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Factors affecting the efficacy of feedback use during source monitoring

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FACTORS AFFECTING THE EFFICACY OF FEEDBACK USE DURING SOURCE MONITORING

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ABSTRACT

The current study considers how individual differences in working memory capacity (WMC) affect feedback effectiveness. Participants, selected to have high and low WMC, first watched a video of a crime. Subsequently, a post-test questionnaire was administered concerning events taken from the video and additional information suggested to have occurred in the video. After a 10 minute filler task, participants were given a two-part memory test requiring them to identify the source of the information presented in the test statements. During the training portion of the test, half of the participants received feedback as to the accuracy of their source decisions. On the second (assessment) portion of the test, participants did not receive any feedback. Both high and low WMC participants benefited equally from the presentation of feedback; both groups significantly reduced their misattributions of suggested items to the video. There was also a trend toward better source monitoring performance on suggested items in high WMC than low WMC participants, regardless of whether they received feedback. These findings suggest that feedback may be used to improve memory accuracy without requiring substantial executive resources.

INTRODUCTION

Imagine that you just witnessed a crime. Afterwards, police officers spend hours asking you questions, you end up discussing details of the crime with other witnesses and finally, just as you arrive home, the local news on television is describing the crime you had just witnessed. After several months, you are asked to give your testimony for the court. The expectation in such a situation is that you should be able to accurately recall the details of the crime, and only those details. Prior research has found that such situations involve quite a difficult memory task and that errors may often result (e.g., Allen & Lindsay, 1998; Lane & Zaragoza, 2007; Lane, Mather, Villa, & Morita, 2001; Lindsay, 1993; Lindsay, Allen, Chan, & Dahl, 2003; Loftus, Miller, & Burns, 1978; Zaragoza & Lane, 1994). In some circumstances, real-life witness errors may be highly consequential as evidenced by numerous false convictions that have been documented as a result of DNA exonerations (Scheck, Neufeld, & Dwyer, 2000). Because of the prevalence of these and other types of memory errors, there is great interest in understanding factors that affect accuracy and discovering ways that errors can be remediated (Benjamin & Bawa, 2004; Hicks & Marsh, 1999; Koriat & Goldsmith, 1996; Starns, Lane, Alonzo & Roussel, 2007).

Although there may be many ways to reduce memory errors, the current study focuses on the ability of people to adjust the expectations they bring to a memory task in ways that allow them to increase the accuracy of their judgments (e.g., Dodson & Schacter, 2002; Ghetti & Castelli, 2006; Johnson, Hashtroudi, & Lindsay, 1993). When faced with a memory test, participants may choose their initial retrieval strategy or decision criteria based on instructions given by the experimenter, memory for the encoding phase, or lay theories about memory (e.g., Koriat, Bjork, Sheffer, & Bar, 2004). To the extent that this metamnemonic knowledge accurately reflects task constraints, participants' judgments should be accurate (Lane, Roussel et al., 2007).

However, there is evidence to suggest that the metamnemonic knowledge of participants in false memory research studies is often inaccurate or incomplete (e.g., Mather, Henkel, & Johnson, 1997; Schooler, Gerhard, & Loftus, 1986), and thus may be one reason for the occurrence of errors in such studies. Interestingly, there is recent research that suggests that such knowledge can sometimes be updated in ways that increase memory accuracy using pre-test warnings or feedback (e.g., Lane, Roussel, et al., 2007; Starns et al., 2007).

The following study is designed to follow up on recent findings that people are capable of improving source memory accuracy following a period of feedback training (Lane, Roussel, et al., 2007; Lane, Groft, & Roussel, 2007). For example, Lane, Roussel, et al. (2007; Exp. 3) studied the effects of feedback training on source memory accuracy using the eyewitness suggestibility paradigm (e.g., Loftus et al., 1978; Zaragoza & Lane, 1994). Participants viewed a video of a mock crime and later answered a questionnaire about the crime. Unknown to the participants was that some questions included information that did not occur during the crime. After completing the questionnaire, participants were told about this incorrect information and given a source test containing items from the video, the questionnaire, both sources, and new (never presented) items. For a third of the participants, correct feedback was given during the first half of the source test (the training phase). Following each test response, participants were told the correct source ("This item was only in the video"). In addition, a third of the participants received incorrect feedback during training, and a third received no feedback (the control group). The focus was on participants' performance on the second half (assessment phase) of the test. No group received feedback during this phase. Individuals who had received correct feedback significantly decreased their source misattribution of suggested items to the video, relative to the incorrect and no feedback groups.

