altering their memory self-efficacy in response to feedback throughout their lives, rather than the relationship being a result of memory self-efficacy impacting reality monitoring ability. While reality monitoring possesses many unique traits, researchers interested in the relationship between memory self-efficacy and other memory tasks, particularly recognition tasks, should heavily consider whether MSE is actually a cause of changes in memory performance, or whether it may instead be an effect, or perhaps possess a bidirectional relationship with memory ability.

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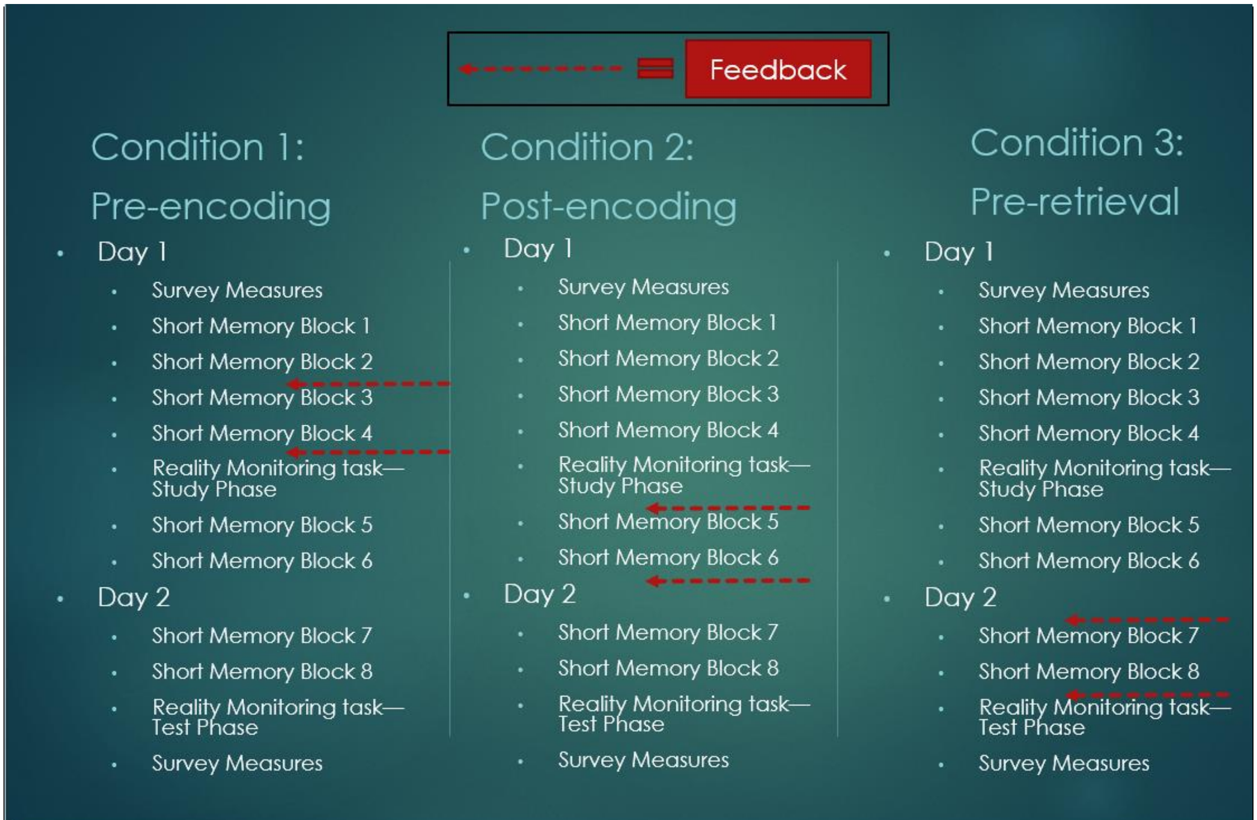

Figure 1. Display of the Order of Events in Study 3 for the Three Different Conditions. Dotted arrows indicate the placement of assigned feedback regarding memory performance.

Table 1.

Study 1 Reality Monitoring Task Performance

	Mean	Median	SD
Hits	.80	.83	.15
False Alarms (lure)	.33	.28	.25
False Alarms (new)	.11	.06	.14

Table 2.

Differences in Self-Efficacy By Variations in Manipulation Procedure

	High MSE			Low MSE			Comparison	
MSEQ-4	Mean	SD	N	Mean	SD	N	d	p
Simpler	71.45	14.02	27	65.95	18.70	26	.34	.23
More Complex	67.10	15.60	32	65.23	19.34	29	.11	.68
Expectation of difficulty	68.08	14.55	32	60.86	21.84	19	.42	.21
No expectation of difficulty	70.28	15.56	27	68.06	16.90	36	.14	.60
Absolute Feedback	66.05	14.27	17	65.92	15.61	16	.01	.98

Note: Means with different superscripts differ at $p < .05$.

**$p < .01$, two-tailed. *$p < .05$, two-tailed.

Table 3.

Study 3 Reality Monitoring Task Performance

	Mean	Median	SD
Hits	.79	.83	.16
False Alarms (lure)	.38	.33	.29
False Alarms (new)	.13	.06	.18

Table 4.

Differences in Memory Self-Efficacy By Feedback Manipulation and Timing

	High MSE Feedback			Low MSE Feedback			Total		
Timing	MSEQ-4	SD	N(*)	MSEQ-4	SD	N(*)	MSEQ-4	SD	N(*)
Pre-encoding	70.48	15.76	23	61.39	16.32	25	65.75	16.53	48
Post-encoding	61.13	12.59	31	57.75	18.44	21	59.77	15.14	52
Pre-retrieval	60.80	19.59	26	62.90	19.75	28	61.89	19.51	54
Total	63.71	16.42	80	60.93	18.16	72	62.38	17.28	154

(*) includes number of participants remaining after exclusion of those who reported skepticism of the manipulation.

Note: All MSEQ-4 Measures refer to post-test values

Table 5.

Memory Accuracy Values According to Self-Efficacy Manipulation and Timing

	High MSE			Low MSE		
Timing	Hits	FA (Lure)	A’	Hits	FA (Lure)	A’
Pre-encoding	.79	.32	.78	.82	.35	.78
Post-encoding	.80	.31	.80	.82	.38	.78
Pre-retrieval	.79	.41	.74	.77	.34	.74
Total	.80	.34	.78	.80	.35	.76

(*) includes number of participants remaining after exclusion of those who reported skepticism of the manipulation.

Table 6.

