Individual Differences in Disqualifying Monitoring Underlie False Memories Across Different Paradigms

B. Hunter Ball¹, Matthew K. Robison¹, Allison Coulson², & Gene A. Brewer²

¹University of Texas at Arlington

²Arizona State University

Word Count: 7,355

Author Note:

Address correspondence to B. Hunter Ball, Department of Psychology, University of Texas at Arlington, Arlington, TX 76019. Email: Hunter.Ball@uta.edu

B. Hunter Ball and Matthew K. Robison, Department of Psychology, University of Texas at Arlington, 501 Nedderman Drive, Arlington TX, 76109.

Allison Coulson, and Gene A. Brewer, Department of Psychology, Arizona State University.

Data is available on OSF: https://osf.io/r94uy/?view_only=abcf6104284840368f4458ba9513b843

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

Abstract

The current study leveraged experimental and individual differences methodology to examine whether false memories across differing tasks arise from a common cause. Participants completed multiple false memory (DRM and memory conjunction), working memory (operation and reading span), and source monitoring (verbal and picture) tasks. Memory discriminability in the DRM and memory conjunction tasks loaded onto a single (general) factor and were unaffected by warnings provided at encoding. Consistent with previous research, source monitoring ability fully mediated the relation between working memory and false memories. Moreover, individuals with higher source monitoring ability were better able to recall contextual information from encoding to correctly reject lures. These results suggest that there are stable individual differences in false remembering across tasks. The commonality across tasks may be due, at least in part, to the ability to effectively use disqualifying monitoring processes.

Keywords: false memory; working memory; source monitoring; individual differences; rejection strategies

Individual Differences in Disqualifying Monitoring Underlie False Memories Across Different Paradigms

Examination of false memories provides insights into the processes that underlie the organization of memories, with important implications in legal (Loftus, 1975, 2019), clinical (Loftus and Pickerall, 1995; Pope, 1996), and interpersonal contexts (Brashier & Schacter, 2020; Meade & Roediger, 2002). For example, memory errors associated with eyewitness misidentifications are the leading cause of wrongful convictions that have been later overturned by DNA evidence (West & Meterro, 2015). While the ubiquity of false memory research has undoubtedly contributed to the understanding of the principles underlying memory retrieval, the variety of false memory paradigms has made it more difficult to determine whether similar memory monitoring mechanisms operate across different contexts. The purpose of the current paper is to leverage experimental and individual differences methodology to determine which cognitive processes underlie false memory and the extent to which these processes operate across seemingly different paradigms.

Two widely used methods to examine false memories are the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) and the memory conjunction (MC) paradigm (Lampinen, Odegard, & Neuschatz, 2004; Odegard & Lampinen, 2005). The typical DRM finding in recognition memory is that after studying a list of associatively or semantically related words (e.g., *bed*, *rest*, *tired*), people erroneously claim that a non-presented critical lure (e.g., *sleep*) was originally studied. The general finding in the MC paradigm is that after studying a set of compound words (e.g., *nosebleed*, *skydive*), people often erroneously claim that a non-presented critical lure composed of features of previously presented items (e.g., *nosedive*) was originally studied. The primary difference between these paradigms is

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

that DRM errors primarily arise through semantic (or associative) similarities between studied items and lures, whereas MC errors arise via phonological (or perceptual) similarities (Matzen & Benjamin, 2009; Matzen, Taylor, & Benjamin, 2011; Odegard, et al., 2005). In both instances, however, it is thought that the high degree of overlap between studied items (e.g., *bed*; *nosebleed*) and critical lures (e.g., *sleep*; *nosedive*) causes participants to mistake lure items as having previously been experienced. The question is whether general monitoring mechanism underlies false remembering across these different tasks.

