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The Effects of Individual Differences in Imagery Ability and Working Memory Capacity on False Memories for Imagined Actions

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by

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Under the Direction of Heather Kleider-Offutt

ABSTRACT

False memories for events that never actually occurred can have detrimental effects, particularly in eyewitness testimony. The current study is used to explore how individual differences in imagery ability and working memory capacity may contribute to the formation of false memories and the phenomenological experience of both true and false memories. Results suggest that although imagery ability does not appear to affect overall false memory rate, individuals with high imagery ability appear to have more vivid memories of both experienced and imagined events than individuals with low imagery ability. Results involving working memory capacity suggest that the effect of imagery ability on the phenomenological experience of memory is not influenced by working memory capacity; however the working memory capacity scores in the sample were of limited range. Results are discussed in the context of both the Source Monitoring Framework and the Dual Process Theory.

INDEX WORDS: Mental imagery, Imagery vividness, Working memory capacity, Source monitoring, False memories, Misinformation effect

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1 INTRODUCTION

False memory creation is a phenomenon that has been revealed in a myriad of contexts from memory for past childhood events to eyewitness memory. A large body of work has grown from researchers' attempts to establish the factors that contribute to such memory error. The cognitive underpinnings that endorse false memory are not fully understood, but confusion about the source of information has been implicated in the creation of false memories (Johnson, Hashtroudi, & Lindsay, 1993). For example, someone may think that an event actually happened when in fact they only imagined the event taking place. This memory error is due to the confusion of an internal source of information (imagining) with an external source of information (reality) (Johnson & Raye, 1981). Determining the source of information is referred to as source monitoring (Johnson et al., 1993). Two important qualities of a memory that are evaluated to determine the source of the memory are perceptual detail and memory of cognitive operations that may have been performed while the original memory trace was laid down (Fairfield & Mammarella, 2009; Johnson et al., 1993; Johnson, Raye, Foley, & Foley, 1981). Engaging in vivid mental imagery is an action that likely influences both of these memory attributes. Many researchers have found support for the idea that engaging in vivid mental imagery leads to an increase in source confusion and false memories for imagined events (Dobson & Markham, 1993; Drivdahl & Zaragoza, 2001; Goff & Roediger, 1998; Gonsalves et al., 2004; Hyman & Billings, 1998; Hyman & Pentland, 1996; Kleider, Goldinger, & Knuycky, 2008; Libby, 2003; Loftus & Pickrell, 1995; Peters, Smeets, Giesbrecht, Jelicic, & Merckelbach, 2007; Thomas & Loftus, 2002). The results of these studies suggest that vivid imagery experienced while imagining an event promotes the creation of perceptual details about the imagined event. Memories for events that actually happened generally contain more perceptual details than memories for events that did not happen (Conway, Pleydell-Pearce, Whitecross, & Sharpe, 2003), so perceptual details created for vividly imagined events can make the imagined events feel familiar because the memories retain the sensory cues similar to the cues encountered when retrieving the memory for an experienced event. This familiarity then makes accurate source monitoring difficult.

Conversely, there is some evidence suggesting that perceptual details created by vivid imagery may actually aid in source monitoring and protect against false memories for imagined events (Intraub & Hoffman, 1992; Jacoby, 1991; Leding, 2012; McDonough & Gallo, 2008). Proponents for this idea suggest that individuals might use the perceptual details they have stored about an imagined event to suppress automatic feelings of familiarity for the event (Jacoby, 1991). This could be explained by the idea that as vivid imagery is generated internally, it may also create memories of the cognitive operations that are being performed (i.e. the mental processes that must be carried out in order to form mental images). There is evidence to suggest that memory of cognitive operations can improve source monitoring accuracy by aiding in the identification of a memory as self-created (Durso & Johnson, 1980; Fairfield & Mammarella, 2009; Foley & Foley, 2007; Johnson et al., 1981; McDonough & Gallo, 2008). It is well established that false memories are influenced by imagery (Robin, 2010), but there is some debate over the specific ways that vivid imagery may influence source monitoring decisions. Moreover, the extent to which individual differences in the processing and retrieval of perceptual information may play a role in source monitoring decisions has not been thoroughly explored. The current study was conducted to investigate the role of vivid imagery in source monitoring and false memory creation and whether individual differences in working memory capacity and imagery ability are contributing factors to source error.

1.1 Imagery

Mental imagery is important in the formation of false memories because it can provide perceptual details about an internally generated event. Although it is generally accepted that vividly imagining an event should provide perceptual details about the event, there is some debate about how those perceptual details are used for source monitoring. The Source Monitoring Framework (Johnson et al., 1993) and the Dual Process Theory (Jacoby, 1991) are two prominent theories with opposing ideas on the role of perceptual details in source monitoring. According to the Source Monitoring Framework, people use the amount of perceptual information they have stored about an event to determine whether the event was experienced rather than familiar for some other reason. Because experienced events provide rich sensory-perceptual details, the more perceptual details one has about an event the more likely it will be evaluated as an actual experienced event. Therefore, someone is at risk for developing false memories for an event after vividly imagining the event taking place (Johnson et al., 1993).

Many researchers have provided support for the Source Monitoring Framework by finding that vivid or repeated imagining of an event leads to false memories of the imagined event, i.e. imagination inflation, (Dobson & Markham, 1993; Drivdahl & Zaragoza, 2001; Goff & Roediger, 1998; Hyman & Pentland, 1996; Kleider et al., 2008; Libby, 2003; Lindsay, Hagen, Read, Wade, & Garry, 2004; Loftus & Pickrell, 1995; Peters et al., 2007; Thomas & Loftus, 2002). In some studies participants were encouraged to recall false events using guided imagery, a technique that focuses on perceptual information and is controversially used in psychotherapy to unlock memories from the past (Hyman & Pentland, 1996; Loftus & Pickrell, 1995; Thomas & Loftus, 2002). Participants in these studies often reported that they remembered imagined events as experienced. Participants in the study by Lindsay, Hagen and colleagues (2004) were more likely to remember experiencing an imagined event falsely if they were provided with a real photograph from the same time period as the suggested event. Lindsay, Hagen and colleagues (2004) concluded that the photograph allowed participants to imagine events more vividly because it provided a source of perceptual details that participants added to their mental imagery while they imagined the events. Support for the Source Monitoring Framework was also found by Drivdahl and Zaragoza (2001) when they observed that participants reported more false memories for imagined events when they were asked to elaborate on the perceptual details of the imagined event. Drivdahl and Zaragoza concluded that participants who were asked to elaborate on perceptual information created vivid mental imagery of imagined events. In turn, the large amount of perceptual information that was stored in participants' memory for imagined events was easily confused with the large amount of perceptual information that is normally stored in memory for events that have actually occurred. These results are important and particularly relevant because it is a common practice for interviewers to ask eye witnesses to focus and elaborate on perceptual details of criminal events (Fisher & Geiselman, 1992; Nori, Bensi, Gambetti, & Giusberti, 2014).

Given that imagery plays an important role in source confusions and false memories for imagined events, it follows that individual differences in imagery ability are important to consider. The existence of individual differences in the ability to generate vivid mental imagery is well established (Cui, Jeter, Yang, Montague, & Eagleman, 2007; Marks, 1973; Pearson, Rademaker, & Tong, 2011); and differences in imagery ability have been linked to differences in source monitoring ability and false memory creation (Dobson & Markham, 1993; Eberman & McKelvie, 2002; Horselenberg et al., 2000; Winograd, Peluso, & Glover, 1998). Horselenberg and colleagues replicated a previous result by finding that participants reported false memories for childhood events after they were asked to imagine vividly the events taking place. They also found that the participants with higher imagery abilities, often referred to as “high imagers”, were the ones to most often report these false memories. Participants with lower imagery abilities seemed to be less susceptible to developing false memories for the imagined events (Horselenberg et al., 2000). Dobson and Markham (1993) showed participants a film of an event and then presented written descriptions of the event that provided different (incorrect) information and encouraged mental imagery. Participants with high imagery abilities were more likely to report that information about the event was seen in the film when it was actually only in the written account. Eberman and McKelvie (2002) replicated this finding using audiotapes in place of film. Taken together these results support the Source Monitoring Framework by providing evidence that vivid mental imagery of imagined events increases source monitoring errors and false memories.

Alternatively, the ideas put forth in the Dual Process Theory suggest that the perceptual details created with vivid imagery may reduce source monitoring errors and false memories (Jacoby, 1991). The Dual Process Theory of memory is based on the idea that recognition memory judgments are made using two separate mental processes (Jacoby, 1991). One of these processes is familiarity with a stimulus, which is described as non-analytic and automatic. The other process is recollection, which is described as analytic and intentional and it requires prior experience with a stimulus. According to the Dual Process Theory, false memories for an imagined event may result from the automatic sense of familiarity for the event rather than from a recollection of perceptual details for the event (Jacoby, 1991; Jacoby, Woloshyn, & Kelley, 1989). The perceptual details that are associated with a vividly imagined event aid in the intentional process of recollection, so they could be used to over-ride an automatic sense of familiarity. Participants in a recent study (Leding, 2012) appeared to be making memory judgments in this way by using what Leding referred to as a “recall to reject” strategy. Participants were presented with a list of words and their memory for the list was tested after a delay. Some of the words presented during the test were not on the original list but they were very similar, so they evoked an automatic sense of familiarity. Leding found that participants were able to determine correctly that the source of these lure words was not the original list because they distinctly remembered that those items were missing in the original list. The participants who made the fewest errors on the recall task were better at using their memory for the original list to over ride the automatic sense of familiarity for the lure items. Because a sense of familiarity existed for the lure items, it is most likely that the lure words came into mind while reading the word lists. Participants who used the recall-to-reject strategy may have better remembered the context and details of the lure word coming into mind as they read the list. It seems logical that participants who were adept at creating mental imagery were also able to encode more sensory-perceptual information associated with thoughts of the lure word. However, this study did not include measures of imagery ability so it is not known whether imagery ability was a factor in false alarm to lure rates.

Additionally, the Dual Process theory allows that the creation of perceptual details may aid in source monitoring indirectly through memories of cognitive operations performed during encoding. The cognitive operations that occur during actions like imagining and visualizing can act as ear marks during retrieval to help avoid endorsing false memories (Durso & Johnson, 1980; Fairfield & Mammarella, 2009; Foley & Foley, 2007; Intraub & Hoffman, 1992; Johnson et al., 1981; McDonough & Gallo, 2008). It is expected that memories for both actual pictures and vividly imagined events will contain high levels of perceptual details; however, imagined memories will be distinct because they uniquely include high levels of cognitive operations (McDonough & Gallo, 2008). McDonough and Gallo (2008) found that participants were better able to avoid false recognition when an encoding task involved autobiographical elaboration of words than when the encoding task involved more simple semantic judgments of words. The autobiographical elaboration required deep processing and probably created perceptually detailed episodic memory that relates to the "recollection" memory process in the Dual Process theory of memory, and the semantic judgments required shallow processing that relates to the "familiarity" memory process in the Dual Process Theory. Interpreted in this way, individuals with more detailed memories were able to invoke a recollection process to avoid false memories. Several other studies have also found that false recognition is reduced when the encoding task requires more cognitive operations (Gunter, Bodner, & Azad, 2007; Hege & Dodson, 2004; Intraub & Hoffman, 1992; McCabe & Smith, 2006). Although one of these studies used actual photographs and more complex written material (Intraub & Hoffman, 1992), the majority of these studies have employed the Deese/Roediger-McDermott (DRM) paradigm, which involves word lists and semantically-related lure words (Roediger & McDermott, 1995). These studies also did not explore the possible influences of mental imagery ability.

In the current study photographs and more complex actions were used rather than single words as stimuli and should therefore be more relatable to real world situations than studies that rely on simple stimuli such as words or objects. Recollection of the cognitive operations performed during vivid imagining could invoke the recollection process of memory and over-ride an initial "gut" or intuitive feeling of familiarity for an action, thus identifying it as something that was self-created versus something that was experienced. If individuals with high imagery ability create more perceptual details about an imagined action than low imagers, they will also perform more cognitive operations in the act of imagining the action. The recollection of these cognitive operations might later aid in the avoidance of false recognition.

The first experiment of the current study was designed to determine the effect of individual differences in imagery ability on the rate of false memories for imagined actions. If the Dual Process Theory is supported, then all individuals should experience a sense of familiarity with imagined actions, but individuals with higher imagery abilities should have fewer false memories for the imagined actions because they will override familiarity for the false actions by recollecting how the high level of perceptual details for an action came about (cognitive operations). Alternatively, the Source Monitoring Theory suggests that vivid perceptual details do not enhance source memory but make it more difficult. After considering this body of research I hypothesized that the additional perceptual details arising from vivid imagery would make differentiation between true and self-generated actions more difficult, thus creating more opportunity for false memories, consistent with the Source Monitoring Framework.