Differences in Memory Qualities By Feedback at Retrieval

	High MSE (N=26)		Low MSE (N=28)		Comparison	
Quality/Enc. Condition	Rating (1-7)	SD	Rating (1-7)	SD	*d*	*p*
Detail/Past	3.20	1.07	2.71	1.36	.40	.145
Detail/Future	2.96	1.07	2.57	1.28	.33	.233
Detail/ None	2.10	1.29	1.46	.81	.61*	.038
Cog. Operations/Past	3.03	1.26	2.29	1.09	.63*	.025
Cog. Operations/Future	2.74	1.09	2.10	.93	.64*	.023
Cog. Operations/ None	2.00	1.34	1.34	.69	.66*	.030

Note: Means with different superscripts differ at $p < .05$.

**$p < .01$, two-tailed. *$p < .05$, two-tailed.

APPENDICES

A. Memory Self-Efficacy Questionnaire (MSEQ-4)

B. Memory Self-Efficacy Questionnaire - Adapted Reality Monitoring Subscale (MSEQ-ARMS)

C. Theories of Memory Scale

D. Demographics Survey

E. Perseverance of Effort Subscale from the Short Grit Scale

F. Example Memory Questions for Presence, Color, and Location

G. Attention-Screening Task

H. Vividness of Visual Imagery Questionnaire (VVIQ)

I. Post-Study Survey (Experiment 1)

J. Post-Study Survey (Experiment 2)

K. Post-Study Survey (Experiment 3)

L. Revised Manipulation Instructions

M. Short Memory Task Instructions: Pre-Encoding

N. Short Memory Task Instructions: Post-Encoding

O. Short Memory Task Instructions: Pre-Retrieval

P. IRB Approval

APPENDIX A

<u>MEMORY QUESTIONNAIRE</u>

MSEQ-4

The purpose of these questions is to find out what you think about your own memory ability.

We would like to know your opinions. There are no right or wrong answers.

DIRECTIONS:

There are some memory tasks described on the following pages. Please put your responses on the MSEQ Answer Sheets.

If you <u>know that you cannot do</u> the task described, you circle the 0.

If you are <u>100% sure that you can do</u> the task described, you circle 100.

If you think you might be able to do it, but you are not 100% sure, your answer would fall in the middle somewhere between 10 and 90, depending on how certain you are.

Use the full scale, from 0 to 100 to show how confident you are that you can do the task described in each statement.

<u>EXAMPLE</u>:

These questions ask you about <u>your ability to remember to do some errands</u> for a friend who is ill. To help you answer these questions, here is a sample list of errands. This is just an example; you will not be asked to remember this list at this time.

---

take shirt to the cleaners	**pick up prescription medicine**
get money at the bank	**buy some tissues**
buy milk	**fill car with gas**
find birthday card for brother	**call nurse about her condition**

X-1. IF A SICK FRIEND ASKED ME TO DO 8 ERRANDS FOR HER, I COULD REMEMBER TO DO ALL 8 ERRANDS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

X-2. IF A SICK FRIEND ASKED ME TO DO 8 ERRANDS FOR HER, I COULD REMEMBER TO DO 2 OF THESE ERRANDS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

*******Do You Have Any Questions?*******

These questions ask you about <u>your ability to remember where you have recently placed common household items</u>. To help you answer these questions, there are some examples below of items that you could put away. Some time later (10-20 minutes later), you would need to find them again. These are only examples; you will not be asked to find these items at this time.

---

rubber band, scarf, scissors, notepad, thread, stapler, coaster, stamp, keys, matches, book, pencil, magnet, brush, necklace, toothbrush, comb, wallet

---

A-1. IF I PLACED 18 COMMON EVERYDAY OBJECTS IN DIFFERENT LOCATIONS AT HOME, A FEW MINUTES LATER I COULD REMEMBER WHERE I HAD PUT ALL 18 OF THE ITEMS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

A-2. IF I PLACED 18 COMMON EVERYDAY OBJECTS IN DIFFERENT LOCATIONS AT HOME, A FEW MINUTES LATER I COULD REMEMBER WHERE I HAD PUT 14 OF THE ITEMS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

go to next page

A-3. IF I PLACED 18 COMMON EVERYDAY OBJECTS IN DIFFERENT LOCATIONS AT HOME, A FEW MINUTES LATER I COULD REMEMBER WHERE I HAD PUT 10 OF THE ITEMS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)
0 10 20 30 40 50 60 70 80 90 100
I cannot do it — Moderately certain I can do it — 100% sure I can do it

A-4. IF I PLACED 18 COMMON EVERYDAY OBJECTS IN DIFFERENT LOCATIONS AT HOME, A FEW MINUTES LATER I COULD REMEMBER WHERE I HAD PUT 6 OF THE ITEMS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)
0 10 20 30 40 50 60 70 80 90 100
I cannot do it — Moderately certain I can do it — 100% sure I can do it

A-5. IF I PLACED 18 COMMON EVERYDAY OBJECTS IN DIFFERENT LOCATIONS AT HOME, A FEW MINUTES LATER I COULD REMEMBER WHERE I HAD PUT 2 OF THE ITEMS.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)
0 10 20 30 40 50 60 70 80 90 100
I cannot do it — Moderately certain I can do it — 100% sure I can do it

go to next page

These questions ask you about <u>your ability to remember a friend's shopping list</u>. To help you answer these questions, here is a sample shopping list. This is only an example; you will not be asked to remember this list at this time.

---

cottage cheese, blueberries, rolls, bread, paper towels, peaches, napkins, tissues, milk, eggs, margarine, lunch meat, chicken, aspirin, peas, birthday card, t-shirt, hamburger

---

C-1. IF I WENT TO THE STORE THE SAME DAY, I COULD REMEMBER 18 ITEMS FROM A FRIEND'S SHOPPING LIST OF 18 ITEMS, WITHOUT USING A LIST.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

C-2. IF I WENT TO THE STORE THE SAME DAY, I COULD REMEMBER 14 ITEMS FROM A FRIEND'S SHOPPING LIST OF 18 ITEMS, WITHOUT USING A LIST.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

go to next page

C-3. IF I WENT TO THE STORE THE SAME DAY, I COULD REMEMBER 10 ITEMS FROM A FRIEND'S SHOPPING LIST OF 18 ITEMS, WITHOUT USING A LIST.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

C-4. IF I WENT TO THE STORE THE SAME DAY, I COULD REMEMBER 6 ITEMS FROM A FRIEND'S SHOPPING LIST OF 18 ITEMS, WITHOUT USING A LIST.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

C-5. IF I WENT TO THE STORE THE SAME DAY, I COULD REMEMBER 2 ITEMS FROM A FRIEND'S SHOPPING LIST OF 18 ITEMS, WITHOUT USING A LIST.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

go to next page

These questions ask you about <u>your ability to remember people's names</u>. To help you answer these questions, here is a sample list of names. This is only an example; you will not be asked to remember these names at this time.