Dual-process theories of memory posit that recognition memory occurs via either automatic (familiarity) or controlled (recollection) processes (Jones & Jacoby, 2001). False memory paradigms are successful in eliciting memory errors because the similarity between lures and previously studied items often invokes a feeling of lure familiarity in the absence of recollection. This idea is central to two of the more prominent theories of false remembering. Activation-monitoring theory suggests studying a list of related items implicitly activates the critical lure via automatic spreading activation during encoding (Anderson, 1983; Collins, & Loftus, 1975; Gallo & Roediger, 2002; Gallo, 2006; Roediger & McDermott, 1995), whereas the fuzzy trace theory argues that participants extract the overall theme, or gist, of the study lists (Brainerd & Reyna, 2001, 2004; Brainerd, Wright, Reyna, & Mojardin, 2001). At test the activated lure, or gist trace, produces a strong feeling of familiarity. To reject these lures, participants must decide whether the item was previously seen (e.g., *bed*; *nosebleed*), it was merely imagined (e.g., *sleep*), or it contains some but not all elements from study (e.g., *nosedive*; Johnson, Lindsay, and Hashtroudi, 1994). Both theories argue that errors occur when recollective retrieval processes fail at test. Although the exact retrieval mechanisms slightly differ across

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

theories (source monitoring vs. recollection rejection), for the purposes of the current study we will use the term “monitoring” to describe the lure rejection process.

Gallo describes two different ways in which monitoring can be implemented to reduce false memories (Gallo 2004; Gallo 2006; Gallo 2010). *Disqualifying monitoring* is a rule-based strategy in which retrieval of contextual information from study disqualifies a familiar lure as having been previously encountered (Jacoby, 1991; Hintzman & Curran, 1994), whereas *diagnostic monitoring* is a heuristic-based strategy where the quality of the retrieved details is compared to an otherwise expected amount (Johnson et al., 1993; Mitchell & Johnson, 2000, 2009, 2015). For example, using a disqualifying monitoring strategy a lure may be rejected by recalling specific items from study (“I remember seeing skydive, so I could not have seen nosedive”). In contrast, using a diagnostic monitoring strategy a lure may be rejected based on an inference that the item would have been remembered if actually studied (“I would have remembered seeing nosedive because I recently flew in a plane that had a rough landing”). While both are considered a type of recollective monitoring, they differ in the *type* of retrieved information used to reject items.

Research in the DRM paradigm supports the idea that both types of monitoring can operate to reduce errors. For example, warning participants of the illusion prior to encoding and presenting lures in a to-be-excluded list increases diagnostic monitoring (Gallo, Bell, Beier, & Schacter, 2006; Neuschatz, Benoit, & Payne, 2003). Presumably these manipulations help in identifying the theme during encoding (e.g., *sleep*), which subsequently allow participants to disqualify it as having been presented. Additionally, being able to recall all items from the studied list (e.g., *bed, rest, tired*, etc.) can disqualify the lure (Gallo, 2004). Alternatively, manipulations that increase the distinctiveness of studied items (e.g., pictures versus words) increases

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

diagnostic monitoring by allowing participants to reject lures that do not have distinctive representations (Arndt & Reder, 2003; Benjamin, 2001; Hege and Dodson, 2004; Smith & Hunt, 1998). Research in the MC paradigm has largely focused on disqualifying monitoring. Several studies have assessed phenomenological reports at retrieval, finding that following rejection of compound lures (e.g., *nosedive*) participants often report being able to recall related words from study (e.g., *nosebleed*; *skydive*; Arndt & Jones, 2008; Odegard, Lampinen, & Toglia, 2005; Leding & Lampinen, 2009). Warnings at retrieval also cause participants to more carefully monitor memory for the studied associates (Lampinen, Odegard, & Neuschatz, 2004). Note that this is slightly different from the DRM paradigm in which warnings primarily only reduce errors when given at encoding (Gallo, Roberts, & Seamon, 1997; Gallo, Roediger, & McDermott, 2001; McDermott & Roediger, 1999). It has also been shown that distinctive processing at encoding reduces false alarms (Arndt & Jones, 2008; Lloyd, 2007). However, differing from the DRM paradigm, this appears to be driven by decreased familiarity for lures rather than increased diagnostic monitoring (Lloyd, 2013). Together these findings highlight monitoring as an important construct, although what information is used to reject lures may differ across paradigm types.