1.2 Remember/Know Paradigm

To explore the effects of imagery ability and other variables of interest on the quality of false memories for imagined actions, both Experiments 1 and 2 used remember/know judgments. The remember/know paradigm (J. Gardiner, 1988; Tulving, 1985) provides information about the memory processes involved in participants' source monitoring decisions by asking about the subjective experience of the memory. When participants report that something has been seen before, they are asked to assign a "remember" value to it if their memory includes conscious recollection and retrieval of details. If the memory does not include details and is instead based on a sense of familiarity, participants are asked to assign a "know" value to the memory.

Proponents of the Dual Process Theory of memory contest that remember/know judgments reflect the two distinct memory processes of automatic, non-analytic familiarity and intentional, analytic recollection (Kelley & Jacoby, 1998; Tulving, 1989; Uncapher & Rugg, 2005; Yonelinas, 2002). Proponents of the Source Monitoring Framework of memory have a slightly different view that remember/know judgments reflect varying degrees of recollection rather than two separate processes (Leynes & Phillips, 2008; Wais, Mickes, & Wixted, 2008; Wixted, 2007). Both views agree that remember/know judgments reflect the phenomenological experience of memories and that the recall of perceptual details is required for strong recollection of a memory. Therefore, under both views a "remember" response reflects the recall of specific perceptual details about a memory. Because mental imagery while imagining an action involves the creation of perceptual details, I hypothesized that individuals with high imagery abilities would make more "remember" responses when recalling false memories.

1.3 Working Memory Capacity

In additional to mental imagery ability, there is another individual difference that has been implicated in source monitoring ability. Previous research suggests that the source monitoring process is made more difficult when people have difficulty with dual-tasks. That is, when simultaneous tasks require attention, those individuals who have limited attention capacity are most likely to make source errors (Gerrie & Garry, 2007; Leding, 2012; Watson, Bunting, Poole, & Conway, 2005). As previously described, Leding (2012) found that many of her participants were able to engage in accurate source monitoring and avoid false memories for lure items. Leding also found that the participants who were better at source monitoring had higher working memory capacities (WMC) than participants with less accurate source monitoring. Working memory has been described as a system that is used to store and manipulate information temporarily (Baddeley, 1992). Engle (2010) has expressed support for the idea that WMC is related to attention control and that performance on WMC tasks shows ability to keep attention focused on important events while ignoring events that are not important to the current task or goal. Both the Source Monitoring Framework and the Dual Process Theory predict that high WMC will aid in source monitoring. Theoretically according to the Dual Process Model, individuals with high WMC can focus on perceptual details and use them to help suppress familiarity responses to lures to make accurate source monitoring and memory judgments (Gerrie & Garry, 2007; Leding, 2012; Watson et al., 2005). Within the Source Monitoring Framework, individuals with high WMC are able to focus their attention on the goal of accurate recollection and ignore the confusing perceptual details that may be associated with a memory lure. Individual differences in WMC and how they might relate to source monitoring and false memories have been extensively studied with the bulk of the results suggesting that a high WMC is associated with more accurate source monitoring and fewer false memories (Gerrie & Garry, 2007; Leding, 2012; Watson et al., 2005). The current study was used to explore the possible interactions of the contributions of vivid imagery ability and working memory capacity on the rate of false memories for imagined actions. WMC may have contributed to differences in previous research that tested imagery ability and related source errors, so a WMC assessment was included in the testing paradigm for this study. The effect of individual differences in Working Memory Capacity (WMC) on the rate of false memories for imagined actions, and the potential interaction effects of WMC and imagery ability were tested. WMC was measured with the Running Span Task (Broadway & Engle, 2010).

I hypothesized that a high WMC would lower any potential negative effect of imagery ability on source monitoring by allowing a high imagery individual to ignore the abundant perceptual details created by imagining an event. If however, high imagery ability was found to increase source monitoring accuracy as predicted by the Dual Process Theory, then I expected that a high WMC would provide an even greater advantage to the source monitoring task such that individuals with both high imagery and high working memory capacity will make the fewest source monitoring errors. If high WMC was not found to interact with the effect of perceptual details created by high vivid imagery, then high imagery ability was expected to lead to the most false memories regardless of WMC, consistent with the Source Monitoring Framework.

1.4 Cognitive Operations and the SMF

The Source Monitoring Framework is in accordance with the Dual Process Theory in that source monitoring decisions are based not only on perceptual details but also on the memory of cognitive operations that occur when a memory is created (Johnson et al., 1993). Proponents of the SMF state that memory of cognitive operations may aid source monitoring decisions when the memory is recent; however, the memory of cognitive operations fades quickly over time and soon is no longer useful (Durso & Johnson, 1980; Fairfield & Mammarella, 2009; Foley & Foley, 2007; Johnson et al., 1981; McDonough & Gallo, 2008). Therefore, memory of cognitive operations might account for an improved ability of high imagers to recognize imagined events as false when tested immediately after a witnessed event, but high imagery ability would not aid in recognition with a delayed test. Experiment 2 of the current study was designed to test this by comparing the rates of false memories to imagined actions reported on an immediate test versus a delayed test. Imagery ability, WMC, and false memory rates were calculated in the same manner as Experiment 1. I hypothesized that when tested with an immediate test soon after encoding, all participants would have low rates of false memories to imagined actions. This is because high imagers could use their memory of cognitive operations to make accurate source monitoring judgments, and low imagers should also have a low rate of false memory due to the recency of encoding. Additionally I hypothesized that both low and high imagers would increase false memory rates when the test was delayed rather than immediate, but there would be a significantly larger increase in false memory rate between immediate and delayed test in the high imagery group relative to the low imagery group. This is because the high imagers would no longer have access to the memory of cognitive operations during encoding, but they would still have access to the perceptual details that make the imagined actions seem real. However, a significant increase in false memory rate may only be seen for high imagers with low WMC. This is because I expected high WMC to have the same hypothesized effect as in Experiment 1, which is to protect against false memories for imagined actions.

In summary, I expected that the results of Experiment 1 would be replicated for the delayed test, and significant increases over time in false memory rate would be seen only for high imagers with low WMC. The expected results would provide support for the Source Monitoring Framework and the idea that perceptual details of vividly imagined events can confuse source monitoring decisions. Alternatively, if WMC was not found to protect against false memories, then I would expect high imagers to increase their false memory rates significantly with the delayed test, regardless of WMC.

1.5 Misinformation Effect

Memories for experienced events can sometimes be altered when a witness later encounters incorrect information about the witnessed event (Loftus, 2003; Paz-Alonso, Goodman, & Ibabe, 2013; Zhu et al., 2010). This phenomenon has been identified as the misinformation effect (Loftus, 2003). One interpretation is that incorrect or misleading information appears to over-write the original memory for an event and completely replace it, which leads to false memories (Loftus & Loftus, 1980). Another interpretation is that the original memory remains but the incorrect or misleading information introduces another potential source for a memory that an individual must differentiate from (Lindsay, Allen, Chan, & Dahl, 2004; Zaragoza & Lane, 1994), thus false memories caused by misinformation would be the result of source monitoring errors (Paz-Alonso et al., 2013; Zhu et al., 2010). If source monitoring is more difficult for high imagers and individuals with low WMC, then these same individuals should also be more susceptible to the misinformation effect if it is indeed a source monitoring task. Imagery ability may also be involved if the original memories are substituted because presumably, very detailed memories would be better at replacing a detailed memory for a real item. These opposing views were tested in Experiment 2 by examining the hit rate (actions correctly identified as photographs). If original memories for actual actions are replaced by misinformation, then the hit rate should be lower when misinformation about the action is provided. Evidence in support of this idea would further support the contention that perceptual details are of paramount importance to source monitoring and that the possession of abundant perceptual details about a false event facilitates false memories and effectively erases true memories. Experiment 2 of the current study employed a misinformation paradigm to elicit false memories. Rather than simply asking participants to imagine actions, participants read false statements about the actions they have previously seen, written from the perspective of someone who saw the same actions. The participants were asked to place themselves in the shoes of the author of the written statements and imagine viewing the actions from the author's perspective. Reading this account from another person's perspective should make the experiment more relevant to actual interactions that might occur with eye witnesses to crimes. It is a common practice for an interviewer to ask an eye-witness to place themselves into another person's point of view when describing an event (Fisher & Geiselman, 1992). I hypothesized that individuals in Experiment 2 with high imagery ability would have higher rates of false memories for the incorrect information (misinformation) provided in the written account of actions than individuals with low imagery ability. High imagers were expected to be more susceptible to the misinformation effect than low imagers because high imagers were expected to be better able to create vivid, perceptually detailed mental pictures of the misinformation as they attempted to view the actions from the perspective of the person who wrote the account.

2 EXPERIMENT 1

2.1 Method

2.1.1 Participants

A total of 189 undergraduate university students were recruited, but 44 were excluded from the final data pool because they did not successfully complete both sessions of the experiment. Participants were recruited via the Georgia State University SONA participant pool website and were granted class credit in exchange for participation. The sample was 75.5% female and 24.5% male with a mean age of 20.9. Race/ethnicity percentages were: 53.1% African American, 17.5% White/Caucasian, 18.2% Asian, 7.0% Latino/a, 0.7%. Native American, and 3.5% biracial.

2.1.2 Materials

2.1.2.1 Imagery ability

Imagery ability was measured using an adapted Vividness of Visual Imagery Questionnaire (VVIQ) (Marks, 1973). The VVIQ consists of 4 main themes with 4 statements under each theme for a total of 16 items. Participants are first instructed to think of each theme, such as a person they are familiar with, and then they are presented with 4 statements about that theme that they are to imagine. For example, one statement under the familiar person theme is "The exact contour of face, head, shoulders and body". After imagining each statement participants are asked to rate the vividness of their mental imagery on a 5 point scale. All of the original statements on the VVIQ remained unchanged. However, the instructions were adapted for presentation with E-prime software, and the rating scale was reversed to improve clarity. The original rating scale includes a rating of "1" to be the most vivid and a rating of "5" to be the least vivid. This was reversed so that a rating of "1" is the least vivid and a rating of "5" is the most vivid. In another study that included the VVIQ, Borst and Kosslyn (2010) have found the VVIQ to be a reliable measure of imagery vividness with a Cronbach's alpha of 0.87. Physiological support that the VVIQ is a valid measurement of individual differences in imagery ability has been provided by a study resulting in differential brain activation for high and low imagery (Cui et al., 2007). Scores are obtained by calculating the sum of all the numerical responses.

2.1.2.2 Working memory capacity

Working memory capacity was measured using the Running Span Task (Broadway & Engle, 2010), in which participants are instructed to remember a varying number of letters at the end of a list of letters presented to them one at a time with E-prime. The run file for this task was provided by the original authors and no changes were made. Broadway and Engle (2010) have determined that the running span task is a reliable measure of working memory capacity with a Cronbach's alpha of .869 and high correlations ($r = .848$) with other established working memory tasks such as operation span. Scores are automatically calculated by the E-prime program.

2.1.2.3 Source monitoring task

The source monitoring task used in this study was adapted from the task published by Kleider and colleagues in 2008. The task consists of a slide show presented with E-prime depicting a hair stylist and an auto mechanic performing everyday actions either in a salon or in a parking lot near a car. Some of the slides did not include a picture but instead instructed the participants to imagine vividly either the hair stylist or the mechanic performing an action. The slide show included 38 actions depicted with photographs and 38 statements to imagine. This was followed 48 hours later by a memory test that presented participants with various action statements and asked whether they were shown in the slide show photographs or not. The memory test included 38 statements describing actions in the photographs, 38 statements describing the imagined actions, and 18 statements describing new actions that were neither in the photographs or the imagined actions. When participants reported that an action was shown in the slide show photographs, the quality of their memory for the action was assessed with remember/know judgments (Tulving, 1985). Participants were asked to report whether they vividly remembered seeing the photograph of the action or whether they were only vaguely familiar with seeing the photograph of the action.