Melissa, James, Sarah, Derek, Rachel,
Daniel, Karen, Patrick, Angela, Brian

D-1. IF SOMEONE SHOWED ME THE PHOTOGRAPHS OF 10 PEOPLE AND TOLD ME THEIR NAMES ONCE, I COULD IDENTIFY 10 PERSONS BY NAME IF I SAW THE PICTURES AGAIN A FEW MINUTES LATER.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

D-2. IF SOMEONE SHOWED ME THE PHOTOGRAPHS OF 10 PEOPLE AND TOLD ME THEIR NAMES ONCE, I COULD IDENTIFY 8 PERSONS BY NAME IF I SAW THE PICTURES AGAIN A FEW MINUTES LATER.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

go to next page

D-3. IF SOMEONE SHOWED ME THE PHOTOGRAPHS OF 10 PEOPLE AND TOLD ME THEIR NAMES ONCE, I COULD IDENTIFY 6 PERSONS BY NAME IF I SAW THE PICTURES AGAIN A FEW MINUTES LATER.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

D-4. IF SOMEONE SHOWED ME THE PHOTOGRAPHS OF 10 PEOPLE AND TOLD ME THEIR NAMES ONCE, I COULD IDENTIFY 4 PERSONS BY NAME IF I SAW THE PICTURES AGAIN A FEW MINUTES LATER.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

D-5. IF SOMEONE SHOWED ME THE PHOTOGRAPHS OF 10 PEOPLE AND TOLD ME THEIR NAMES ONCE, I COULD IDENTIFY 2 PERSONS BY NAME IF I SAW THE PICTURES AGAIN A FEW MINUTES LATER.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

go to next page

These questions ask you about <u>your ability to remember the main points from a story</u>. To help you answer these questions, here is a sample story. This is only an example; you will not be asked to remember this story at this time.

<u>Sample story</u>: Leroy is enjoying a holiday. He is staying with his family in Minneapolis, Minnesota. His oldest son, Arthur, works at the university there. His other son, Ronald and his family have come up from Chicago. There are five children and five adults staying in Arthur's house. Leroy is staying in the ground floor guestroom. It is a little noisy. It is, however, conveniently located near a bathroom, the kitchen, and the dining room. The four bedrooms upstairs and the extra room in the basement are enough for everyone else. It is crowded, but it's good to see the family.

E-1. IF I HAD JUST READ PART OF A STORY (ABOUT 10 SENTENCES) I COULD CORRECTLY REMEMBER THE MAIN POINTS FROM ALL 10 SENTENCES.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

E-2. IF I HAD JUST READ PART OF A STORY (ABOUT 10 SENTENCES) I COULD CORRECTLY REMEMBER THE MAIN POINTS FROM 8 SENTENCES.

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

go to next page

E-3. **IF I HAD JUST READ PART OF A STORY (ABOUT 10 SENTENCES) I COULD CORRECTLY REMEMBER THE MAIN POINTS FROM 6 SENTENCES.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)										
0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

E-4. **IF I HAD JUST READ PART OF A STORY (ABOUT 10 SENTENCES) I COULD CORRECTLY REMEMBER THE MAIN POINTS FROM 4 SENTENCES.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)										
0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

E-5. **IF I HAD JUST READ PART OF A STORY (ABOUT 10 SENTENCES) I COULD CORRECTLY REMEMBER THE MAIN POINTS FROM 2 SENTENCES.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)										
0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

Thanks very much!!

APPENDIX B

MSEQ-ARMS

Sometimes, you may perform everyday actions around your house, while other times, you may only think about performing those actions. These questions ask you about your ability to remember whether you performed or only thought about small everyday actions. To help you answer these questions, here is a sample list of actions. Next to each action that was only thought about, the action itself would not have been performed. This is only an example; you will not be asked to remember these actions later.

Thought about paying a bill online	**Texted a specific friend back**
Wrote a reminder note about an errand	**Thought about checking your email**
Moved clothes to the dryer	**Thought about locking your door**
Put leftovers in the refrigerator	**Set a timer**
Thought about eating a snack	**Thought about brushing your teeth**
Called a friend who didn't pick up	**Thought about taking your pill**
Thought about feeding your pet	**Purchased bread while shopping**

A-1. **IF I THOUGHT ABOUT OR PERFORMED 14 SMALL, EVERYDAY ACTIONS, TWO WEEKS LATER I COULD REMEMBER WHETHER ALL 14 ACTIONS WERE PERFORMED OR ONLY THOUGHT ABOUT.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

A-2. **IF I THOUGHT ABOUT OR PERFORMED 14 SMALL, EVERYDAY ACTIONS, TWO WEEKS LATER I COULD REMEMBER WHETHER 12 ACTIONS WERE PERFORMED OR ONLY THOUGHT ABOUT.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

A-3. **IF I THOUGHT ABOUT OR PERFORMED 14 SMALL, EVERYDAY ACTIONS, TWO WEEKS LATER I COULD REMEMBER WHETHER 10 ACTIONS WERE PERFORMED OR ONLY THOUGHT ABOUT.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

A-4. **IF I THOUGHT ABOUT OR PERFORMED 14 SMALL, EVERYDAY ACTIONS, TWO WEEKS LATER I COULD CORRECTLY REMEMBER WHETHER 8 ACTIONS WERE PERFORMED OR ONLY THOUGHT ABOUT.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

A-5. **IF I THOUGHT ABOUT OR PERFORMED 14 SMALL, EVERYDAY ACTIONS, TWO WEEKS LATER I COULD CORRECTLY REMEMBER WHETHER 6 ACTIONS WERE PERFORMED OR ONLY THOUGHT ABOUT.**

HOW CERTAIN ARE YOU THAT YOU CAN DO THIS? (circle a percentage)

0	10	20	30	40	50	60	70	80	90	100
I cannot do it					Moderately certain I can do it					100% sure I can do it

APPENDIX C

Theories of Memory Scale

Please rate how much you agree with each of the following statements, according to the following options.

1-Strongly Agree 2-Agree 3-Mostly Agree 4-Mostly Disagree 5-Disagree 6-Strongly Disagree

1. You have a certain amount of memory ability, and you can’t really do much to change it.
2. Your memory ability is something about you that you can’t change very much.
3. No matter who you are, you can significantly change your memory ability.
4. To be honest, you can’t really change how well you can remember things.
5. You can always substantially change how well you can remember things.
6. You can memorize new things, but you can’t really change your basic ability to remember.
7. No matter what your memory is like, you can always change it quite a bit.
8. You can change even your basic memory ability considerably.