Lane, Roussel, et al. (2007) suggested that the feedback allowed participants to update their metamnemonic knowledge about the types of features that discriminate between sources, and such knowledge improved the accuracy of subsequent retrieval and post-retrieval processes. These findings have also been replicated using picture and word stimuli developed by Henkel and Franklin (1998). In this research (Lane, Groft, & Roussel, 2007), participants studied pictures and formed images from presented words. Unbeknownst to participants, the pictures and images varied in their relation (i.e., they formed stimulus pairs that were either from the same category, looked similar to each other, or were unrelated). Forty-eight hours later, participants received a two-part source memory test that included items that had been seen as pictures or were imagined, and new items. One-half of the participants received correct feedback about their judgments on the first part of the test, and the other half (control participants) did not. As with Lane, Roussel, et al. (2007), the focus was on the second half of the test in which there was no feedback administered. Results revealed that, relative to the control group, the feedback group reduced their misattribution of imagined items to the picture source.

The findings of both Lane, Roussel, et al. (2007) and Lane, Groft, et al. (2007) reveal that providing feedback during training allows participants to significantly decrease source misattribution errors. Because the items on the first and second part of the test are different items, this demonstrates that feedback training allows participants to improve the accuracy of their retrieval or post-retrieval processing. Although these results are quite interesting, many issues remain to be investigated. For example, it is not yet clear whether there are individual differences in the ability to use feedback to reduce subsequent errors; or the mechanisms employed during the feedback presentation that allow participants to reduce their source errors.

The following study will examine the effect individual differences in working memory have on the ability of participants to learn from feedback. In the next sections, I first discuss the Source Monitoring framework (Johnson et al., 1993) as a theoretical explanation of source monitoring judgments. Next, I discuss the knowledge updating framework developed by Dunlosky and Hertzog (2000) and explain how such a framework can be applied to how participants learn from feedback in a source monitoring task. Finally, I describe the concept of working memory (Baddeley, 2007; Cowan, 2005; Engle, Tuholoski, Laughlin, & Conway, 1999), the design of the current study and my hypotheses.

Source Monitoring

According to the source monitoring framework (Johnson et al., 1993), an individual's ability to recognize the source of a memory does not come directly from the memory trace; rather its source is inferred by evaluating characteristics or mnemonic features of that memory. These judgments are possible because different sources have, on average, different types and amounts of mnemonic features such as perceptual information, contextual information, and semantic detail. For example, a memory that is based on perception is more likely to contain sensory (e.g., color, shape or location) or contextual detail than a memory that is the result of imagination, which is more likely to contain information about the cognitive operations involved in generating it. Johnson, et al., (1993) also argue that some source monitoring decisions can be made relatively automatically in the course of remembering them (heuristic processes). However, there is evidence to suggest that other source monitoring decisions are more systematic. Decisions made using these types of processes are relatively more time consuming and deliberate because they involve the retrieval of supporting mnemonic features and highlight relationships between these features and their source.

According to the source monitoring framework, errors in source judgments primarily occur due to three reasons (Johnson, et al., 1993). First, because source monitoring depends on the quality of encoding, when situations transpire that negatively affect encoding, source judgments will suffer. Second, errors may occur in situations where the decision process is impaired (e.g. time constraints or intense stress). Third, source errors are likely to occur when the sources are difficult to discriminate, meaning that each source has similar qualities and mnemonic features associated with it. It has also been recently argued that source errors may also occur because participants' metamnemonic knowledge is incomplete or incorrect (Lane, Roussel, et al. 2007; Starns et al., 2007). In such a situation, a participant may believe that a given feature helps discriminate between memories from different sources, when in fact it does not.

Knowledge Updating

Dunlosky and Hertzog (2000) have recently offered the knowledge updating framework to explain how people learn from experience to update their metamnemonic knowledge. To date, they have focused mostly on how people learn to adopt new and better strategies for learning as a function of experience with study-test trials (Dunlosky & Hertzog, 2000; Hertzog & Dunlosky, 2004).This framework has much in common with the previously mentioned source monitoring framework (Johnson et. al, 1993) in that both have criteria that must be met in order to either, correctly judge a source (source monitoring framework) or effectively update metamnemonic knowledge (knowledge updating framework). The following section will compare the main assumptions of the knowledge updating framework to the source monitoring framework.

Starting with the knowledge updating framework, Dunlosky and Hertzog, 2000, maintain that one must learn four major things to update their knowledge successfully (i.e., in ways that improve performance). First, mnemonic features must be differentially effective (effectiveness criterion). This is similar to the source monitoring framework's assertion that source monitoring accuracy will increase as the characteristics of memories, particular to source, diverge. The second requirement in the knowledge updating framework is that one must monitor their memories for these features. In other words, participants must notice that variations in internal mnemonic cues are associated with items of different types (Koriat, 1997). Again, the source monitoring framework argues that judgments concerning source are also made on the basis of these variations in memory characteristics. Third, one must use this information to modify their ideas about which features are the most discriminative (updating metamnemonic knowledge). The fourth and final assumption is that all information provided from the first three assumptions must be utilized in order to modify behavior and improve performance. Deviating from this last assumption, the source monitoring framework specifies two processes by which one can determine source. The first, a systematic process, is similar to this last assumption of the knowledge updating framework; with this process one must have and utilize all available information regarding the source decision. This process is said to be more deliberate and involve strategic processing. The second, a heuristically based process, is made relatively automatically and relies on the qualitative features of relevant memories.