2.1.3 Procedure

After providing consent, participants completed the running span task. They then completed the VVIQ and finally viewed the slide show depicting a hair stylist and an auto mechanic performing everyday actions either in a salon or in a parking lot near a car. Some of the slides did not include a picture and instead instructed the participants to imagine vividly either the hair stylist or the mechanic performing an action. The instructions given before the slide show included a guided imagery training procedure in which the researcher gave participants two example action statements and instructed them to think about perceptual details as they imagined the action. After giving time to imagine the example action, the researcher asked questions about the perceptual details in participants' mental images, such as the color of an object or the smell of the setting, to ensure that participants understood that they should imagine the actions vividly. That completed the first session. Session two of the experiment took place 48 hours after session 1. Participants completed a recognition task that tested their memory for the slide show they saw in session 1. They were presented with statements describing actions that may or may not have been shown in the slide show. Some of the statements described actions that participants were asked to imagine in session 1. Participants were asked to determine whether each statement was something that was presented in the slide show or not, and how vivid their memory for each action was. Finally, they provided some demographic information and were debriefed, thanked for their participation, and dismissed. See Figure 1 for an overview of the procedure for Experiment 1.

2.1.4 Data Preparation and Analysis

Complete data were collected from 145 participants. Two participants were removed from the data analyses because their scores on the VVIQ were identified as extreme outliers with scores more than 3 standard deviations from the mean, thus the final data pool for Experiment 1 was 143 participants. The dependent variable "false alarm to imagined actions rate" was calculated by dividing the number of times each participant said that an imagined test statement was "old" (shown in the pictures) by the total number of imagined statements in the test. The dependent variable "remember response to false alarm rate" was calculated by dividing the total number of "vividly remember" responses for false alarms (imagined actions identified as slide show photographs) by the total number of opportunities for such a response (the total number of false alarms). The dependent variable "hit rate" was calculated by dividing the number of times each participant said that a test statement was "old" (shown in the pictures) by the total number of old (shown in the pictures) statements in the test. The dependent variable "remember response to hit rate" was calculated by dividing the total number of "vividly remember" responses for hits by the total number of opportunities for such a response (the total number of hits). The dependent variables *d'* and *C* were calculated using signal detection analysis (Macmillan & Creelman, 2005). The *d'* scores take into account both false alarm rate and hit rate to provide an overall discrimination accuracy score. Higher *d'* scores indicate better discrimination accuracy than lower scores. *C* scores represent the criterion, or response bias, used to differentiate whether a statement is "old" (was shown in the pictures) or "new" (was not shown in the pictures). Criterion scores range from conservative/strict (positive numbers), suggesting a tendency to not identify statements as "old," to liberal/lax (negative numbers), suggesting a tendency to identify statements as "old."

Participants with VVIQ scores in the top 33% of the sample were defined as the high imagery ability group (n = 32). Participants with VVIQ scores in the bottom 33% of the sample were defined as the low imagery ability group (n = 30). The independent variable working memory capacity (WMC) was also divided into high WMC (n = 30) and low WMC (n = 32) groups in the same manner based on scores from the running span task. A 2 (imagery ability: low, high) x 2 (WMC: low, high) ANOVA was run for each dependent variable of interest. Participants with imagery and WMC scores between the high and low groups were not used in the 2x2ANOVA analyses. Within the middle range of scores, multiple participants had the same score, thus the removed middle group accounted for more than one-third of the total data set (n = 62 for ANOVAs without the middle groups). Although the high and low groups were the main focus of this experiment, it was decided that the middle groups should also be explored for any further information, thus 3 (imagery: low, medium, high) x 3 (WMC: low, medium, high) secondary ANOVAS were run for each dependent variable to identify the pattern of results for the middle groups of imagery ability and WMC. When appropriate, post-hoc tests with Bonferroni correction were used to examine main effects and simple contrast tests were used to examine interaction effects. N = 143 for all ANOVAS that included the middle groups. Bivariate correlations were run on the variables of interest before other analyses to provide an overview of possible relationships (see Table 1). Refer to Table 2 for a summary of the overall means and standard deviations for each dependent variable.

2.2 Results

2.2.1 Imagery ability and imagery vividness for imagined actions

To test the relationship between VVIQ scores (imagery ability) and the self reported imagery vividness of the imagined actions in the slide show, a simple correlation analysis was run with VVIQ scores and mean imagery vividness scores. There was a significant correlation, $r = .44$, $p = .00000004$, such that higher VVIQ scores were associated with higher mean imagery vividness ratings (Figure 2).

2.2.2 Imagery ability and WMC x False alarms to imagined actions rate

The mean false alarm to imagined actions rate for all participants was 45.6%. No main effects (imagery ability: $F(1, 58) = .26$, $p > .05$; WMC: $F(1, 58) = 1.62$, $p > .05$; see Table 3 and Table 4 for marginal means) or interactions ($F(1, 58) = .30$, $p > .05$) of imagery ability and WMC were found to be statistically significant. Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects involving the middle range of scores on the VVIQ or WMC.

2.2.3 Imagery ability and WMC x quality of false memories

The mean “remember” rate for false alarms to imagined actions was 36.3%. There was a main effect of imagery ability *F*(1, 58) = 6.25, *p* = .02, □^{2} = .10, such that individuals with high imagery ability (*M* = 42.9%, *SE*= .04) reported more “vividly remembered” responses to falsely recalled imagined actions than individuals with low imagery ability (*M* = 28.5%, *SE*= .04; Table 5; Figure 3). There was no significant main effect of WMC, *F*(1, 58) = 1.49, *p* > .05 (see Table 6 for marginal means). There was also no significant interaction *F*(1, 58) = 2.25, *p* > .05. Interpretation of a secondary ANOVA that included all participants (low, medium, and high), revealed that individuals with medium imagery ability had similar “remember” rates to individuals with low imagery ability, *M* = 31.4%, *SE* = .03). Interpretation of the secondary ANOVA initially appeared to indicate that individuals with medium WMC had higher “remember” rates than both low and high WMC, (low WMC *M* = 29.2%, *SE* = .03; medium WMC *M* = 41.1%, *SE* = .03; high WMC *M* = 38.2%, *SE* = .03); However, statistical differences between the groups did not survive post-hoc Bonferroni correction.

2.2.4 Imagery ability and WMC x Hit rate

The mean hit rate (correctly identified actions from photographs) for all participants was 64.3%. No main effects of imagery ability *F*(1, 58) = 2.95, *p* > .05, or working memory capacity *F*(1, 58) = .03, *p* > .05, were found to be statistically significant (see Table 7 and Table 8 for marginal means). The interaction was also not statistically significant *F*(1, 58) = .34, *p* > .05. Interpretation of a secondary ANOVA that included all participants (low, medium, and high), revealed that individuals with medium imagery ability, *M* = 68.7%, *SE*= .02, had higher hit rates than individuals with low imagery ability, *M* = 56.5%. However, individuals with medium imagery ability had statistically equal hit rates to individuals with high imagery ability, *M* = 64.0%, *SE* = .03. These results involving the middle group for imagery ability were not considered usefully interpretable because there was also no significant difference between the hit rates for the high and low groups.

2.2.5 Imagery ability and WMC x Quality of accurate memories

The mean remember rate for hits (correctly recalled actions from photographs) was 56.8%. There was a significant main effect of imagery ability, $F(1, 58) = 4.69$, $p = .03$, η^2 = .075, such that individuals with high imagery ability (*M* = 61.1%, *SE*= .05) reported higher rates of remember responses to hits than individuals with low imagery ability (*M* = 46.8%, *SE*= .05; Table 9; Figure 4). There was no significant main effect of WMC $F(1, 58) = .03$, $p > .05$ (see Table 10 for marginal means). There was a significant interaction effect of imagery ability and WMC $F(1, 58) = 6.83$, $p = .01$, η^2 = .11, such that individuals with high WMC did not differ in their rate of "remember" responses to hits regardless of their imagery ability level (high WMC, low imagery ability *M* = 56.0%, *SE*= .07; high WMC, high imagery ability *M* = 53.1%, *SE*= .07) , but individuals with low WMC had a higher rate of "remember" responses to hits if they had high imagery ability, *M* = 37.7%, *SE*= .07 than if they had low imagery ability, *M* = 69.2%, *SE*= .06 (Table 11; Figure 5). Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects involving the middle range of scores on the VVIQ or WMC.

2.2.6 Imagery ability and WMC x d'

The mean *d*' discrimination score for all participants was 0.83 (*SD* = .54). No main effects of imagery vividness, $F(1, 58) = .98$, $p > .05$, or working memory capacity, $F(1, 58)$ =

2.68, $p > .05$, were found to be statistically significant (see Table 12 and Table 13 for marginal means). The interaction of WMC and imagery ability was also not statistically significant, $F(1, 58) = .58$, $p > .05$. Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects involving the middle range of scores on the VVIQ or WMC.

2.2.7 Imagery ability and WMC x C

The mean criterion score for all participants was 0.02 ($SD = .39$). No main effects of imagery vividness, $F(1, 58) = 1.25$, $p > .05$, or working memory capacity, $F(1, 58) = .73$, $p > .05$, were found to be statistically significant (see Table 14 and Table 15 for marginal means). The interaction of WMC and imagery ability was also not statistically significant, $F(1, 58) = .13$, $p > .05$. Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects involving the middle range of scores on the VVIQ or WMC.

2.3 Discussion

The results for mean hit rate and mean false alarm to imagined actions rate suggest that the slide show was successful in creating both valid memories for the actions in the photographs and false memories for the imagined actions. In contrast to the mean false alarm to imagined actions rate (45.6%), the mean false alarm to new actions (actions not in the slide show pictures or imagined statements) rate was much lower at 12.6%. This suggests that participants were actually influenced by imagining the actions rather than just guessing during the test. The mean criterion score of 0.02 suggests that participants overall did not have a strong tendency to choose “old” or “new” for the test items, meaning they did not simply choose a button and keep pressing it during the test.

2.3.1 Imagery ability and imagery vividness for imagined actions

The VVIQ involved imagining mainly inanimate objects that do not perform complex actions. In contrast, the imagined actions in the experiment slide show involved people who performed actions that were common but involved some complexity. The positive correlation between the VVIQ imagery ability measure and participant's mean ratings of the vividness of their mental pictures while imagining actions in the slide show is encouraging because it provides evidence that the VVIQ was a good choice to represent the specific type of mental imagery that was invoked in the experiment. Therefore, despite the VVIQ being developed many years ago, I conclude that it is still relevant and I will continue to use it in future explorations of imagery ability. Although the correlation is significant, it is not a perfect correlation, so there is still some unexplained variability. This might be due to a tendency for participants to select similarly high or low numbers on both the VVIQ and vividness scales regardless of their actual imagery vividness. However, I am inclined to believe in the meaningfulness of participants' self-reports of imagery vividness, particularly given the existing support that individuals generally have a good metacognitive understanding of the vividness of their mental imagery (Pearson et al., 2011).

2.3.2 Imagery ability and WMC x False alarms to imagined actions rate

Contrary to the hypothesis that individuals with high WMC would have lower false alarm rates to imagined actions than individuals with low WMC, individuals in this experiment with high and low WMC did not differ in their false alarm to imagined actions rate. The lack of effect of WMC in this experiment could be attributed to the low range of WMC scores in the sample. The mean WMC score reported in a study used to validate the Running Span task (Broadway & Engle, 2010) was 32.8 (*SD* = 11.2), while the mean score in this experiment was much lower at

20.5 (*SD* = 6.7). It is possible that some differences for the effects of working memory capacity may have been revealed if participants were placed under a cognitive load so that some participants would still be able to focus on the memory task and some would not. A possible future study that includes cognitive load may promote larger differences between groups that could be detected, however if the majority of participants possess low WMC then too many of them may be unable to focus on the memory task.

Contrary to the hypothesis that individuals with high imagery ability would have higher false alarm rates to imagined actions than individuals with low imagery ability, individuals in this experiment with high and low imagery ability did not differ in their false alarm to imagined actions rate. It is possible that errors were made in this experiment that caused differences in imagery ability to go undetected. Differences may also have been difficult to detect due to the range of VVIQ scores in the sample, i.e. the scores were in a normal bell curve shape when graphed with a frequency histogram, but the range of scores was located on the higher end of the scale and there were no scores on the extreme low end. It is also possible that imagery ability does not have any effect on false memory creation in general, or simply for the types of everyday actions that were included in this study. However, there was evidence that imagery ability does have some effect on the quality of false memories for imagined actions.