APPENDIX D

Demographics survey

1. How old are you? ________

2. Sex: (Choose One)

Male Female

3. Please select your highest level of education ________

High School Diploma College Degree (B.A., B.S., etc.)

4. If you are currently a student, what is your current year in your program?

Freshman Sophomore Junior Senior

APPENDIX E

Perseverance of Effort Subscale from the Short Grit Scale

Items are rated on a 5-point scale from 1 *not at all like me* to 5 *very much like me.*

1. I have achieved a goal that took years of work.
2. I have overcome setbacks to conquer an important challenge.
3. I finish whatever I begin.
4. Setbacks don’t discourage me.
5. I am a hard worker.
6. I am diligent.

APPENDIX F

Example Memory Questions for Presence, Color, and Location

1. Which color was the word “bed” presented in?
    a. Red
    b. Blue
    c. Green
    d. Purple
    e. Black

2. What area of the screen was the word “sugar” presented in?
    a. Top left
    b. Top middle
    c. Top right
    d. Center right
    e. Center
    f. Center Left
    g. Bottom Left
    h. Bottom Middle
    i. Bottom Right

3. Was the word “system” presented?
    a. Yes
    b. No

APPENDIX G

Attention-screening task

Please read the following question CAREFULLY.

Please indicate which science you like best.

Instructions for this Question:

The science someone selects as their favorite can say a lot about them. Recognizing how science preferences link to personality traits is an indicator of their intelligence. For example those who prefer physics are the smartest in the world and those who prefer ecology are not smart at all. Only, that is not true and that is not what this study is about. We are interested in how individuals approach events and situations that can be very complex, and how closely the pay attention to instructions. Thus, ignore the question at the top of the screen and please select option "scientology", and congratulations for passing this little test. Thank you for taking our study seriously, we appreciate it, so follow what we just told you because the next sentence will be another trap for those just skimming. So, if science preference can have that much of a predictor about intelligence, what does that say about you? Please indicate what your favorite science is now.

- Biology
- Chemistry
- Psychology
- Physics
- Scientology
- Mathematics
- Geology
- Zoology

APPENDIX H

VIVIDNESS OF VISUAL IMAGERY QUESTIONNAIRE (VVIQ)

For each item on this questionnaire, try to form a visual image, and consider your experience carefully. For any image that you do experience, rate how vivid it is using the five-point scale described below. If you do not have a visual image, rate vividness as ‘1’. Only use ‘5’ for images that are truly as lively and vivid as real seeing. Please note that there are no right or wrong answers to the questions, and that it is not necessarily desirable to experience imagery or, if you do, to have more vivid imagery.

Perfectly clear and vivid as real seeing	5
Clear and reasonably vivid	4
Moderately clear and lively	3
Vague and dim	2
No image at all, you only “know” that you are thinking of the object	1

For items 1-4, think of some relative or friend whom you frequently see (but who is not with you at present) and consider carefully the picture that comes before your mind’s eye.

1. The exact contour of face, head, shoulders and body ______________
2. Characteristic poses of head, attitudes of body etc. ______________
3. The precise carriage, length of step etc., in walking ______________
4. The different colours worn in some familiar clothes ______________

Visualise a rising sun. Consider carefully the picture that comes before your mind’s eye.

5. The sun rising above the horizon into a hazy sky ______________
6. The sky clears and surrounds the sun with blueness ______________
7. Clouds. A storm blows up with flashes of lightning ______________
8. A rainbow appears ______________

Think of the front of a shop which you often go to. Consider the picture that comes before your mind’s eye.

9. The overall appearance of the shop from the opposite side of the road ______________
10. A window display including colours, shapes and details Of individual items for sale ______________
11. You are near the entrance. The colour, shape and details of the door. ______________
12. You enter the shop and go to the counter. The counter assistant serves you. Money changes hands ______________

Finally think of a country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind’s eye.

13. The contours of the landscape ______________
14. The colour and shape of the trees ______________
15. the colour and shape of the lake ______________
16. A strong wind blows on the trees and on the lake causing waves in the water. ______________

APPENDIX I

Post-Study Survey (Experiment 1)

1. During the portion of the experiment in which you recalled events from your past or imagined events in your future, did you find the instructions clear? (Yes/No)
2. Please rate on a scale from 1 (not clear at all) to 10 (perfectly clear) how clearly you were able to interpret the instructions during that portion of the study.
3. During the portion of the experiment in which you recalled events from your past or imagined events in your future, did you use any particular strategies to make it easier for you to remember the event later? (Yes/No)
4. If so, please describe what strategy you used
5. During the portion of the experiment in which you were asked to recall an event from the previous day, and then respond whether it was a past event (or, sometimes, whether it was a future event), did you find the instructions clear? (Yes/No)
6. Please rate on a scale from 1 (not clear at all) to 10 (perfectly clear) how clearly you were able to interpret the instructions during that portion of the study.
7. During the portion of the experiment in which you were asked to recall an event from the previous day, and then respond whether it was a past event (or, sometimes, whether it was a future event), did you use any particular strategies to make it easier to remember what the source of event had originally been? (Yes/No)
8. If so, please describe what strategy you used
9. Please rate on the following scale the total number of hours that you have spent sleeping since you completed Part 1 of this study.

APPENDIX J

Post-Study Survey (Experiment 2)

After completing memory tasks during this study, you received feedback related to your performance. Please answer the following questions about the feedback that you received.