Although the knowledge updating framework was originally developed to explain how people learn to change their encoding strategies and the source monitoring framework developed to explain how one judges source, they can both be modified to explain how people might learn from feedback at test in ways that improve subsequent performance. As argued above, participants come to the memory test with a set of assumptions about the memory task that may be based on their memory of the encoding phase, from test instructions, or from knowledge of previous memory tasks (e.g., Lane, Roussel et al., 2007). After being presented with a test item, participants first retrieve mnemonic features associated with this item (i.e. relevant characteristics of activated memory). Subsequently, they have to evaluate these features and set a criterion by which they make their judgment. During the training phase in feedback research, participants then receive feedback about their judgment (i.e., the correct source). If the previous answer is incorrect, participants must first reflect on his or her previous answer, noting the type and amount of features present for that item. Then they would have to link this information to the correct item source and the existing strategies or criteria they are currently using to make their judgments. For example, in the case of someone deciding whether an item was previously presented as a picture or was imagined, they might call an item a picture if they can clearly recall what the picture looked like. Participants could also react to receiving feedback by changing what they use to cue memory (retrieval orientation; Herron & Rugg, 2003; Rugg & Wilding, 2000) or adjusting the weights assigned to different features in decision criteria (Johnson, et al., 1993). Ultimately, successful updating involves using more discriminative features in subsequent source monitoring judgments.

Viewed through the lens of both the source monitoring framework and the knowledge updating framework, learning from feedback at the time of test would appear to rely on relatively deliberate, resource-consuming, systematic processes (Johnson, et al., 1993). Thus, one potential factor that might influence feedback use concerns individual differences in working memory.

Working Memory

Working memory (WM) is conceptualized as temporary storage for information that is being attended to or being manipulated by an executive attentional control component (Baddeley, 2007; Cowan, 2005; Engle et al., 1999). Working memory is critical for a number of different cognitive activities such as language comprehension or arithmetic (Cowan, 2005). Depending on the model, working memory has been conceptualized as modular, such as in Baddeley and Hitch's multicomponent model (Baddeley, 2007), or as an embedded system with differing levels of activation (Cowan, 2005). Despite these differences in models, most researchers agree that working memory is limited in its capacity to store information, although the exact limit is still debated. Owing to this limited capacity, the executive attentional control component or focus of attention is crucial in a number of activities such as inhibiting distracters, maintaining task goals, and processing new information (Unsworth & Engle, 2005). It is the capacity of this executive attentional component that is purportedly measured in working memory capacity span tasks (Unsworth, et al. 2005).

It has been argued that individual differences in working memory capacity (WMC) are associated with differences in the ability to search for and reactivate information from long-term memory (e.g., Unsworth & Engle, 2007). Although most of the research supporting this claim has come from studies using multiple study-test trials and short delays (e.g., 30 seconds), there is recent evidence that memory accuracy for longer-term memories is affected by WMC (Lane, Elliott, Shelton, Roussel, Groft & Karam, 2008). Participants in that study saw pictures and formed images of objects. Forty-eight hours later, participants were asked to recall only the pictures they had seen and subsequently completed a source recognition test for all the items. Results revealed that high WMC participants' source recall and source recognition was significantly more accurate than low WMC participants.

Current Study

The goal of the following study was to gain a more comprehensive understanding of the mechanisms underlying learning from test feedback. To that end, we examined working memory capacity (WMC) and its effects on an individual's ability to use feedback. Specifically, does feedback vary in its efficacy depending on one's working memory capacity? High and low WMC participants (identified from a previous screening) were invited to participate. All participants were shown a short video of a burglary and chase scene (Zaragoza et. al, 1994). Following the film, participants completed a post-test questionnaire over material taken from the video. Unbeknownst to participants, some information in this questionnaire did not occur in the video; instead it was only "suggested" to have occurred. Participants completed a 10 minute filler task then a two-part source monitoring test. Each part of the test consisted of 16 statements where they were asked to indicate whether this statement occurred in the video, questionnaire, both the video and questionnaire, or neither. In the first section, the training phase, half of the participants received feedback concerning the accuracy of their source decision. The remaining participants received no additional information. During the second section, the assessment phase, no participants receive feedback concerning the accuracy of their source decisions for a new set of 16 statements. Thus, the assessment phase is used to evaluate whether participants have improved the accuracy of their source decisions as a function of receiving feedback.

Although not the focus of this study, it is first predicted that high WMC participants will have better source monitoring performance than low WMC participants, based on the research discussed previously (Lane, et al., 2008). In the context of the current study, the specific prediction is that high WMC participants should be less likely to claim to have seen suggested items in the video than low WMC participants, regardless of whether they receive feedback.