2.3.3 Imagery ability and WMC x quality of false memories

The hypothesis that individuals with high imagery ability will make more remember responses when recalling false memories was supported by the significant positive correlation between VVIQ scores and remember responses for falsely recalled imagined actions. This suggests that individuals with high imagery ability are generating and remembering more perceptual details for imagined actions than individuals with low imagery ability. The interpretation of this result demonstrates the role of imagery ability in the phenomenological experience of false memories. The perceptual details created by high imagery ability make false memories particularly vivid, which may lead individuals with high imagery ability to be more adamant in their endorsements of false memories. In fact, a review of remember/know literature concluded that remember responses were basically equivalent to high confidence ratings (Dunn, 2004).

2.3.4 Imagery ability and WMC x Quality of accurate memories

Actual photographs provide many perceptual details (Lindsay, Hagen, et al., 2004) so it was not surprising that participants had high mean "remember" rates to actions correctly identified from the slide show pictures. Initially, it appears logical to expect that individuals with high and low imagery ability would have similar remember rates for hits because all participants had access to the same amount of perceptual details in the pictures and they did not have to create any perceptual details through mental imagery. High imagery ability may have contributed to the higher "remember" rates seen for hits for several reasons. Individuals with high imagery ability could have simply been biased to respond "remember" for everything regardless of their actual recollection, however this does not seem to be the case because their mean remember rate for false alarms (42.9%) is much lower than their mean remember rate for hits (61.1%). An explanation that makes more sense is that individuals with high imagery ability could put more emphasis on perceptual details when making source monitoring decisions than individuals with low imagery ability. This would mean that when individuals with high imagery ability report that they have seen something before, they will be more likely to attribute their memory to the existence of perceptual details if there are any and therefore report that they vividly remember an action. In contrast, when individuals with low imagery ability say that they have seen something before, they may be focusing more on their initial feelings of familiarity with the action rather than any perceptual details that may be associated with the memory, even if they do possess such perceptual details, as they likely would in the case of actual photographs. This interpretation does not invalidate the results because it leaves open the idea that individuals with high imagery ability may create more perceptual details than individuals with low imagery ability when imagining and simply adds that high imagery individuals may also place more emphasis on perceptual details when making decisions, which still makes high imagery ability a trait that could contribute to more vivid feeling false memories and therefore high confidence in false memories. If low imagery ability individuals do posses perceptual details about an action but they are not thinking about those perceptual details when judging their memories, then their memories will not seem as perceptually vivid. A Dual Process theory interpretation would be that individuals with high imagery ability are invoking the intentional recollection process of memory more often than individuals with low imagery ability (who may be invoking the automatic familiarity process of memory more often). This could potentially be tested in a future experiment by examining the reaction times to the initial “old” response that occurs before the remember/know response. The Dual Process interpretation of the remember/know paradigm is that remember responses must involve deep processing that is intentional, which should take longer than know responses which are based on an automatic sense of familiarity (Tulving, 1985).Theoretically, if high imagery individuals are invoking an intentional recollection process more often than low imagery ability individuals when identifying actual actions, then their reaction times for the “old” responses should be longer than low imagery ability individuals.

3 EXPERIMENT 2

3.1 Method

3.1.1 Participants

A total of 212 undergraduate university students were recruited, but 20 were excluded from the final data pool because they did not successfully complete both sessions of the experiment. Participants were recruited via the Georgia State University SONA participant pool website and were granted class credit in exchange for participation. The sample was 80.6% female and 19.4% male with a mean age of 20.8. Race/ethnicity percentages were: 43.8% African American, 20.6% White/Caucasian, 23.8% Asian, 5.0% Latino/a, and 6.9% biracial.

3.1.2 Materials

3.1.2.1 Creative Imagination Scale.

The CIS (Barber & Wilson, 1978) was adapted and used as an additional imagery measure and distracter task for this experiment. The original CIS asks participants to imagine 10 different scenarios that are read aloud by the researcher. The scenarios include imagery from different modalities, including auditory, visual, gustatory, and tactile. The scenarios are read slowly and encourage mental imagery. An example statement from one of the scenarios is “As you create the image of the orange, feel yourself peeling it and let yourself see and feel the orange skin on the outside and the soft white pulp on the inside of the skin.” After going through all of the scenarios participants rate how similar each one was to a real experience. Ratings are made on a 0-4 scale with 0 as “not at all the same” and 4 as “almost exactly the same.” Scores are calculated by adding up all of the numerical responses. Higher scores indicate more vivid mental imagery as well as a higher potential for hypnotic suggestibility. Measures of reliability indicate that the CIS is a reliable measure, r =.89, and measures of validity indicate that the CIS is correlated with several measures of hypnotic suggestibility and mental imagery (Barber & Wilson, 1978). To fit the time constraints for this experiment, only 3 scenarios were used: 1 auditory (imagining listening to music), 1 gustatory (imagining eating an orange), and 1 tactile (imagining feeling warmth on the hand).

I decided to use the CIS to determine which measure might be more related to susceptibility for false memories in this experiment because the CIS employs different types of mental imagery than the VVIQ. It is possible that participants created auditory, gustatory, or tactile perceptual information when they were imagining the written statements from the writer's perspective. I compared scores on the CIS to the VVIQ scores and if they were significantly different I planned to run statistical analyses to see whether the CIS scores were related to any dependent variables in the experiment.

3.1.2.2 Imagery ability

Imagery ability was measured using the Vividness of Visual Imagery Questionnaire (VVIQ) (Marks, 1973). See the materials section for Experiment 1 above for a full description of the measure.

3.1.2.3 Working memory capacity

Working memory capacity was measured using the Running Span Task (Broadway & Engle, 2010). See the materials section for Experiment 1 above for a full description of the measure.

3.1.2.4 Source monitoring task

The source monitoring task that was used in this study was adapted from the task published by Kleider and colleagues in 2008. See the materials section for Experiment 1 above for a full description of the task. Two changes were made to the source monitoring task from

Experiment 1: the inclusion of post slide show misinformation statements, and the removal of the imagined action statements from within the slide show and from the memory test. The memory test for Experiment 2 included 38 statements that described actions from slide show photographs, 19 misinformation statements from the written account that contradicted details of actions in the slide show photographs, and 29 statements that were in neither the photographs or the written account (this includes the counterbalanced 19 misinformation statements that were shown to the other half of participants and 10 completely new actions). As in Experiment 1, Participants were asked to determine whether each statement was something that was presented in the slide show pictures or not, and whether they vividly remember it or are only vaguely familiar with it.

3.1.2.5 Misinformation statements

Instead of the 38 actions to imagine that were interspersed throughout the slide show in Experiment 1, Experiment 2 included a post-event written account with 38 statements about the slide show. Participants were told that someone who also watched the slide show wrote the statements and that the statements may or may not be correct. Participants were told to take the perspective of the author and were asked to imagine themselves seeing the slide show from this person’s perspective. Participants were given the same imagery instructions as in Experiment 1. Half (19) of these statements were accurate for what was seen in the slide show and half had a detail changed so that they were inaccurate, misinformation about the slide show. The slide show actions that were changed to misinformation were counterbalanced so that approximately half of participants saw each action as misinformation in the written statements and the other half saw the same action depicted accurately in the written statements.

3.1.3 Procedure

After providing consent, participants completed the VVIQ, watched the slide show, and read the misinformation statements in that order. Approximately half of the sessions of participants continued through the rest of the experiment, and the other half returned to the lab in 48 hours to complete the rest of the tasks. The order of the remaining tasks was the same for the 1 and 2 day versions: Running Span, CIS, memory test, demographic questions, and debrief. For those completing all tasks on the same day, there was an approximate 20 minute delay between the written account and the memory test while the participants completed the Running Span task and the CIS. Upon completing all tasks in the experiment, participants were thanked for their participation and dismissed. See Figure 6 for an overview of the procedure for Experiment 2.

3.1.4 Data preparation and analysis

Complete data were collected from 192 participants. Two participants were removed from the data analyses because their scores on the VVIQ were identified as extreme outliers with scores more than 3 standard deviations from the mean. Thirty participants were removed from the analyses due to a false alarm to new actions (never shown in pictures or the written statement) rate of 100%, thus the final data pool for Experiment 2 was 160 participants. The dependent variable "false alarm to misinformation rate" was calculated by dividing the number of times each participant said that a misinformation statement from the written account was shown in the pictures by the total number of opportunities to make such an error. The dependent variable "hit rate" was calculated by dividing the number of times each participant correctly identified that a statement was shown in the slide show pictures by the total number of opportunities for this type of correct response. The dependent variables *d'* and *C* were calculated using the same signal detection analysis as in Experiment 1 (Macmillan & Creelman, 2005).

Imagery ability and WMC scores were divided into low and high groups in the same manner as in Experiment 1 (top and bottom 33%). A 2 (test day: 1, 2) x 2 (imagery ability: low, hi) x 2 (WMC: low, hi) ANOVA was run for each dependent variable of interest. Participants with imagery and WMC scores between the high and low groups were not used in the 2x2x2 ANOVA analyses. Within the middle range of scores, multiple participants had the same score, thus the removed middle group accounted for more than one-third of the total data set (n = 64 for ANOVAs without the middle groups). Although the high and low groups were the main focus of the experiment, it was decided that the middle groups should also be explored for any further information, thus 2 (test day: 1, 2) x 3 (imagery: low, medium, high) x 3 (WMC: low, medium, high) secondary ANOVAS were run for each dependent variable to identify the pattern of results for the middle groups of imagery ability and WMC. When appropriate, post-hoc tests with Bonferroni correction were used to examine main effects and simple contrast tests were used to examine interaction effects. N = 160 for all ANOVAS that included the middle groups. Bivariate correlations were run on the variables of interest before other analyses to provide an overview of possible relationships (see Table 16). Before presenting the results, it is prudent to point out that the ability of participants to perform source monitoring successfully in Experiment 2 was low, which calls into question the interpretability of the results. Therefore, any findings below are presented cautiously. Refer to Table 17 for a summary of the overall means and standard deviations for the dependent variables.

3.2 Results

3.2.1 Imagery ability and CIS

To test whether VVIQ scores, which involved only visual mental imagery, were correlated with CIS scores, which involve auditory, gustatory, and tactile mental imagery, a simple correlation analysis was run with VVIQ scores and CIS scores. There were 155 participants included in this analysis because 5 participants were missing CIS data. No significant correlation was found, $r = .14$, $p > .05$. However, the CIS was not significantly correlated with any of the other variables of interest in the study, so it was not explored further.

3.2.2 Misinformation as substitution or source confusion

The mean hit rate for all correctly identified actions from photographs, including the actions that had incorrect details in the written account (misinformation) and the actions that were correctly reported in the written account, was 91.8% (*SD* = .11). The mean hit rate for only those actions later associated with misinformation in the written account was also 91.8%, (*SD* = .12).

3.2.3 Test day, imagery ability, and WMC x false alarms to misinformation rate

The mean false alarm to misinformation rate for all participants was 71.6% (*SD* = .26). There was a main effect of WMC, $F(1, 56) = 5.49$, $p = .02$, $\square^2 = .09$, such that individuals with high WMC, *M* = 61.5%, *SE*= .04, had lower false alarm to misinformation rates than individuals with low WMC, *M* = 75.9%, *SE*= .05 (Table 18; Figure 7). No main effects of test day, $F(1, 56) = 2.40$, $p > .05$, or imagery ability, $F(1, 56) = .01$, $p > .05$, were found (see Table 19 and Table 20 for marginal means). There was an interaction effect of test day and WMC, $F(1, 56) = 14.37$, $p = .0004$, $\square^2 = .20$, and examination of simple contrast analyses showed that the effect of test day on the false alarm to misinformation rate was only significant for individuals with high WMC, $F(1,56) = 14.92$, $p = .0003$, such that higher false alarm to misinformation rates were seen with a delayed test, *M* = 77.9%, *SE*= .06, than with an immediate test, *M* = 45.0%, *SE*= .06. The effect of test day in the low WMC group was not significant, $F(1, 56) = 2.41$, $p > .05$ (Table 21; Figure 8). Interpretation of a secondary ANOVA that included all participants (low, medium, and high) revealed a main effect of test day, $F(1, 56) = 7.74$, $p = .01$, $\square^2 = .05$, such that individuals with an immediate test, *M* = 65.9%, *SE*= .03, had lower false alarm to misinformation rates than individuals with a delayed test, *M* = 76.9%, *SE*= .03. Interpretation of the secondary ANOVA also indicated that individuals with medium WMC, *M* = 77.5, *SE*= .03, had higher false alarm to misinformation rates than individuals with high WMC and similar false alarm to misinformation rates to individuals with low WMC. Interpretation of the secondary ANOVA did not indicate any significant effects on the false alarm to misinformation rates involving the middle range of scores on the VVIQ, *M* = 69.9%, *SE* = .03.