1. Regarding the task in which you viewed words, and then tried to remember the color, size, and placement of the words, how clearly did you feel that you understood the instructions? [Please use a 1 (not clear at all) to 10 (perfectly clear) scale]
2. What was your approximate percentile rank, according to feedback from your most recent performance? (1-100 scale)
3. How confident are you that you accurately remember your percentile rank, at least within 10 percentile points? (1-5 scale)
4. After, you were given the rank of your memory performance during the task, what kind of performance would you say this rank suggested? (1-5 scale, poor to good)
5. Would you say that you were encouraged or disappointed by your rank? (1-5 scale, disappointed to encouraged)
6. Do you think your rank was accurate about how you performed? (1-5 scale, not accurate to very accurate)
7. Do you think your rank was accurate about your memory ability in general? (1-5 scale, not accurate to very accurate)
8. When you received your percentile rank about your memory performance, did you think your feedback was calculated from your answers on the memory task? (Yes/No)
9. If you did not think your feedback was calculated from your answers on the memory task, why did you think you received the feedback? (Open-ended)

APPENDIX K

Post-Study Survey (Experiment 3)

1. During the portion of the experiment in which you recalled events from your past or imagined events in your future, did you find the instructions clear? (Yes/No)
2. Please rate on a scale from 1 (not clear at all) to 10 (perfectly clear) how clearly you were able to interpret the instructions during that portion of the study.
3. During the portion of the experiment in which you recalled events from your past or imagined events in your future, did you use any particular strategies to make it easier for you to remember the event later? (Yes/No)
4. If so, please describe what strategy you used
5. During the portion of the experiment in which you were asked to recall an event from the previous day, and then respond whether it was a past event (or, sometimes, whether it was a future event), did you find the instructions clear? (Yes/No)
6. Please rate on a scale from 1 (not clear at all) to 10 (perfectly clear) how clearly you were able to interpret the instructions during that portion of the study.
7. During the portion of the experiment in which you were asked to recall an event from the previous day, and then respond whether it was a past event (or, sometimes, whether it was a future event), did you use any particular strategies to make it easier to remember what the source of event had originally been? (Yes/No)
8. If so, please describe what strategy you used
9. Please rate on the following scale the total number of hours that you have spent sleeping since you completed Part 1 of this study.

After completing memory tasks during this study, you received feedback related to your performance. Please answer the following questions about the feedback that you received.

1. Regarding the task in which you viewed words, and then tried to remember the color, size, and placement of the words, how clearly did you feel that you understood the instructions? [Please use a 1 (not clear at all) to 10 (perfectly clear) scale]
2. What was your approximate percentile rank, according to feedback from your most recent performance? (1-100 scale)
3. How confident are you that you accurately remember your percentile rank, at least within 10 percentile points? (1-5 scale)
4. After, you were given the rank of your memory performance during the task, what kind of performance would you say this rank suggested? (1-5 scale, poor to good)
5. Would you say that you were encouraged or disappointed by your rank? (1-5 scale, disappointed to encouraged)
6. Do you think your rank was accurate about how you performed? (1-5 scale, not accurate to very accurate)
7. Do you think your rank was accurate about your memory ability in general? (1-5 scale, not accurate to very accurate)
8. When you received your percentile rank about your memory performance, did you think your feedback was calculated from your answers on the memory task? (Yes/No)
9. If you did not think your feedback was calculated from your answers on the memory task, why did you think you received the feedback? (Open-ended)

APPENDIX L

Revised Manipulation Instructions

You will now complete a task commonly used to assess a person's general memory ability. You will be presented with a series of words in different colors (black, blue, red, green, purple) and locations on the screen (top, middle, bottom and left, center, right). While each word is presented, please study it as best you can. After viewing all of the words, you will be asked to answer several questions about them.

This will be the first of several times that you are asked to complete a task like this. As you complete these tasks, you will be provided with feedback updating you about how your performance compares with norms established through a national database of subject pools at large research universities. You should know that these questions are designed to capture the far-reaches of the capability of human memory. As a result, the average person correctly answers only about half of the questions correctly.

To give you a sense of what kinds of questions you will encounter, please complete the following short practice version of this task, before proceeding to the full task. Your performance on these initial questions will NOT affect any feedback you receive about how your performance ranks compared with others nationally.

APPENDIX M

Short Memory Task Instructions: Pre-Encoding

Memory Specification Task

You will now complete a task commonly used to assess a person's general memory ability. You will be presented with a series of words in different colors (black, blue, red, green, purple) and locations on the screen (top, middle, bottom and left, center, right). While each word is presented, please study it as best you can. After viewing all of the words, you will be asked to answer several questions about them.

This will be the first of several times that you are asked to complete a task like this. You will complete four word-sets belonging to the Memory Specification Task sequentially first, and afterward you will be asked to complete more word-sets at different times throughout the study. As you complete the initial four word-sets tasks, you will be provided with feedback updating you about how your performance compares with norms established through a national database of subject pools at large research universities. You should know that these questions are designed to capture the far-reaches of the capability of human memory. As a result, the average person correctly answers only about half of the questions correctly.

To give you a sense of what kinds of questions you will encounter, please complete the following short practice version of this task, before proceeding to the full task. Your performance on these initial questions will NOT affect any feedback you receive about how your performance ranks compared with others nationally.

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APPENDIX N

Short Memory Task Instructions: Post-Encoding

Memory Specification Task

You will now complete a task commonly used to assess a person's general memory ability. You will be presented with a series of words in different colors (black, blue, red, green, purple) and locations on the screen (top, middle, bottom and left, center, right). While each word is presented, please study it as best you can. After viewing all of the words, you will be asked to answer several questions about them.

This will be the first of several times that you are asked to complete a task like this. You will complete four word-sets belonging to the Memory Specification Task sequentially first, and afterward you will be asked to complete more word-sets at different times throughout the study. After you complete the initial four word-sets, your scores can begin calculation. When you return to the next portion of the Memory Specification Task, you will be provided with initial feedback updating you about how your performance compares with norms established through a national database of subject pools at large research universities. This feedback will adjust as you complete more word-sets within the task throughout the study.

You should know that these questions are designed to capture the far-reaches of the capability of human memory. As a result, the average person correctly answers only about half of the questions correctly.

To give you a sense of what kinds of questions you will encounter, please complete the following short practice version of this task, before proceeding to the full task. Your performance on these initial questions will NOT affect any feedback you receive about how your performance ranks compared with others nationally.

→

APPENDIX O

Short Memory Task: Pre-Retrieval

Memory Specification Task

You will now complete a task commonly used to assess a person's general memory ability. You will be presented with a series of words in different colors (black, blue, red, green, purple) and locations on the screen (top, middle, bottom and left, center, right). While each word is presented, please study it as best you can. After viewing all of the words, you will be asked to answer several questions about them.

This will be the first of several times that you are asked to complete a task like this. After you complete Part 1 of this study, your baseline scores on the Memory Specification Task can be entered for calculation. When you return tomorrow to complete Part 2 of this study, you will be provided with initial feedback updating you about how your performance compares with norms established through a national database of subject pools at large research universities. This feedback will adjust as you complete more word-sets within the task throughout Part 2 of the study.

You should know that these questions are designed to capture the far-reaches of the capability of human memory. As a result, the average person correctly answers only about half of the questions correctly.

To give you a sense of what kinds of questions you will encounter, please complete the following short practice version of this task, before proceeding to the full task. Your performance on these initial questions will NOT affect any feedback you receive about how your performance ranks compared with others nationally.