The question of greatest interest is the effect of WMC on the ability to utilize feedback. The knowledge updating framework would appear to suggest that learning from feedback at test should be particularly demanding of executive resources. If this is correct, this would predict that high WM participants will benefit more from feedback than low WM participants. In other words, because learning from feedback is cognitively demanding, those with additional attentional resources should be better able to take advantage of it. For high WMC participants, this would be seen as a greater difference between the control condition and feedback condition, compared to low WMC participants.

Although the knowledge updating framework appears to predict that learning from feedback is resource-demanding, there are alternative predictions that can be made. For instance, given the previous research described above that found that high WMC participants were more accurate at source monitoring than low WMC (Lane, et al., 2008), it is possible that feedback is less effective for high WMC participants. This is because high WMC participants may already know which features are most discriminative of source (i.e., they are well-calibrated), and thus may not benefit from the feedback as much as low WMC participants whose metamnemonic knowledge may be initially less accurate. Finally, there is some data in the feedback literature that suggests that people may benefit from feedback even without being aware of its influence on their performance. For example, Han and Dobbins (2008) found that feedback during a recognition test could influence participants' criterion even when they were unaware that the feedback was biased (i.e., systematically incorrect). In addition, Lane, Roussel et al. (2007) found that many participants claimed on a post-experiment questionnaire that the feedback was not helpful, despite the clear effects of feedback. Both of these findings suggest that learning from feedback may not tax executive resources. In the context of this study, this would predict that high and low WMC participants would profit similarly from feedback.

MATERIALS AND METHODS

Participants

A total of 70 Louisiana State University undergraduates participated for course credit. Prior to this experiment, each participant completed three working memory span tasks, which included the operation span, the symmetry span, and the reading span (Unsworth , 2007). Scores for each span task were converted into z-scores, and then averaged for each participant. To take part in this study, a participant's average z-score must have been either one standard deviation above or below the mean. Those participants who scored below one standard deviation will be referred to as participants with low working memory capacity (WMC). The remaining participants, those with an average z-score of above one standard deviation, will be referred to as participants with high working memory capacity (WMC). See **Table 1** for descriptive statistics concerning the WMC tasks. Participants were randomly assigned to either the control condition or the feedback condition, with the provision that there were equal numbers of participants with high and low WMC. There were 19 participants with low WMC in the control condition and 19 in the feedback condition. For participants with high WMC, 17 were in the control condition and 15 assigned to the feedback condition.

Materials

The materials used in this study were identical to those used in Lane, Roussel, et al. (2007). These materials included an eyewitness event, a post-test questionnaire, and a two-part source test. The eyewitness event was a video depicting of a home robbery and chase scene, lasting approximately seven minutes (see Zaragoza & Mitchell, 1996).

The thirty-two item post-event questionnaire required participants to make a forced choice judgment on material from the video. Unbeknownst to the participants, information that was not in the video was embedded into select questionnaire items; these items will now be referred to as critical items.

Table 1

Descriptive Statistics for Working Memory Span Tasks.

Working memory span Task		Condition: No FB Low	No FB High	FB Low	FB High
Operation Span	Mean	40.47	72.06	35.58	71.93
	Standard Deviation	13.24	2.28	13.48	2.89
	Minimum	18	68	52	65
	Maximum	64	75	12	75
Symmetry Span	Mean	20.74	38.82	21.00	38.33
	Standard Deviation	6.07	2.65	7.10	2.47
	Minimum	9	34	7	34
	Maximum	29	42	32	42
Reading Span	Mean	31.47	71.59	30.26	71.33
	Standard Deviation	12.07	2.29	12.75	3.94
	Minimum	7	67	11	62
	Maximum	52	75	51	75
Z-score Average		-1.70	1.19	-1.87	1.16

Notes. Data presented in this table gives the mean, standard deviation, minimum and maximum score for each working memory span task. Participants were invited to participate in the current study if their average z-score was either one standard deviation above or below the mean.

This "suggested" information was presupposed in the question rather than being its focus (see example at end of paragraph). Additionally, the suggested information was either presented once (suggested once) or three separate times (suggested thrice).A total of twelve critical items were used across the experiment. This experiment included three counterbalanced versions of the post-test questionnaire. In each version, four critical items were suggested once, four were suggested thrice, and the other four were not presented in the questionnaire (i.e., they served as control items for the source test). Across the experiment, all critical items were suggested once, suggested thrice, and served as control items equally often. The following is an example of a suggested statement (underlined statement) imbedded within a critical item: "Before leaving the house <u>the thief checked the gun at his waist</u> and looked both ways to see if anyone was watching. After he got out the door, did he begin to run?"