3.2.4 Test day, imagery ability, and WMC x quality of false memories

The mean remember rate for false alarms to misinformation was 71.5% (*SD* = .24). There was a main effect of imagery ability $F(1, 56) = 4.44$, $p = .04$, $\square^2 = .07$, such that individuals with high imagery ability (*M* = 77.0%, *SE*= .04) reported more "vividly remembered" responses to falsely recalled misinformation than individuals with low imagery ability (*M* = 64.8%, *SE*= .04; Table 22; Figure 9), consistent with findings of Experiment 1. There was no significant main effect of test day, $F(1, 56) = .21$, $p > .05$, or WMC, $F(1, 56) = 2.14$, $p > .05$ (see Table 23 and Table 24 for marginal means). There was a 3 way interaction $F(1, 56) = 5.33$, $p = .03$, $\square^2 = .09$, and examination of simple contrast analyses showed that an interaction of imagery ability and WMC was significant but only with an immediate test, $F(1,56) = 4.12$, $p = .047$, such that "remember" rates for individuals with low imagery ability were higher with high WMC, *M* = 74.9%, *SE* = .08 than low WMC, *M* = 64.2%, *SE* = .01, and "remember" rates for individuals with high imagery ability were higher with low WMC, *M* = .90%, *SE* = .08, than high WMC, *M* = 60.0%, *SE* = .80 (Table 25; Figure 10 and Figure 11). Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects on the "remember" rate for false alarms to misinformation involving the middle range of imagery ability, *M* = 72.5%, *SE* = .03, or WMC, *M* = 74.1%, *SE* = .03.

3.2.5 Test day, imagery ability, and WMC x Hit rate

The mean hit rate (correctly identified actions from photographs) for all participants was 91.8% (*SD* = .11). No main effects of test day, $F(1, 56) = .35$, $p > .05$, imagery vividness $F(1, 56) = .21$, $p > .05$, or working memory capacity $F(1, 56) = .84$, $p > .05$, were found to be statistically significant (see Table 26, Table 27, and Table 28 for marginal means). All possible interactions were also not statistically significant. Interpretation of a secondary ANOVA that included all participants (low, medium, and high), did not indicate any significant effects on the hit rate involving the middle range of scores on the VVIQ, *M* = 91.7%, *SE* = .02, or WMC, *M* = 93.5%, *SE* = .02.

3.2.6 Test day, imagery ability and WMC x quality of accurate memories

The mean "remember" rate for hits (correctly recalled actions from photographs) was 78.0% (*SD* = .19). There was a significant main effect of imagery ability, $F(1, 56) = 5.25$, $p = .03$, $\square^2 = .09$, such that individuals with high imagery ability (*M* = 82.5%, *SE*= .03) reported higher rates of "vividly remembered" responses to hits than individuals with low imagery ability (*M* = 71.6%, *SE*= .03; Table 29; Figure 12), consistent with Experiment 1. There was no significant main effect of test day, $F(1, 56) = 2.17$, $p > .05$, or WMC $F(1, 56) = .60$, $p > .05$ (See Table 30 and Table 31 for marginal means). All possible interactions were not significant. Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects involving the middle range of scores on the VVIQ or WMC.

3.2.7 Test day, imagery ability, and WMC x d'

The mean *d*' discrimination score for all participants was 0.24 (*SD* = .42). No main effects of test day, $F(1, 56) = 1.72$, $p > .05$, imagery vividness, $F(1, 56) = 1.43$, $p > .05$, or working memory capacity, $F(1, 56) = .001$, $p > .05$, were found to be statistically significant (see Table 32, Table 33, and Table 34 for marginal means). All possible interactions were also not significant. Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects on *d'* involving the middle range of scores on the VVIQ or WMC.

3.2.8 Test day, imagery ability, and WMC x C

The mean criterion score for all participants was -.92 (*SD* = .62). There was a significant main effect of imagery ability, $F(1, 56) = 4.23$, $p = .045$, □^{2} = .07, such that individuals with low imagery ability (*M* = -1.1, *SE*= .10) had more liberal criteria (were more likely to say they had seen something in the slide show) than individuals with high imagery ability (*M* = -.82, *SE*= .10; Table 35; Figure 13). No main effects of test day, $F(1, 56) = 1.70$, $p > .05$, or working memory capacity, $F(1, 56) = 3.74$, $p > .05$, were found to be statistically significant (see Table 36 and Table 37 for marginal means). There was a 3 way interaction $F(1, 56) = 6.50$, $p = .01$, □^{2} = .10, but examination of simple contrast analyses showed that the differences in criterion scores were not statistically significant. Interpretation of a secondary ANOVA that included all participants (low, medium, and high) did not indicate any significant effects on criterion involving the middle range of scores on the VVIQ or WMC.

3.3 Discussion

The high numbers for mean hit rate (91.8%), mean false alarm to misinformation rate (71.6%), and especially mean false alarm to new actions rate (79.5%) suggest that participants were reporting that they had seen actions in the slide show most of the time, even when an action had never been introduced in the slide show or the written misinformation. The mean criterion score (-.92) provides evidence that participants were employing very liberal criteria, meaning they were most likely to answer that an item had been shown in the slide show than to answer that it was not shown. The low mean *d'* score (.24) indicates that participants were not very good at discriminating between actions that were shown in the slide show pictures and actions that were not shown in the slide show pictures. The mean WMC score, $M = 21.19$, $SD = 6.45$, was very similar to the mean score in Experiment 1, which is far below other studies and causes Experiment 2 to have the same issues with WMC findings as was discussed for Experiment 1. The interpretation of these preliminary results indicates the need for caution when examining significant effects for Experiment 2. However, because all participants with false alarm rates at ceiling (100%) were removed from the analysis and the resulting mean false alarm rates were lower than the mean hit rate, it is possible that some legitimate differences between groups can be found for this experiment, thus the statistically significant findings are discussed below.

3.3.1 Misinformation as substitution or source confusion

The hit rates for actual photographs were the same whether false (misinformation) or accurate (reinforcing) information was presented in the post-slide show statement. This suggests that misinformation does not over-write or replace actual memories. Instead, misinformation likely adds an additional source and creates source confusion, as found in previous research (Lindsay, Allen, et al., 2004; Zaragoza & Lane, 1994; Zhu et al., 2010). However, this could not be explored further due to the lack of significant findings for false memory rates.

3.3.2 Test day, imagery ability, and WMC x false alarms to misinformation rate

It was unexpected that a main effect of test day was not found in the ANOVA for the false alarm to misinformation rate, given that participants should certainly have made more false alarm errors with a delayed test vs. an immediate test. However, examination of the marginal means does show that the mean false alarm rate was higher for the delayed test (73.5%) than the immediate test (63.9%). Furthermore, the ANOVA did show a main effect of test day when the middle groups of participants were left in the analysis. An independent sample t-test confirmed that the simple difference between the means for the false alarm to misinformation rates for the 1 day and 2 day test groups was statistically significant, $t(,158) = -3.34$, $p = .001$. These results, although not extremely robust, support the hypothesis that both low and high imagers would increase false memory rates when the test was delayed rather than immediate. There was no support found for the hypothesis that there would be a significantly larger increase in false memory rate between immediate and delayed test in the high imagery group than in the low imagery group. Imagery ability did not play a role in false recognition rates.

The significant main effect found for WMC does appear to support previous research by suggesting that a high WMC may be protecting against false memories for imagined actions, however if this result was robust the *d'* (discrimination) scores for high WMC would be expected to be higher than the *d'* scores for low WMC, but the *d'* scores for low, $M = .309$ and high, $M = .306$ WMC are very similar in this data set. It is a possibility that some small differences between the low and high WMC groups are being identified in this experiment and not in Experiment 1 because the source monitoring task in Experiment 2 was more difficult, and therefore likely required more cognitive capacity.

3.3.3 Test day, imagery ability, and WMC x quality of false memories

The main effect found for imagery on the remember rate for false alarms to misinformation is encouraging in that it replicates the results for false alarms to imagined actions in Experiment 1. There seems to be no solid reason to assume that all of the remember judgments were purely guesses even if the “seen in the slide show” (old/new) judgments were sometimes guesses. It seems most likely that individuals would choose “know/familiar” rather than “remember” in cases when the initial old/new response was a guess, so when “remember” was chosen, it might be a legitimate answer. This idea is supported by the results of a study in which participants were asked to provide explanations of their remember, know, and guess responses on a memory task (J. M. Gardiner, Ramponi, & Richardson-Klavehn, 1998). Guesses were found to be associated with familiarity but not recollection. However, the remember rate was rather high compared to Experiment 1 so this might not be a valid explanation. Overall, the significant findings here tentatively provide support for the hypothesis that individuals with high imagery ability will make more remember responses when recalling false memories in a misinformation paradigm. Similar to the interpretation in Experiment 1, this suggests that individuals with high imagery ability are generating and remembering more perceptual details for misinformation than individuals with low imagery ability, and these perceptual details may make high imagery ability individuals more adamant in their endorsement of false memories.

The 3 way interaction is more difficult to interpret. Why would high WMC promote more “remember” responses than low WMC in the low imagery ability group? This low imagery ability group presumably creates fewer perceptual details in their mental images, so they should not have very vivid memories of something that they just read, and high WMC would be expected to protect against this confusion further. “Remember” rates are relatively high (compared to Experiment 1) for all of the groups in this analysis, which is indicative of some overall confusion. However, it may be worth noting that individuals with high imagery ability and low WMC had much higher "remember" rates than any other group, which is in line with predictions that high imagery ability creates more perceptually detailed mental images that may lead to more vivid memories of falsely recalled actions, and low WMC may not aid in keeping track of the source of the perceptual details.

3.3.4 Test day, imagery ability and WMC x quality of accurate memories

The main effect found for imagery ability on remember rates for hits replicates the effect found in Experiment 1. The patterns of the data in this analysis for Experiment 2 are identical to those found in Experiment 1; therefore the reader may refer to the corresponding discussion section for Experiment 1 for interpretation of this result.

3.3.5 Test day, imagery ability, and WMC x C

Although a main effect of imagery ability was found for the criterion score, it did not translate to differences in false alarm rates or hit rates for the low and high imagery ability groups. Therefore, the effect was not interpreted.

4 GENERAL DISCUSSION

One of the main goals of this study was to explore the effects of individual differences in mental imagery ability on false memories in order to provide support for either the Source Monitoring Framework or the Dual Process Theory. The Source Monitoring Framework predicts that high imagery ability should pair with a higher rate of false memories, and the Dual Process Theory predicts that high imagery ability should pair with a lower rate of false memories. The main significant finding of this study (found in both experiments but more interpretable in Experiment 1) was that individuals with high imagery ability were more likely to report vividly remembering both true and false actions than individuals with low imagery ability. This finding does not directly provide support for either the Source Monitoring Framework or the Dual Process Theory in regards to the overall rate of false memories, as no differences in memory accuracy were found between high and low imagery ability groups. However, this finding does speak to the way in which source monitoring decisions may have been made. In the discussion section of Experiment 1, the findings are interpreted within the Dual Process theory: individuals with high imagery ability are invoking the intentional recollection process of memory more often than individuals with low imagery ability who may be invoking the automatic familiarity process of memory more often. This could potentially be tested in a future experiment by examining reaction times for the source monitoring decisions. If no differences in reaction times are found, then there is another possible interpretation: according to the Source Monitoring Framework, individuals use the amount of perceptual details they can recall about an event to determine the source of an event (Johnson et al., 1993). Individuals in this study who relied on the amount of perceptual details in their memories to make source decisions would be expected to say that they often vividly remember actions that they are reporting as "old", because they would report an action as "old" when they could recall a lot of perceptual details about the action. Because individuals in Experiment 1 with high imagery ability reported that they vividly remembered true actions (hits) 61.1% of the time and false actions (false alarms) 42.9% of the time, it is likely that they were relying heavily on the level of perceptual detail for their decisions, in line with the Source Monitoring Framework. In contrast, according to the Dual Process Theory, false memories for an imagined event may result from the automatic sense of familiarity for the event rather than from a recollection of perceptual details for the event (Jacoby, 1991; Jacoby et al., 1989). Individuals in Experiment 1 with low imagery ability only reported that they vividly remembered true actions (hits) 46.8% of the time and false actions (false alarms) 28.5% of the time, which suggests that their reason for reporting an action as “old” was not as often the number of perceptual details they could recall but was more often due to a feeling of familiarity. Therefore, the low imagery ability group finding seems to provide support for the Dual Process Theory. A logical conclusion is that individuals with high and low imagery ability may be using different strategies for source monitoring, and that both the Source Monitoring Framework and Dual Process Theory are correct when applied to different groups. If both individuals with high and low imagery ability used the same strategy, I would expect to find differing false alarm rates between the groups, unless imagery ability did not lead to differential amounts of perceptual details in memory.