→

APPENDIX P

THE UNIVERSITY OF ALABAMA | Office of the Vice President for Research & Economic Development
Office for Research Compliance

February 14, 2020

Kyle R. Kraemer, M.A.
Doctoral Graduate Student
Department of Psychology
College of Arts and Sciences
The University of Alabama
Box 870348

Re: IRB # 17-OR-138-R3 "Differing Characteristics of Memory among Individuals"

Dear Mr. Kraemer:

The University of Alabama Institutional Review Board has granted approval for your renewal application. Your renewal application has been given expedited approval according to 45 CFR part 46. You have also been granted the requested waiver of one element of informed consent. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The approval for your application will lapse on February 13, 2021. If your research will continue beyond this date, please submit a continuing review to the IRB as required by University policy before the lapse. Please note, any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

Please use reproductions of the IRB approved informed consent form to obtain consent from your participants.

Good luck with your research.

Sincerely,

[redacted]

Informed Consent Notification (Experiment 1)

You are being asked to be in a research study called, "Differing Characteristics of Memory Among Individuals" This study is being conducted by Kyle R. Kraemer, a doctoral candidate in experimental psychology at the University of Alabama. Drs. Sheila Black and Ian McDonough, professors in the psychology department at the University of Alabama, are overseeing the research study. You are eligible for this study if you are 18 years of age or older.

This study is being done to find out more about how different people remember things and what individual characteristics lead to success in memory. This study involves participating in two different sessions, spaced 24 hours apart. During both sessions, you will be asked to perform a number of tasks. For example, in this study, you will be asked to complete several different surveys about yourself and your memory. You will also be asked to recall memories from your past, and to describe different qualities about your experience with that memory. In addition, you will be asked to imagine events in your future, and to describe different qualities of that imagination. You will also be asked a number of questions about your experiences both imagining and remembering different events.

The first session of this experiment will last approximately 1.5 hours, and you will receive 1.5 units of credit for participation. The second session of this experiment will last approximately 1 hour, and you will receive 1 additional credit for participating in the second session. Other than course credits, there is no direct benefit to the participants for participating. It is possible that you may experience slight boredom. Your participation involves minimal risk, which means that you will not be subject to any more risk than you would experience in everyday life.

Your responses will be strictly confidential. Each participant's responses will be coded by a unique participant code rather than identifying information such as a name, and only members of the research team will have access to participant's responses. You should know that your participation is strictly voluntary and that you have a right to withdraw your consent to participate at any time without prejudice. You should also know that you have the right to ask questions regarding the procedures. You may direct questions to Kyle R. Kraemer, M.A. at krkraemer@crimson.ua.edu. You should only agree to participate if all of your questions have been answered to your satisfaction. If you have any questions or concerns before or after completing this research project please contact Kyle R. Kraemer, M.A. at krkraemer@crimson.ua.edu or Dr. Sheila Black at (205) 348-0613. If you have questions or complaints about your rights as a research participant, call Ms. Tanta Myles, the Research Compliance Officer of the University at 205-348-8461 or toll-free at 1-877-820-3066. You may also ask questions, make a suggestion, or file complaints and concerns through the IRB Outreach Website at http://ovpred.ua.edu/research-compliance/prco/. After you participate, you are encouraged to complete the survey for research participants that is online there. You may also e-mail us at rscompliance@research.ua.edu. If you understand the statements above, are at least 18 years old, and freely consent to be in this study, click on the ">>" button to begin.

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 2-14-20
EXPIRATION DATE: 2-13-21

Informed Consent Notification (Experiment 2)

You are being asked to be in a research study called, "Differing Characteristics of Memory Among Individuals" This study is being conducted by Kyle R. Kraemer, a doctoral candidate in experimental psychology at the University of Alabama. Drs. Sheila Black and Ian McDonough, professors in the psychology department at the University of Alabama, are overseeing the research study. You are eligible for this study if you are 18 years of age or older.

This study is being done to find out more about how different people remember things and what individual characteristics lead to success in memory. During this study, you will be asked to perform a number of tasks. For example, in this study, you will be asked to complete several different surveys about yourself, your memory, and your ability to imagine things. You will also be asked to make a number of memory judgments, in which you will be shown a series of words and will be subsequently asked questions about what you remember from the presentation of those words. You will also be given feedback about your performance on this memory task, and you may personally interpret that feedback positively or negatively. You will also be asked a number of questions about your experiences both imagining and remembering different events.

This experiment will last approximately 1 hour, and you will receive 1 unit of credit for participation. Other than course credits, there is no direct benefit to the participants for participating. It is possible that you may experience slight boredom. In addition, you will receive feedback about your relative memory performance compared with others who have completed these tasks, and while this feedback may be positive, it may also be negative which could lead to disappointment. Your participation involves minimal risk, which means that you will not be subject to any more risk than you would experience in everyday life.

Your responses will be strictly confidential. Each participant's responses will be coded by a unique participant code rather than identifying information such as a name, and only members of the research team will have access to participant's responses. You should know that your participation is strictly voluntary and that you have a right to withdraw your consent to participate at any time without prejudice. You should also know that you have the right to ask questions regarding the procedures. You may direct questions to Kyle R. Kraemer, M.A. at krkraemer@crimson.ua.edu. You should only agree to participate if all of your questions have been answered to your satisfaction. If you have any questions or concerns before or after completing this research project please contact Kyle R. Kraemer, M.A. at krkraemer@crimson.ua.edu or Dr. Sheila Black at (205) 348-0613. If you have questions or complaints about your rights as a research participant, call Ms. Tanta Myles, the Research Compliance Officer of the University at 205-348-8461 or toll-free at 1-877-820-3066. You may also ask questions, make a suggestion, or file complaints and concerns through the IRB Outreach Website at http://ovpred.ua.edu/research-compliance/prco/. After you participate, you are encouraged to complete the survey for research participants that is online there. You may also e-mail us at rscompliance@research.ua.edu. If you understand the statements above, are at least 18 years old, and freely consent to be in this study, click on the ">>" button to begin.

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 2-14-20
EXPIRATION DATE: 2-13-21

Informed Consent Notification (Experiment 3)

You are being asked to be in a research study called, "Differing Characteristics of Memory Among Individuals" This study is being conducted by Kyle R. Kraemer, a doctoral candidate in experimental psychology at the University of Alabama. Drs. Sheila Black and Ian McDonough, professors in the psychology department at the University of Alabama, are overseeing the research study. You are eligible for this study if you are 18 years of age or older.