The source test was comprised of thirty-two statements; sixteen presented in the first phase (i.e., training phase) and sixteen presented in the second phase (i.e., assessment phase). Over the course of the experiment, all thirty-two statements were presented to both conditions and occurred in the training and assessment phases equally often. Each statement originated from one of four sources including information found only in the video, information exclusively from the post-test questionnaire, information from both the video and questionnaire, and information that was never presented. In both phases of the source test, there were four statements belonging to each source (i.e. "video only", "questions only", "both" and "neither"). For the "questions only" source two statements were always suggested once, and the other two always suggested thrice. Two statements from the "neither" source were control items and served as suggested items in other versions of the post-test questionnaire. For the feedback condition, the training phase also included a display of the correct source (approximately two seconds) appearing after each source decision. Following the assessment phase participants completed a short questionnaire. The items in the questionnaire addressed issues concerning the amount of effort expended during the task, confidence ratings for the items and other demographic questions (e.g. age, gender, etc.). For the feedback condition, several additional questions asked participants about their feedback usage. Specifically participants were asked whether they used the feedback, how much effort was put into using the feedback, and how helpful the feedback was.

Procedure

The experiment was administered to no more than five individuals within one session. Participants first watched the eyewitness event, and were then given the post-test questionnaire. They were told that due to the large amount of detail in the film there might be multiple questions for any given scene. After these instructions, participants completed the questionnaire at their own pace. Upon completion, a 10-minute filler task was administered asking participants to complete a number of puzzles.

After the 10 minutes had elapsed, participants proceeded to the first section of the source test, or training phase. To increase motivation, two fifty dollar awards were offered to the two people with the best performance. At this point participants in both conditions were given instructions concerning the format of the source test. They were told that sixteen statements would appear on the screen, one at a time (e.g., "the thief stole a ring"). Furthermore, some of these statements had occurred only in the video, some only in the questionnaire, some in both and some were never presented. Their task for this test was to indicate the original source for each of these statements ("video only", "questions only", "both" and "neither"). They made their decision by pressing the appropriate key on the keyboard (labeled stickers identified these designated keys). The control condition completed the first section of the source test with no additional instruction. In contrast, participants in the feedback condition were told that immediately following their judgments the correct source of the statement would be presented both visually and auditorally. They were instructed to use this feedback with the aim of improving their performance over the course of the test. After completing the training phase, participants were asked to complete the second section of the source test, or the assessment phase. Similar to the training phase, the assessment phase displayed another set of sixteen statements. For the control condition, the assessment phase was identical to the training phase, in that they were again presented with statements and told to make their source judgment. For the feedback condition, this phase was the same as the previous phase with the exception that they were not given any feedback as to the accuracy of their source judgments. After completing the source test participants were asked a few demographic questions and debriefed.

RESULTS

The current study addresses the question of how individual differences in working memory capacity (WMC) affect the efficacy of feedback use during a source monitoring task. In order to address this question, the primary analyses examined the between-subjects factors of feedback and WMC, and the within-subject factor of repetition (suggested once vs. suggested thrice) in 2X2X2 ANOVA. The first factor, feedback, was provided during the training phase (Part 1) of the source test. Half of the participants received this feedback so that comparisons could be made between the conditions. Analyses will focus on the assessment phase in order to examine the changes in metamnemonic knowledge due to feedback. The second factor, individual differences in WMC, was collected prior to this study. These participants completed three working memory measures and were identified as having either low or high WMC. The third factor, repetition, concerned how many times participants saw a suggested item in the post-event questionnaire. This factor was not of primary interest in the study. In each of the analyses below, there was a significant main effect of repetition with participants making more errors to thrice-suggested items than once-suggested. However, the effect did not interact with feedback or WMC, and for that reason, the specific analyses are not reported below.

The primary dependent measure, source error rates, was examined in both training and assessment phases. Specifically, our analyses focused on suggested information falsely attributed to the eyewitness event (critical items attributed to either the video or both the video and questionnaire). In previous work, it has been found that feedback helps to reduce these source errors. Here we examine how individual differences in WMC affect both the tendency for one to make these errors and the efficacy with which feedback is used to improve source accuracy.

Source Memory – Training Phase (Part 1)