Another goal of the current study was to test the interaction effects of imagery ability and working memory capacity (WMC) on false memories for imagined events. WMC did not affect false memory rates in Experiment 1 and findings did not provide support for either the Source Monitoring Framework or the Dual Process Theory. A high WMC did appear to prevent some false memories in Experiment 2, but false alarm rates for even the high WMC group were very high (61.5%) and WMC did not affect overall discrimination ability. Findings related to WMC in this study are not entirely reliable due to the restricted range of WMC scores on the lower end of the scale. It is possible that the majority of participants in this study did not have the protection of WMC against false memories simply because their WMC was not high enough. It may be that relatively low or even “average” working memory capacity is not enough to aid in source monitoring at all and that only very high WMC will produce an effect.

The very liberal criteria and high false alarm to new actions rate in Experiment 2 were unexpected given that the slide show used in Experiment 2 was the same as in Experiment 1 with the only difference being the misinformation after the slide show in place of the imagined actions during the slide show. The number of imagined actions in Experiment 1 and the number of misinformation statements in Experiment 2 were the same (38).The mean false alarm to new actions (actions not in the slide show pictures or imagined statements/misinformation) rate was much lower in Experiment 1 (12.6%) and the mean criterion score in Experiment 1 was 0.02, indicating neutral criteria (no strong bias for any particular response). This suggests that participants in Experiment 2 were readily confused by the misinformation and the task was likely too difficult. However, because participants in Experiment 1 were able to complete the task using the same slide show successfully, Experiment 2 may be improved upon in the future by simply making the misinformation portion less confusing. This would allow Experiment 2 to continue to be paired with Experiment 1. Although the results of Experiment 2 must be looked at with caution, they compliment rather than contradict the main findings of Experiment 1 and provide some encouragement that a future experiment with a less confusing source monitoring task might find more robust differences following the same patterns between groups.

The difficulty of source monitoring in Experiment 2 as compared to Experiment 1 shows how readily confusing the introduction of misinformation can be. Misinformation can be introduced in eyewitness interviews, psychotherapy sessions, and everyday interactions and it is important to note that such misinformation could greatly reduce the ability to differentiate the source of information successfully. In Experiment 2 of this study, confusion from misinformation appeared to cause participants to endorse almost everything presented to them as having actually been seen, which could be a very detrimental behavior for an eyewitness.

By conducting Experiments 1 and 2, I hoped to be able to answer questions about the interactions of high and low imagery ability and high and low WMC on false memories for imagined actions. However, I could not thoroughly evaluate the potential interactions of imagery ability and WMC due to lack of significant findings. As previously discussed, lack of significant findings may be due to restricted ranges of measured variables or, in the case of Experiment 2, too much task confusion. It is also possible that individual differences in imagery ability and WMC do not contribute to the rate of false memory creation. However, even if imagery ability is not implicated in the number of false memories, it still appears to be an important factor in the phenomenological experience of false memories. Namely, high imagery ability appears to encourage perceptual vividness in false memories, which likely leads to high confidence in false memories when they occur.

There are several important implications for the connection of high imagery ability and high vividness of false memories. The Cognitive Interview and the updated Enhanced Cognitive Interview (ECI) employ guided mental imagery and are currently used as a technique to receive detailed and complete memories of crimes from eye-witnesses (Fisher & Geiselman, 1992). Proponents of the use of the ECI point to recent research that has found that the ECI increases recall of accurate details about events (Nori et al., 2014). Nori and colleagues (2014) recently found that when interviewed with the ECI rather than an interview that does not employ guided imagery, individuals with high visual imagery abilities recalled more correct information about a film clip than individuals with low imagery ability. Because they did not find any increases in the recall of incorrect information (confabulations), they concluded that the ECI was an efficient tool for memory enhancement, particularly for individuals with high visual imagery ability. However, they did not assess the phenomenological quality of or the confidence in the false memories that did occur. Taking into account the findings of the current study, it is logical to assume that although individuals with high imagery abilities in the study by Nori and colleagues did not have more false memories with the use of the ECI, they may have been more adamant in the endorsement of their false memories and thus may be less reliable witnesses than individuals with low imagery ability.

Guided imagery is also widely used in psychotherapy as a tool to enhance patient memories from the past, despite a growing body of literature criticizing the technique for encouraging the formation of false memories (Hyman & Pentland, 1996; Laney & Loftus, 2013; Loftus & Pickrell, 1995; Thomas & Loftus, 2002). New research is uncovering additional situations in which guided imagery can be dangerous, such as the increased instances of false memories for a traumatic childhood event when guided imagery is used in combination with group therapy (Herndon, Myers, Mitchell, Kehn, & Henry, 2014). The creation of false memories in therapy patients can have particularly devastating consequences when it leads to false testimony of abuse and subsequent conviction of innocent individuals. Proponents of the use of guided imagery can point to some mixed results in the literature, such as studies like the current study in which there were no differences found in the rate of false memory creation. However, it is important to pay attention to the finding that vivid imagery may enhance the recalled experience of the memory and lead to high confidence in false memories.

Besides testimony on the witness stand, there is another implication for vivid imagery and false memories that affects the majority of the population on a regular basis. Advertisements that encourage vivid imagery have been found to encourage false memories of experiences with the products in the advertisements, and in a recent study participants who only viewed the advertisements rated their product experiences as favorably as participants who had actually tried the products (Rajagopal & Montgomery, 2011). It is logical to assume that individuals with high imagery abilities may be particularly affected by advertising and may even be more easily manipulated into thinking they like a certain product and subsequently purchasing it. In summary, the vividness of mental imagery is important to consider when studying false memories and individual differences in imagery ability appear to be connected with differential experiences of false memories. Further research should include measures of the phenomenological experience of memories and not focus merely on the rate of false memory creation or overall memory accuracy.

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Table 1 *Bivariate Correlations for Experiment 1*

	VVIQ	WMC	Av. Viv.	FA img rate	Hit rate	Hit rem rate	FA img rem rate	FA new rate	*d'*	*C*
VVIQ	.	.008	.440*	.077	.148	.241*	.242*	.082	.045	-.110
WMC	.008	.	-.007	.191*	.084	.048	.147	.095	-.111	-.179*
Av. Viv	.440*	-.007	.	.084	-.146	.199*	.259*	-.034	-.104	.024
FA img rate	.077	.191*	.084	.	.337*	.053	.177*	.025	-.614*	-.781*
Hit rate	.148	.084	-.046	.377*	.	.277*	.093	.325*	.512*	-.781*
Hit rem rate	.241*	.048	.199*	.053	.277*	.	.652*	.037	.205*	-.169*
FAimg rem rate	.242*	.147	.259*	.177*	.093	.652*	.	.031	-.051	-.128
FAnew rate	.082	.095	-.034	.025	.325*	.037	.031	.	.077	-.341*
d'	.045	-.111	-.104	-.614*	.512*	.205*	-.051	.077	.	.089
C	-.110	-.179*	.024	-.781*	-.781*	-.169*	-.128	-.341*	.089	.

Note. * = correlation significant at $p < .05$; Av. Viv = average vividness rating; FAimg = false alarm to imagined actions; rem = remember; FAnew = false alarm to new actions.

Table 2 *Summary of Means and Standard Deviations for Experiment 1*

Variable Name	*M*	*SD*
Imagery Ability (VVIQ)	61.7	8.3
WMC (Run Span)	20.5	6.7
False Alarm to Imagined Actions Rate	45.6	21.8
False Alarm to New Actions Rate	12.6	10.8
Remember Rate for False Alarm to Imagined Actions	36.3	22.2
Hit Rate	64.3	15.5
Remember Rate for Hits	56.8	25.0
d’	.83	.54
Criterion	.02	.39

Table 3 *Estimated Marginal Means of False Alarm to Imagined Actions Rate x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.462	.04	.493	.04

Table 4 *Estimated Marginal Means of False Alarm to Imagined Actions Rate x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.439	.04	.516	.04

Table 5 *Estimated Marginal Means of Remember Rate for False Alarms to Imagined Events x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.285*	.04	.429*	.04

Note. * = significant difference at $p < .05$.

Table 6 *Estimated Marginal Means of Remember Rate for False Alarms to Imagined Events x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.322	.04	.392	.04

Table 7 *Estimated Marginal Means of Hit Rate x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.565	.03	.640	.03

Table 8 *Estimated Marginal Means of Hit Rate x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.607	.03	.599	.03

Table 9 *Estimated Marginal Means of Remember Rate for Hits x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.468*	.05	.611*	.05

Note. * = significant difference at $p < .05$.

Table 10 *Estimated Marginal Means of Remember Rate for Hits x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.534	.05	.546	.05

Table 11 *Estimated Marginal Means of Remember Rate for Hits x Imagery Ability and WMC*

Imagery Ability	WMC			
	Low		High	
	M	*SE*	*M*	*SE*
Low	.377*	.07	.560	.07
High	.692*	.06	.531	.07

Note. * = significant difference at $p < .05$.

Table 12 *Estimated Marginal Means of d' x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.624	.10	.757	.09

Table 13 *Estimated Marginal Means of d' x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.800	.09	.581	.10

Table 14 *Estimated Marginal Means of Criterion x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.133	.08	.008	.08

Table 15 *Estimated Marginal Means of Criterion x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.118	.08	.023	.08

Table 16 *Bivariate Correlations for Experiment 2*

	VVIQ	WMC	CIS	FA mis rate	Hit rate	Hit rem rate	FA mis rem rate	FA new rate	*d'*	*C*
VVIQ	.	-.085	.142	.047	.116	.186*	.161*	.096	-.028	.231*
WMC	-.085	.	.043	-.165*	-.001	-.016	-.102	-.151	.027	.050
CIS	.142	.043	.	-.007	-.046	.107	.109	-.025	-.114	.050
FA mis rate	.047	-.165*	-.007	.	.467*	-.065	-.002	.791*	-.526*	-.055
Hit rate	.116	-.001	-.046	.467*	.	.240*	.207*	.617*	.191*	-.002
Hit rem rate	.186*	-.016	.107	-.065	.240*	.	.757*	.035	.183*	.082
FAmis rem rate	.161*	-.102	.109	-.002	.207*	.757*	.	-.007	.132	.062
FAnew rate	.096	-.151	-.025	.791*	.617*	.035	-.007	.	-.363*	-.059
d'	-.028	.027	-.114	.526*	.191*	.183*	.132	-.363*	.	-.224*
C	.231*	.050	.050	-.055	-.002	.082	.062	-.059	-.224*	.

Note. * = correlation significant at $p < .05$; FAmis = false alarm to misinformation; rem = remember; FAnew = false alarm to new actions.

Table 17 *Summary of Means and Standard Deviations for Experiment 2*

Variable Name	*M*	*SD*
Imagery Ability (VVIQ)	62.0	8.6
WMC (Run Span)	21.2	6.5
False Alarm to Misinformation Rate	71.6	25.9
False Alarm to New Actions Rate	79.5	17.2
Remember Rate for False Alarm to Misinformation	71.5	23.6
Hit Rate	91.8	11.0
Remember Rate for Hits	78.0	19.3
d’	.24	.42
Criterion	-.92	.62

Table 18 *Estimated Marginal Means of False Alarms to Misinformation Rate x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.759*	.05	.615*	.04

Note. * = significant difference at $p < .05$.

Table 19 *Estimated Marginal Means of False Alarms to Misinformation Rate x Test Day*

Test Day			
1 Day		2 Day	
M	*SE*	*M*	*SE*
.639	.05	.735	.04

Table 20 *Estimated Marginal Means of False Alarms to Misinformation Rate x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.689	.04	.685	.04

Table 21 *Estimated Marginal Means of False Alarms to Misinformation Rate x Test Day and WMC*

Test Day	WMC			
	Low		High	
	M	*SE*	*M*	*SE*
1 Day	.828*	.07	.450*	.06
2 Day	.690	.06	.779	.06

Note. * = significant difference at $p < .05$.

Table 22 *Estimated Marginal Means of Remember Rate for False Alarms to Misinformation x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.648*	.04	.770*	.04

Note. * = significant difference at $p < .05$.