This study is being done to find out more about how different people remember things and what individual characteristics lead to success in memory. This study involves participating in two different sessions, spaced 24 hours apart. During both sessions, you will be asked to perform a number of tasks. For example, in this study, you will be asked to complete several different surveys about yourself and your memory. You will also be asked to make a number of memory judgments, in which you will be shown a series of words and will be subsequently asked questions about what you remember from the presentation of those words. You will also be asked to recall memories from your past, and to describe different qualities about your experience with that memory. In addition, you will be asked to imagine events in your future, and to describe different qualities of that imagination. You will also be asked a number of questions about your experiences both imagining and remembering different events.

The first session of this experiment will last approximately 2.25 hours, and you will receive 2.25 units of credit for participation. The second session of this experiment will last approximately 1.25 hours as well, and you will receive 1.25 additional credits for participating in the second session. Other than course credits, there is no direct benefit to the participants for participating. It is possible that you may experience slight boredom. In addition, you will receive feedback about your relative memory performance compared with others who have completed these tasks, and while this feedback may be positive, it may also be negative which could lead to disappointment. Your participation involves minimal risk, which means that you will not be subject to any more risk than you would experience in everyday life.

Your responses will be strictly confidential. Each participant's responses will be coded by a unique participant code rather than identifying information such as a name, and only members of the research team will have access to participant's responses. You should know that your participation is strictly voluntary and that you have a right to withdraw your consent to participate at any time without prejudice. You should also know that you have the right to ask questions regarding the procedures. You may direct questions to Kyle R. Kraemer, M.A. at krkraemer@crimson.ua.edu. You should only agree to participate if all of your questions have been answered to your satisfaction. If you have any questions or concerns before or after completing this research project please contact Kyle R. Kraemer, M.A. at krkraemer@crimson.ua.edu or Dr. Sheila Black at (205) 348-0613. If you have questions or complaints about your rights as a research participant, call Ms. Tanta Myles, the Research Compliance Officer of the University at 205-348-8461 or toll-free at 1-877-820-3066. You may also ask questions, make a suggestion, or file complaints and concerns through the IRB Outreach Website at http://ovpred.ua.edu/research-compliance/prco/. After you participate, you are encouraged to complete the survey for research participants that is online there. You may also e-

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mail us at rscompliance@research.ua.edu.If you understand the statements above, are at least 18 years old, and freely consent to be in this study, click on the ">>" button to begin.

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CONSENT FORM APPROVED: 2-14-20
EXPIRATION DATE: 2-13-21

Informed Consent for a Medical Study (UA)—Experiment 4

Study Title: Differing Characteristics of Memory Among Individuals

Principal Investigator: Kyle Rhoads Kraemer, M.A., Doctoral Candidate, Dept. of Psychology

What is this study about? What is the investigator trying to learn?
This purpose of this study is to learn about the individual characteristics that lead to memory success in older adults.

Why have I been asked to be in this study?
You have been asked to participate in this study because you are of age 60+ years old and have given consent to be contacted to participate in research regarding memory and aging through the Alabama Research Institute on Aging (ARIA), the MAC 2 Lab registry, or contacted the lab coordinators through advertisements at senior living communities.

What will I be asked to do in this study?
During both sessions, you will be asked to perform a number of tasks. For example, in this study, you will be asked to complete several different surveys about yourself and your memory. You will also be asked to recall memories from your past, and to describe different qualities about your experience with that memory. In addition, you will be asked to imagine events in your future, and to describe different qualities of that imagination. You will also be asked a number of questions about your experiences both imagining and remembering different events.

How much time will I spend being in this study?
We can expect that the first session will take roughly 1.5 hours and the second session will take roughly 1 hour. Part of the time commitment will include driving to and from the University of Alabama.

Is the researcher being paid for this study?
This study is not being supported by any grant, agency, or company.

Is this research developing a product that will be sold, and if so, will the investigator profit from it?
This research is not developing any product that will be commercialized afterwards.

How many people will be in this study?
Up to 400 other people will be in this study.

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Will being in this study cost me anything?
There will be no costs for participating in the study, but there is a large time commitment because the first session will last for approximately 1.5 hours and the second will last for approximately 1 hour. Besides time spent participating, you may experience boredom or fatigue.

What are the benefits that may happen if I am in this study?
You will not directly benefit from participating, but your participation will help us learn more about the relationship between age and variables that impact memory.

What are the benefits to science or society?
The results of the study will help to better understand and assess the relationship and differences between aging, cognition, and memory.

Will I be compensated for being in this study?
You will earn $10 total for your time participating in this study. That is, you will be paid $5 after the completion of each session.

How will my privacy be protected?
You may decide not to participate, choose not to answer any question, or stop participating any time without any penalty.

What are the risks (dangers or harms) to me if I am in this study?
There are minimal risks involved in this study. You may feel tired, fatigued, bored, or anxious from having your cognition and mental status assessed.

How will my confidentiality be protected?
Data will be collected through Qualtrics Survey Software online, the data will be stored on a password-protected account that only the research investigators will have access to. The records of this study will be stored securely and kept private. Authorized persons from The University of Alabama, members of the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by the law.

What are the alternatives to being in this study? Do I have other choices?
The alternative to being in this study is not to participate.

What are my rights as a participant in this study?
Taking part in this study is voluntary. It is your free choice. You can refuse to be in it at all. If you start the study, you can stop at any time. There will be no effect on your relations with the University of Alabama or the Department of Psychology.

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 2-14-20
EXPIRATION DATE: 2-13-21

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Who do I call if I have questions or problems?

If you have questions, concerns, or complaints about the study right now, please ask them. If you have questions concerns, or complaints about the study later on, please email the laboratory at mac2research@ua.edu or call the supervising investigator, Dr. Ian McDonough, at 205-348-1168.

If you have questions about your rights as a person in a research study, call Ms. Tanta Myles, the Research Compliance Officer of the University, at 205-348-8461 or toll-free at 1-877-820-3066.

You may also ask questions, make suggestions, or file complaints and concerns through the IRB Outreach website at http://ovpred.ua.edu/research-compliance/prco/ or email the Research compliance office at rscompliance@research.ua.edu.

After you participate, you are encouraged to complete the survey for research participants through Qualtrics Survey Software online.

I have read this consent form. I have had a chance to ask questions. I am at least 18 years of age. I agree to take part in it. I will receive a copy of this consent form to keep.

Signature of Research Participant:______________________________ **Date:**

Signature of Investigator: **Date:**

UNIVERSITY OF ALABAMA IRB
CONSENT FORM APPROVED: 2-14-20
EXPIRATION DATE: 2-13-21

Informed Consent for a Medical Study (UA)—Experiment 5

Study Title: Differing Characteristics of Memory Among Individuals

Principal Investigator: Kyle Rhoads Kraemer, M.A., Doctoral Candidate, Dept. of Psychology

What is this study about? What is the investigator trying to learn?
This purpose of this study is to learn about the individual characteristics that lead to memory success in older adults.