Even though our primary interest is in the source errors rates of the assessment phase (Part 2), we first report our findings for the training phase (Part 1). We analyzed source errors for suggested items in a 2X2X2 mixed model ANOVA; suggested once and thrice items served as the within-subjects factor, individual differences in WMC and feedback condition were the between-subjects factors. Most importantly, there was no significant effect of feedback (*M* = .45, *M* = .37 for feedback and the control conditions respectively, F (1, 66) = 1.1, *MSE* = .12, p = .30, η_p^2 = .02, collapsed across WMC), WMC (*M* = .45, *M* = .37, for low WMC and high WMC participants in that order; F (1,66) = 1.1, *MSE* = .12, p = .30, η_p^2 = .02, collapsed across feedback condition) or an interaction between the two, F (1, 66) = .4, *MSE* = .21, p = .53, η_p^2 = .01. Thus, neither high nor low WMC participants benefited from feedback given during the training phase. Next, we examined source accuracy for the video materials. A trend was found that showed individuals with high WMC were more accurate compared to their low WMC counterparts for the video material (*M* = .84, *M* = .70 , high WMC and low WMC respectively; F (1, 66) = 2.6, *MSE* = .05, p = .11, η_p^2 = .04, collapsed across feedback condition). For the feedback conditions we found a pattern similar to the critical item source errors; again participants who didn't receive feedback were slightly more accurate (*M* = .80) in comparison to those who did receive feedback (*M* = .78), F (1, 66) = .240, *MSE* = .05, p = .6, η_p^2 = .004.

Taken as a whole, the training phase showed small differences between the two conditions, with the control condition making slightly fewer source errors to critical items and video materials. Furthermore, high WMC participants were slightly more accurate for both the critical items and video items. Additionally, there was no interaction between WMC and feedback for the video materials (F (1, 66) = 0, *MSE* = .06, p = 1, η_p^2 = 0)

Source Memory Assessment Phase (Part 2)

The results of interest for this study concern the performance on the assessment phase, specifically performance on the critical items (for all unconditionalized data see **Table 2**). All further analyses will address this subsection of the study. To review our prior hypotheses, individuals with high WMC should be able to more effectively use feedback compared to low WMC participants.

Table 2

Unconditionalized Responses on Assessment Phase of Source Test as a Function of Feedback Condition and WMC.

		Condition			
Item Type	Response	No FB Low	No FB High	FB Low	FB High
Video	Video Only	.82 (.05)	.84 (.06)	.84 (.04)	.88 (.07)
	Questions Only	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
	Both	.09 (.03)	.06 (.03)	.03 (.02)	.07 (.04)
	Neither	.09 (.03)	.10 (.04)	.13 (.04)	.05 (.04)
Suggested X 1	Video Only	.05 (.04)	.06 (.04)	.08 (.04)	.00 (.00)
	Questions Only	.34 (.09)	.50 (.10)	.42 (.09)	.53 (.09)
	Both	.34 (.10)	.15 (.06)	.11 (.05)	.10 (.05)
	Neither	.26 (.07)	.29 (.07)	.39 (.09)	.37 (.09)
Suggested X 3	Video Only	.05 (.04)	.06 (.04)	.03 (.03)	.07 (.05)
	Questions Only	.34 (.09)	.41 (.09)	.47 (.09)	.63 (.09)
	Both	.55 (.11)	.35 (.09)	.32 (.08)	.20 (.08)
	Neither	.05 (.04)	.18 (.06)	.18 (.07)	.10 (.05)
Control	Video Only	.08 (.06)	.12 (.05)	.11 (.05)	.13 (.06)
	Questions Only	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
	Both	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
	Neither	.92 (.06)	.88 (.05)	.89 (.05)	.87 (.06)

Note. Standard errors in parentheses.

This would be reflected in an interaction between working memory and the feedback condition. This would be seen as a greater reduction in errors for the high span participants who received feedback, compared to the amount of decrease in errors for low WMC participants when feedback is given. In brief, the difference between the source errors for the feedback and the control conditions should be larger for participants with high WMC than low WMC. On the other hand, participants with high WMC may already have metamnemonic knowledge that accurately reflects the task's constraints. If this were the case, we would not expect the addition of feedback to show a large reduction in errors. Conversely, participants with low WMC, who may have inaccurate metamnemonic knowledge, may show a larger reduction in errors with the inclusion of feedback. If this is the case, the error reduction difference between the control and feedback conditions for participants with low WMC will be larger in comparison to high WMC participants. Finally, a third possibility might show that both high and low WMC participants benefit similarly because strategic processing is not needed in order to benefit from feedback.

To investigate these hypotheses, we conducted analyses similar to those of the training phase. First, we analyzed error rates in a 2X2X2 mixed model ANOVA. Again, the within subjects factor was the number of presentations (suggested once and suggested thrice) and the between-subjects factors were WMC and feedback. Consistent with prior work, we found a main effect of feedback, F (1, 66) = 6.5, MSE = .09, p = .01, η_p^2 = .09, collapsed across WMC, where participants who received feedback in the training session made significantly fewer source errors to critical items (M = .22) compared with the control condition (M = .40). Moreover, we found a near significant main effect of WMC, F (1, 66) = 3.6, MSE = .09, p = .06, η_p^2 = .05, collapsed across feedback condition: with low WMC participants committing more source errors (M = .38) than high WMC participants (M = .25).