Table 23 *Estimated Marginal Means of Remember Rate for False Alarms to Misinformation x Test Day*

Test Day			
1 Day		2 Day	
M	*SE*	*M*	*SE*
.722	.04	.696	.04

Table 24 *Estimated Marginal Means of Remember Rate for False Alarms to Misinformation x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.752	.04	.667	.04

Table 25 *Estimated Marginal Means of Remember Rate for False Alarms to Misinformation x Test Day, Imagery Ability, and WMC*

Test Day	Imagery Ability	WMC			
		Low		High	
1 Day		*M*	*SE*	*M*	*SE*
	Low	.642	.10	.749*	.08
	High	.899	.08	.600	.08
2 Day	Low	.670	.08	.533*	.08
	High	.796	.08	.786	.09

Note. * = significant difference at $p < .05$.

Table 26 *Estimated Marginal Means of Hit Rate x Test Day*

Test Day			
1 Day		2 Day	
M	*SE*	*M*	*SE*
.906	.02	.919	.02

Table 27 *Estimated Marginal Means of Hit Rate x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.907	.02	.918	.02

Table 28 *Estimated Marginal Means of Hit Rate x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.923	.02	.902	.02

Table 29 *Estimated Marginal Means of Remember Rate for Hits x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.716*	.03	.825*	.03

Note. * = significant difference at $p < .05$.

Table 30 *Estimated Marginal Means of Remember Rate for Hits x Test Day*

Test Day			
1 Day		2 Day	
M	*SE*	*M*	*SE*
.806	.04	.735	.03

Table 31 *Estimated Marginal Means of Remember Rate for Hits x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.789	.04	.752	.03

Table 32 *Estimated Marginal Means of d' x Test Day*

Test Day			
1 Day		2 Day	
M	*SE*	*M*	*SE*
.377	.08	.238	.07

Table 33 *Estimated Marginal Means of d' x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
.371	.08	.244	.07

Table 34 *Estimated Marginal Means of d' x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
.309	.08	.306	.07

Table 35 *Estimated Marginal Means of Criterion x Imagery Ability*

Imagery Ability			
Low		High	
M	*SE*	*M*	*SE*
-1.095*	.10	-.815*	.10

Note. * = significant difference at $p < .05$.

Table 36 *Estimated Marginal Means of Criterion x Test Day*

Test Day			
1 Day		2 Day	
M	*SE*	*M*	*SE*
-1.044	.10	-.867	.09

Table 37 *Estimated Marginal Means of Criterion x WMC*

WMC			
Low		High	
M	*SE*	*M*	*SE*
-1.087*	.10	-.824*	.09

Note. * = significant difference at $p < .05$.

WMC task (Running Span)	Imagery ability test (VVIQ)	Slide show (pictures and imagine statements)	48 hour delay	Recognition test	Demographic Info and debrief
session 1				session 2	

Figure 1. Figure 1. Overview of Experiment 1 procedure.

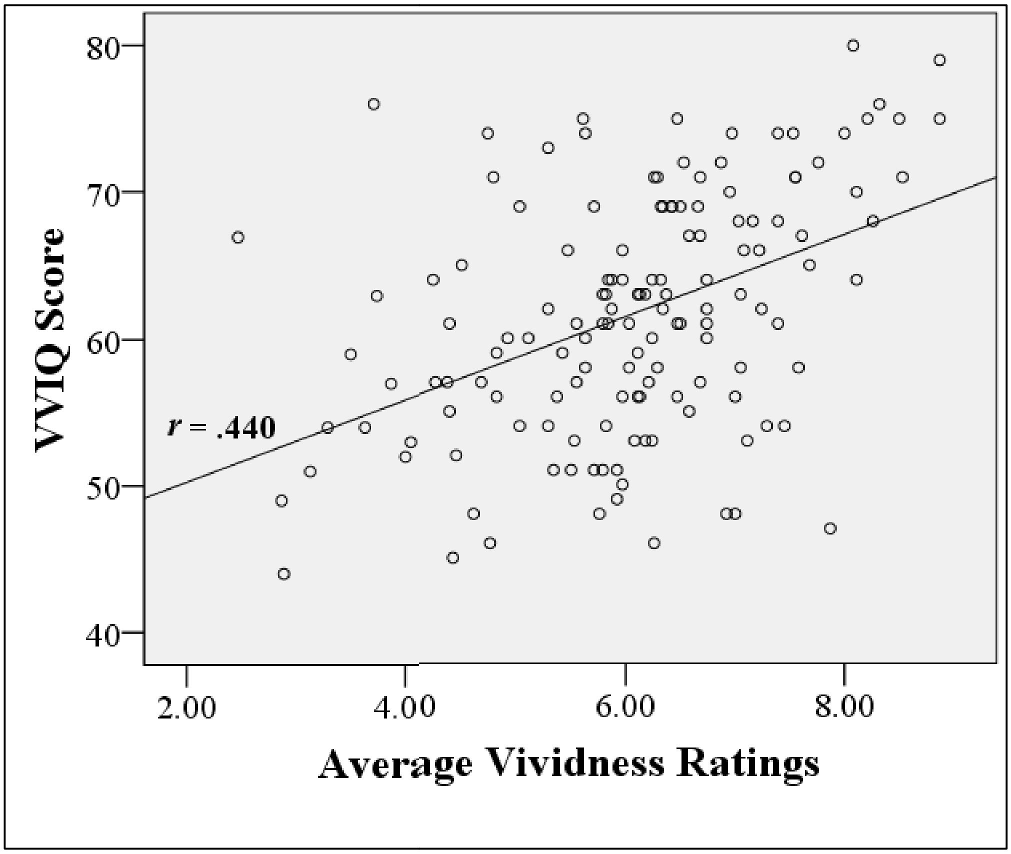

Figure 2. Scatter plot of the correlation between mean VVIQ scores and mean imagery vividness ratings.

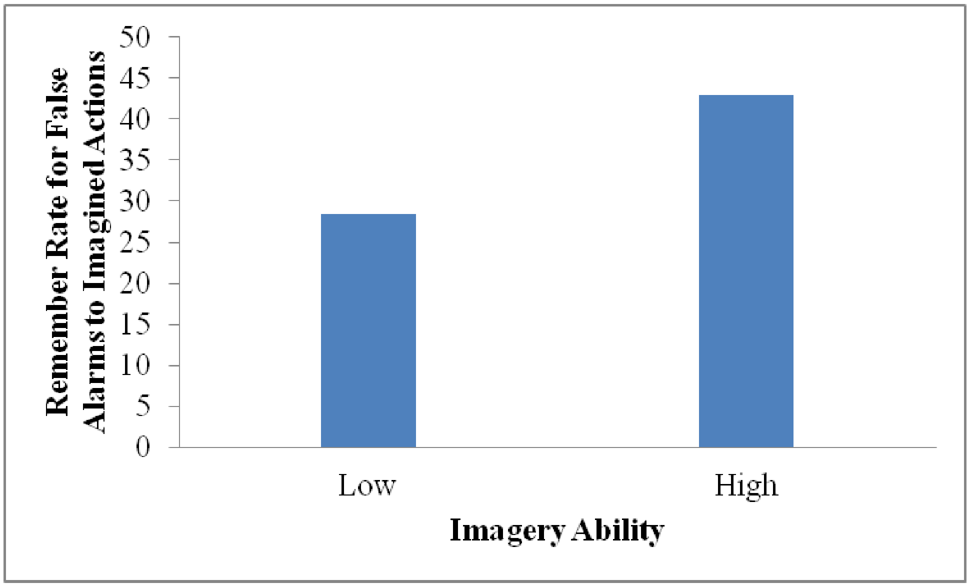

Figure 3. Remember rate for false alarms to Imagined actions by imagery ability.

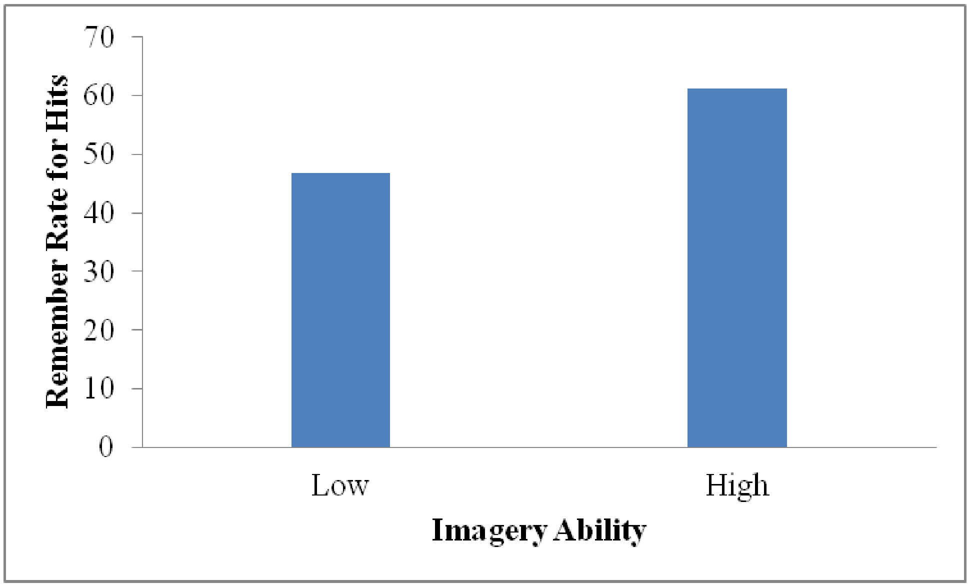

Figure 4. Remember rate for hits by imagery ability.

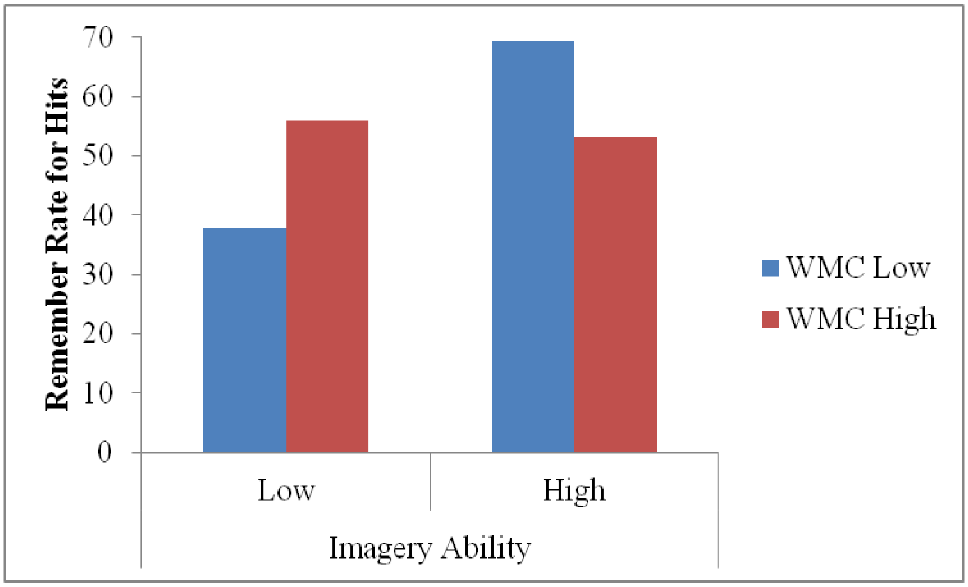

Figure 5. Remember rate for hits by imagery ability and WMC.

Imagery ability test (VVIQ)	Slide show (pictures only)	Misinformation statements	WMC task (Running Span)	CIS	Recognition test	Demographic Info and debrief
session 1			20 minute delay		session 2	

Imagery ability test (VVIQ)	Slide show (pictures only)	Misinformation statements	48 hour delay	WMC task (Running Span)	CIS	Recognition test	Demographic Info and debrief
session 1				session 2			

Figure 6. Overview of Experiment 2 procedure.