Why have I been asked to be in this study?
You have been asked to participate in this study because you are of age 60+ years old and have given consent to be contacted to participate in research regarding memory and aging through the Alabama Research Institute on Aging (ARIA), the MAC 2 Lab registry, or contacted the lab coordinators through advertisements at senior living communities.

What will I be asked to do in this study?
During both sessions, you will be asked to perform a number of tasks. For example, in this study, you will be asked to complete several different surveys about yourself and your memory. You will also be asked to recall memories from your past, and to describe different qualities about your experience with that memory. In addition, you will be asked to imagine events in your future, and to describe different qualities of that imagination. You will also be asked a number of questions about your experiences both imagining and remembering different events.

How much time will I spend being in this study?
We can expect that this session will take roughly 1 hour. Part of the time commitment will include driving to and from the University of Alabama.

Is the researcher being paid for this study?
This study is not being supported by any grant, agency, or company.

Is this research developing a product that will be sold, and if so, will the investigator profit from it?
This research is not developing any product that will be commercialized afterwards.

How many people will be in this study?
Up to 200 other people will be in this study.

Will being in this study cost me anything?
There will be no costs for participating in the study, but there is a large time commitment because this session will last for about 1 hour. Besides time spent participating, you may experience boredom or fatigue. You will receive feedback about your relative memory performance compared with others who have completed these tasks, and while this feedback may be positive, it may also be negative which could lead to disappointment.

What are the benefits that may happen if I am in this study?
You will not directly benefit from participating, but your information will help us learn more about the relationship between aging and memory. You will receive feedback about your relative memory performance compared with others who have completed these tasks, and while this feedback may be positive, it may also be negative which could lead to disappointment.

What are the benefits to science or society?
The results of the study will help to better understand and assess the relationship and differences between aging, cognition, and memory.

Will I be compensated for being in this study?
You will earn $10 total for your time participating in this study. That is, you will be paid $5 after the completion of each session.

How will my privacy be protected?
You may decide not to participate, choose not to answer any question, or stop participating any time without any penalty.

What are the risks (dangers or harms) to me if I am in this study?
There are minimal risks involved in this study. You may feel tired, fatigued, bored, or anxious from having your cognition and mental status assessed.

How will my confidentiality be protected?
Data will be collected through Qualtrics Survey Software online, the data will be stored on a password-protected account that only the research investigators will have access to. The records of this study will be stored securely and kept private. Authorized persons from The University of Alabama, members of the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by the law.

What are the alternatives to being in this study? Do I have other choices?
The alternative to being in this study is not to participate.

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What are my rights as a participant in this study?
Taking part in this study is voluntary. It is your free choice. You can refuse to be in it at all. If you start the study, you can stop at any time. There will be no effect on your relations with the University of Alabama or the Department of Psychology.

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Who do I call if I have questions or problems?
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After you participate, you are encouraged to complete the survey for research participants through Qualtrics Survey Software online.

I have read this consent form. I have had a chance to ask questions. I am at least 18 years of age. I agree to take part in it. I will receive a copy of this consent form to keep.

Signature of Research Participant:________________________________**Date:**

Signature of Investigator: **Date:**

Informed Consent for a Medical Study (UA)—Experiment 6

Study Title: Differing Characteristics of Memory Among Individuals

Principal Investigator: Kyle Rhoads Kraemer, M.A., Doctoral Candidate, Dept. of Psychology

What is this study about? What is the investigator trying to learn?
This purpose of this study is to learn about the individual characteristics that lead to memory success in older adults.

Why have I been asked to be in this study?
You have been asked to participate in this study because you are of age 60+ years old and have given consent to be contacted to participate in research regarding memory and aging through the Alabama Research Institute on Aging (ARIA), the MAC 2 Lab registry, or contacted the lab coordinators through advertisements at senior living communities.

What will I be asked to do in this study?
During both sessions, you will be asked to perform a number of tasks. For example, in this study, you will be asked to complete several different surveys about yourself and your memory. You will also be asked to recall memories from your past, and to describe different qualities about your experience with that memory. In addition, you will be asked to imagine events in your future, and to describe different qualities of that imagination. You will also be asked a number of questions about your experiences both imagining and remembering different events.

How much time will I spend being in this study?
We can expect that the first session will take roughly a little over 2 hours and the second session will take roughly a little more than an hour. Part of the time commitment will include driving to and from the University of Alabama.

Is the researcher being paid for this study?
This study is not being supported by any grant, agency, or company.

Is this research developing a product that will be sold, and if so, will the investigator profit from it?
This research is not developing any product that will be commercialized afterwards.

How many people will be in this study?
Up to 400 other people will be in this study.

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EXPIRATION DATE: 2-13-21

Will being in this study cost me anything?
There will be no costs for participating in the study, but there is a large time commitment because both sessions will last for about 1.5 hours. Besides time spent participating, you may experience boredom or fatigue. You will receive feedback about your relative memory performance compared with others who have completed these tasks, and while this feedback may be positive, it may also be negative which could lead to disappointment.

What are the benefits that may happen if I am in this study?
You will not directly benefit from participating, but your information will help us learn more about the relationship between age and memory. You will receive feedback about your relative memory performance compared with others who have completed these tasks, and while this feedback may be positive, it may also be negative which could lead to disappointment.

What are the benefits to science or society?
The results of the study will help to better understand and assess the relationship and differences between aging, cognition, and memory.

Will I be compensated for being in this study?
You will earn $10 total for your time participating in this study. That is, you will be paid $5 after the completion of each session.

How will my privacy be protected?
You may decide not to participate, choose not to answer any question, or stop participating any time without any penalty.

What are the risks (dangers or harms) to me if I am in this study?
There are minimal risks involved in this study. You may feel tired, fatigued, bored, or anxious from having your cognition and mental status assessed.

How will my confidentiality be protected?
Data will be collected through Qualtrics Survey Software online, the data will be stored on a password-protected account that only the research investigators will have access to. The records of this study will be stored securely and kept private. Authorized persons from The University of Alabama, members of the Institutional Review Board have the legal right to review your research records and will protect the confidentiality of those records to the extent permitted by the law.

What are the alternatives to being in this study? Do I have other choices?
The alternative to being in this study is not to participate.

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Signature of Research Participant:________________________________ **Date:**

Signature of Investigator: **Date:**

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