At this point, we have demonstrated that both of our manipulations have had their prescribed effects; feedback resulted in a decrement of source errors and high WMC participants made fewer critical item source errors compared to low WMC. What is crucial for our prior hypotheses is whether an interaction exists and, if so, what direction did it take. With that said, we found no interaction between feedback condition and WMC, F (1, 66) = .6, MSE = .11, p = .44, η_p^2 = .01. To insure that this finding was not due to low statistical power, a power analysis was conducted. With the partial eta squared equaling .01, one degree of freedom and two groups, an estimated sample size of 1,433 participants would be needed to achieve significance. This finding is in line with our third hypothesis, which suggested that high and low WMC participants would benefit similarly from the inclusion of feedback. This speculation was hypothesized due to prior work, which advocated that the use of feedback might be largely implicit (Han & Dobbins, 2008).

Conditionalized Source Responses

To see conditionalized source response means for critical items and video only items see **Table 3.** To obtain a purer measure of the impact WMC and feedback have on source monitoring, conditionalized accuracy rates were calculated. Unlike unconditionalzed accuracy rates, which include aspects of both source monitoring and old/new recognition, these computations focus exclusively on items recognized as previously studied. In other words, these computations are the proportion of correct source attributions when the item was recognized as old. Similar to our previous analyses, we conducted a 2X2X2 ANOVA, this time with conditionalized accuracy rates for suggested once and thrice items as the within-subjects factor and, again, feedback and WMC as the between-subjects factors. As before, we found a significant main effect of feedback, F (1, 57) = 5.67, MSE = .13, p = .021, η_p^2 = .09, with the feedback condition (M = .75) significantly more accurate then the control condition (M= .53) for critical items.

Unlike the previous analysis, there is only a trend towards high WMC participants being more accurate than low WMC participants (M =.59, M=.69, for low WMC and high WMC participants respectively; F (1, 57) = 1.16, MSE = .13, p = .29, η_p^2 = .02).

Table 3

Conditionalized Responses on Assessment Phase of Source Test.

		Condition			
Item Type	Response	No FB Low	No FB High	FB Low	FB High
Suggested X 1	Accurate Attribution	.53 (.12)	.66 (.11)	.77 (.11)	.85 (.09)
	Misattribution Error	.47 (.12)	.34 (.11)	.23 (.11)	.15 (.09)
Suggested X 3	Accurate Attribution	.39 (.11)	.53 (.11)	.56 (.10)	.70 (.09)
	Misattribution Error	.61 (.11)	.47 (.11)	.44 (.10)	.30 (.09)
Video	Accurate Attribution	.89 (.04)	.91 (.06)	.97 (.02)	.90 (.07)
	Misattribution Error	.11 (.04)	.09 (.06)	.03 (.02)	.10 (.07)

Notes. Standard errors in parenthesis. Data presented in this table represents the proportion of items recognized and attributed to a source. For both the suggested X 1 and suggested X3 items the accurate attribution is questions only, the misattribution error is either a response of video only or a response of both video and questions. For the video items, the accurate attribution is video only the misattribution error is either the response of questions only or attributing it to both sources. Low and high labels indicate the WMC measured in a previous experiment.

Although, these results are not significant it is possible that they are due to the small sample size and the nature of the calculation (i.e. participants must attribute a source to one of the two critical items in order to be included in the analyses). Specifically, a total of nine participants could not be included because they did not attribute at least one suggested item (once or thrice) to an experimental source (i.e., video, questions, or both).

Misinformation Effect

In order to look more closely at the impact of the suggested information in the critical items, misinformation effects were calculated for all participants. These calculations take the source errors made on critical items (responses of video only or both) and then subtract the video and both responses on control items. This allows one to observe participants suggestibility correcting for biases they may have to one or both of these sources. The pattern of data found here is very similar to that found in our previous analyses of the assessment phase. Again, we found a main effect of feedback condition with those who received feedback having a significantly smaller misinformation effect (*M* = .10, *M* = .31, feedback and the control conditions respectively; *F* (1, 66) = 4.5, *MSE* = .16, *p* = .04, η_p^2 = .06, collapsed across WMC). Also, as previously shown, we find a marginally significant main effect of WMC, with low WMC participants having a larger misinformation effect size (*M* = .29) compared to high WMC participants (*M* = .12), *F* (1, 66) = 3.1, *MSE* = .16, *p* = .08, η_p^2 = .05, collapsed across feedback condition. And, as seen before, there was no significant interaction between WMC and feedback, *F* (1, 66) = .4, *MSE* = .16, *p* = .5, η_p^2 = .01.

Post-experiment Questionnaire

Participants in the feedback conditions were asked a number of questions about their use of feedback during the test. Answers to these questions were correlated with source monitoring performance on suggested items in the assessment phase of the test.