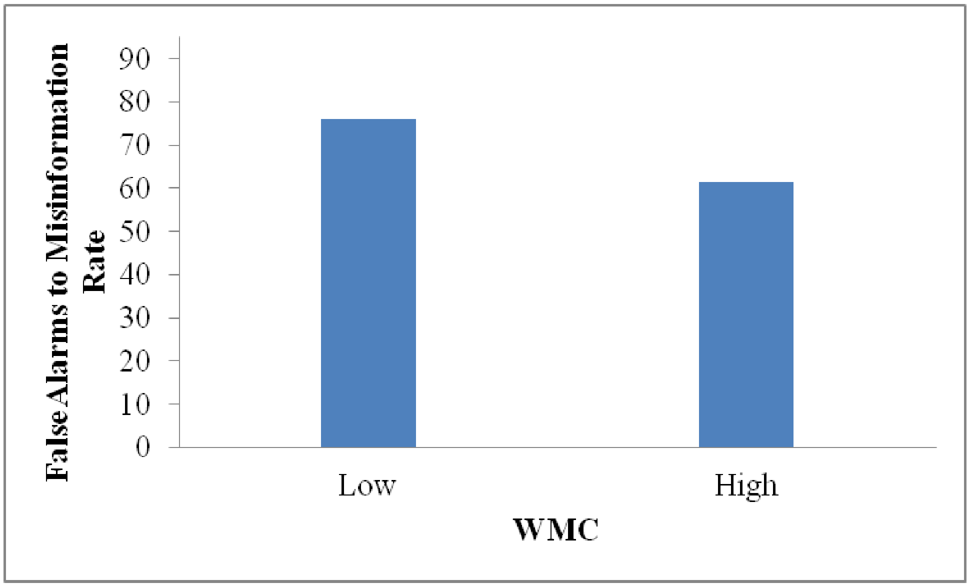

Figure 7. False alarm to misinformation rate by WMC.

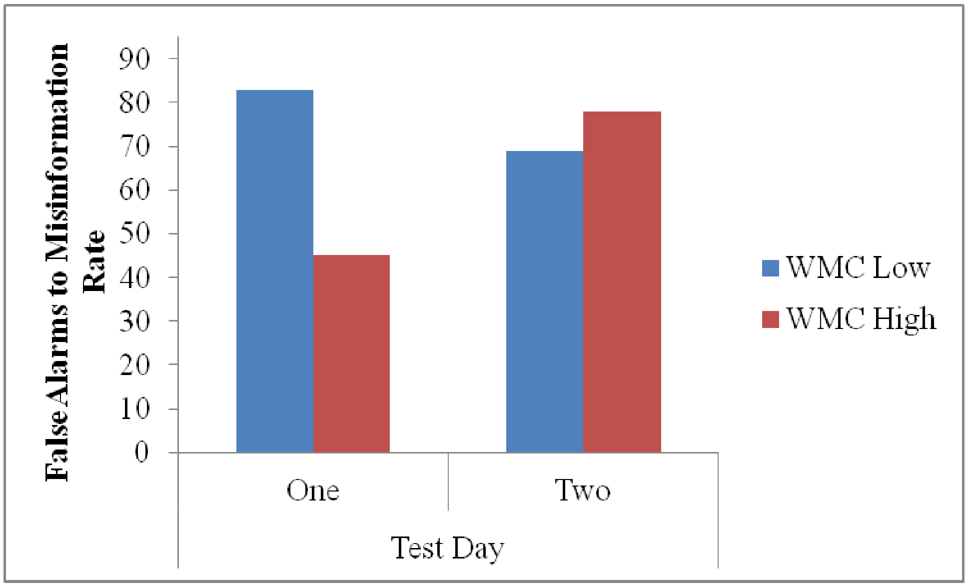

Figure 8. False alarm to misinformation rate by test day and WMC.

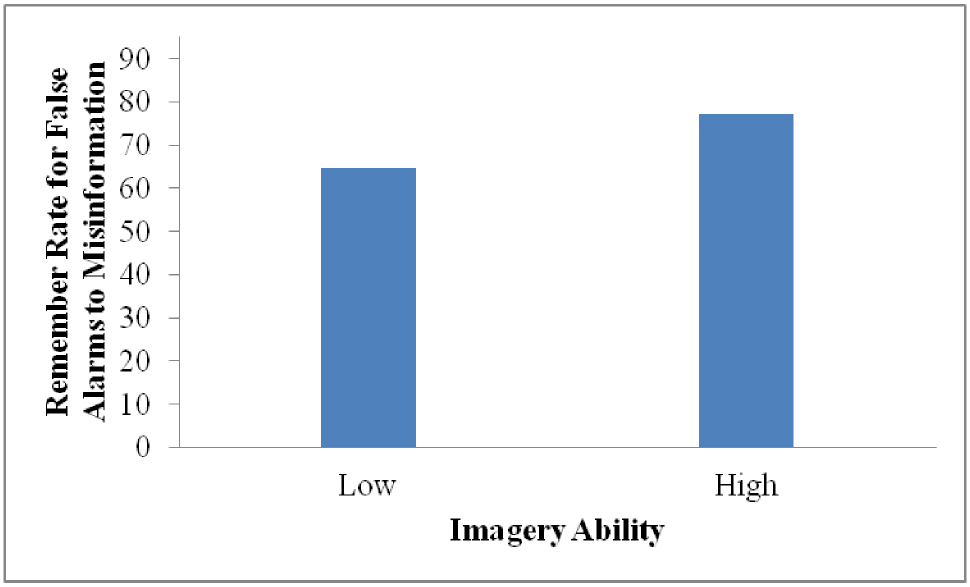

Figure 9. Remember rate for false alarms to misinformation by imagery ability.

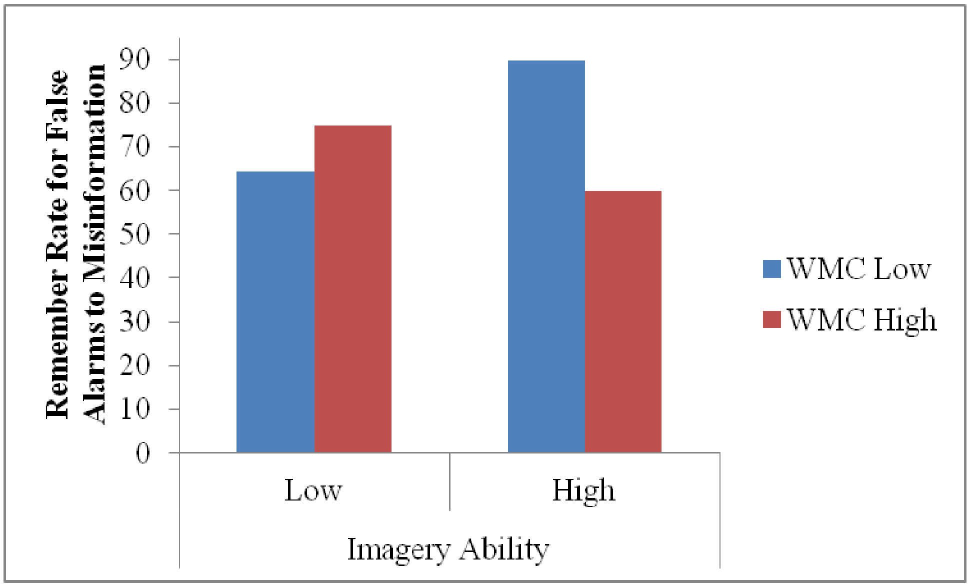

Figure 10. Remember rate for false alarms to misinformation by imagery ability and WMC for memory test on day 1.

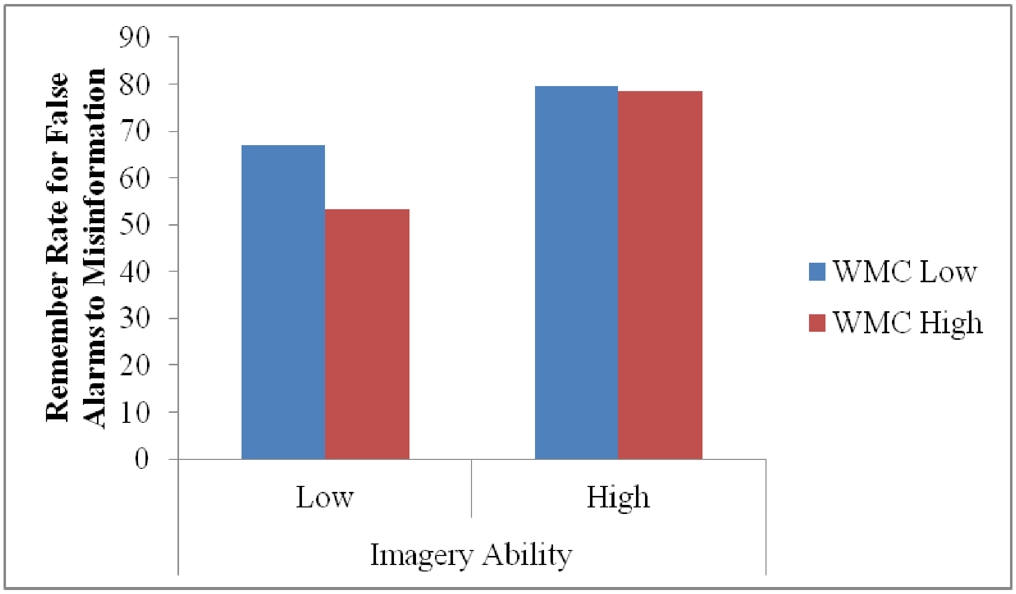

Figure 11. Remember rate for false alarms to misinformation by imagery ability and WMC for memory test on day 2.

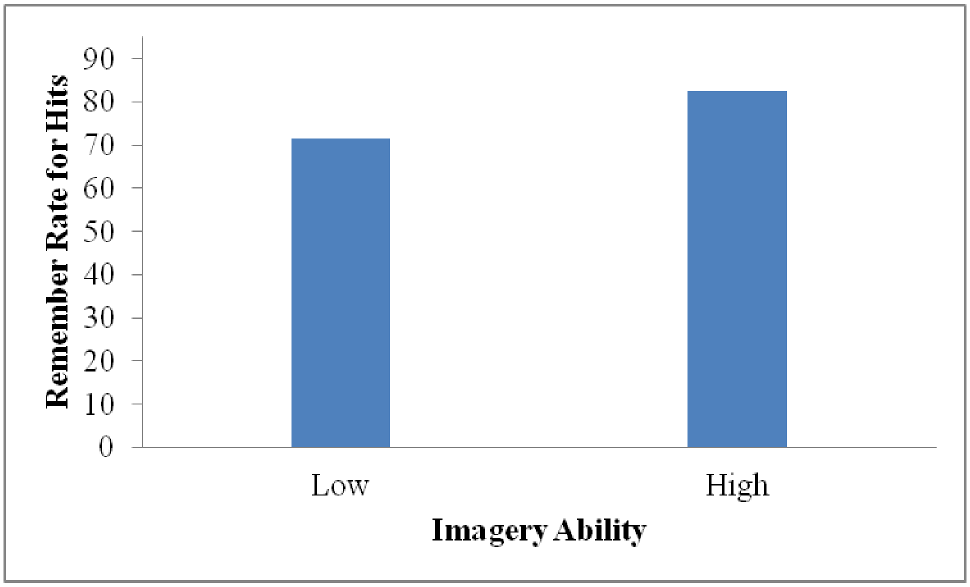

Figure 12. Remember rate for hits by imagery ability.

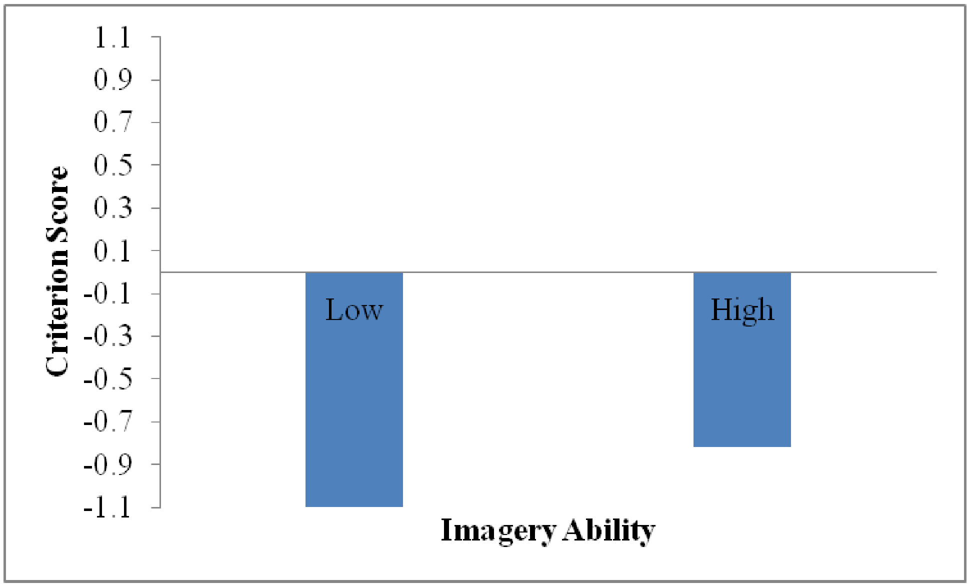

Figure 13. Mean Criterion score by imagery ability.