Additionally, several items in the post-source test questionnaire discussed participant's use of feedback. Because the pattern of correlations was similar for low and high WMC participants, I report the correlations collapsed across WMC conditions. The responses to the following questions were not significantly correlated with source errors during the assessment phase of the test: How challenging was it to use the feedback (r (14) =.16, p = .60), how helpful was the feedback (r (14) =-.21, p = .47), and how often did you use the feedback (r (20) =-.17, p = .46). However, there was a significantly positive correlation between participants' reported effort in using the feedback and source monitoring errors (r (14) = .75, p = .002). In other words, the more effort participants put into using feedback the more source errors they committed.

Together these findings support the suggestion that participants are largely unaware of how they are using feedback or whether it is beneficial. It is also possible, as suggested by the significantly positive correlation between effort and source errors, that participants who attempt to learn from the feedback in more effortful, deliberate manner may end up committing more source errors.

DISCUSSION

As expected from prior work (Lane, et al., 2007), feedback was effective in reducing source misattribution errors for suggested items. Also, as predicted, participants with high WMC produced fewer source errors than participants with low WMC (albeit marginally significant). Finally, there was no evidence that working memory capacity plays a major role in people's ability to improve memory accuracy through the use of feedback.

Our findings do not appear to support the view of feedback usage that is implied by the knowledge updating framework (Dunlosky & Hertzog, 2000). In this view, the process of monitoring, identifying, and updating knowledge appears to be quite demanding of executive resources. In source monitoring terms, this suggests the use of more deliberate systematic processes (Johnson, et al., 1993). Yet, both high and low WMC participants seemed to use feedback to the same benefit. It is important to keep in mind that these working memory span tasks, used for classification of the participants, were developed to measure the executive attentional control component of working memory (Unsworth, et al. 2005). Therefore, it can be inferred that individual differences in this component do not affect feedback usage.

Our findings also contrast with an alternative prediction based on the premise that high WMC participants already have accurate knowledge of task constraints (metamnemonic knowledge) and thus should benefit less, if at all, from feedback relative to low WMC participants. Instead, our results suggest much room for improvement among high WMC participants. For example, high WMC participants attributed, on average, 31% of the suggested items to the video without feedback and 18% of the suggested items with feedback. Thus, even high WMC participants may not detect the degree to which features can be optimally used to discriminate between sources.

The results are most consistent with the view that the processes used to learn from feedback at test are relatively implicit. In other words, participants clearly are aware of the feedback itself, but may be relatively unaware of how this feedback changes subsequent memory decisions. This view is consistent with recent research (Han et al., 2008) that suggests that feedback can have an effect without conscious awareness. In this study, participants were given an old/ new recognition test, which was divided into three blocks. Feedback was administered by informing the participants of the accuracy of their previous response. Unbeknownst to the participants, the feedback they received was systematically accurate or inaccurate. For example, during one block participants were given feedback encouraging a more liberal response (e.g., items that were new but called old elicited a correct feedback response). Then, for the following block, the bias changed; now the feedback encouraged a more conservative response (e.g. items that were old but called new received a correct feedback response). In this way, they manipulated the response criterion of their participants without their explicit knowledge. Although our results do not suggest a criterion shift, participants do seem to be largely unaware of using feedback.

This lack of awareness can also be seen from information obtained during the post-source test questionnaire used in the present study. Several questions addressed how feedback was used, how helpful it was, etc. With one exception, there was no significant correlation between the responses to these questions and overall source accuracy. In the one exception, we asked participants about the amount of effort they expended in trying to improve their performance using feedback (with zero signifying no effort, and nine indicating a lot of effort). We found a significantly positive correlation between source errors and effort, meaning that as reported effort increased so did the number of source errors to critical items. Although not definitive, it appears that participants may either be unaware of how they are using feedback or that trying to use feedback in a more deliberate manner could possibly be counter-productive.

In conclusion, the current experiment provides clear evidence that while participants with high WMC outperform participants with low WMC on critical items, both groups significantly benefit from the inclusion of feedback. Most importantly for our predictions, both groups are able to benefit to the same degree with the inclusion of feedback. This supports the idea that differences in WMC have little to no affect on the ability to successfully use feedback so as to reduce source errors. Future studies will need to more closely examine the potential implicit nature of feedback. An important next test to this theory will be to compare groups where the ability for participants to explicitly use feedback is disrupted and where participants are forced to explicitly use feedback. This may provide more evidence supporting the current findings of this study.

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Currently, Stephanie has presented five posters and two oral presentations for conferences, one of which she was first author. These posters and oral presentations were given at the following conferences: the 47th annual meeting of the Psychonomic Society, Houston, Texas, Munsterberg conference, John Jay School of Criminal Justice, New York, New York, American Psychology and Law Society conference, Jacksonville, Florida, the 48th annual meeting of the Psychonomic Society, Long Beach, California, American Psychology and Law Society conference, Jacksonville, Florida, American Psychology and Law Society conference, Jacksonville, Florida, and the 49th annual meeting of the Psychonomic Society, Chicago, Illinois. She is also working on several manuscripts for publication.