Generality of Monitoring

A central question for theory development is whether a common memory monitoring mechanism operates across different false memory tasks (Gallo, 2010). One way to address this issue is to assess individual differences in performance across multiple false memory paradigms. Assuming there is a common mechanism (e.g., monitoring), individuals with the propensity to false alarm on one type of task (e.g., DRM) should have higher false alarm rates on another task (e.g., MC). Generally consistent with this idea, prior research has shown that DRM errors are

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

positively correlated with false memories for words and pictures (Lovden, 2003; Unsworth & Brewer, 2010), autobiographical memories (e.g., Platt, Lacey, Iobst, & Finkleman, 1998; Meyersburg, Bogdan, Gallo, & McNally, 2009), and misinformation (Zhu, Chen, Loftus, Lin, & Dong, 2013). However, other studies have not always found these associations (Patihis, Frenda, & Loftus, 2018; Ost et al., 2013; Monds, Paterson, & Kempt, 2017; Salthouse & Siedleck, 2007; Wilkinson & Hyman, 1998). The inconsistencies across studies could indicate that a) there is no general monitoring mechanism, b) there is a common mechanism that operates differently across paradigms (e.g., diagnostic versus disqualifying monitoring), or c) there is a common monitoring mechanism, but it not a stable individual differences factor (Patihis et al., 2018; but see Unsworth & Brewer, 2010). Notably, many of these studies used only a single indicator of false memory across different paradigms. As described later, this is not ideal in the context of individual differences because any observed effects (or lack thereof) may simply be an artifact of shared method variance or measurement error.

Another approach to examining the generality of monitoring processes is to examine whether cognitive ability (e.g., monitoring) is related to individual differences in false remembering. One cognitive ability measure commonly assessed in false memory studies is working memory. Working memory refers to the attention processes involved in active maintenance of task-relevant information in the face of distraction (Kane & Engle, 2003) and the memory processes associated with the retrieval of information from long-term memory that has been momentarily displaced from focal awareness (Unsworth & Engle, 2007). Research has shown that individuals with higher working memory capacity show fewer errors in the DRM paradigm (Holden, Conway, Goodwin, 2020; McCabe & Smith, 2002; Lovden, 2003; Peters, Jellic, Verbeek, & Merckelbach, 2007; Unsworth & Brewer, 2010; Watson et al., 2005), MC

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

paradigm (Leding, 2012), misinformation paradigm (Jaschinski & Wentura, 2002; Parker, Garry, Engle, Harper, & Clifasefi, 2008; Zhu et al., 2010), and for missing events (Gerrie & Garry, 2007). The general interpretation of these findings is that that high working memory participants are better able to monitor retrieval in order to determine the source of a memory (e.g., “did I study this or merely imagine it”; but see Watson et al., 2005). While this interpretation is theoretically appealing, it is admittedly a relatively indirect way of assessing the mechanisms underlying false remembering.

Unsworth and Brewer (2010) more directly assessed the role of monitoring in DRM errors by assessing multiple measures of source memory in addition to working memory tasks. Additionally, they had participants perform the DRM task along with several standard delayed free recall and paired associate learning tasks. They found that errors in the DRM, free recall, and paired associates tasks loaded onto a single false memory factor. This means that if a participant had high errors on one task, they were more likely to have high errors on another. Critically, they also found that relation between working memory and false memory was fully mediated by source monitoring ability. That is, the reason high working memory individuals had fewer memory errors is because they were better able to monitor for the origin of a memory. This suggests that there may be a common memory monitoring mechanism across multiple tasks. It is not entirely clear, however, if the false memory reduction was due to better disqualifying or diagnostic monitoring for high ability participants.

A study by Leding (2012) partially addressed the issue of what type of monitoring high ability participants use. Participants performed an MC task with and without warnings and were to indicate what strategy they used to reject lures. It was found that high working memory participants showed fewer MC errors, regardless of whether or not they were warned of the

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

illusion at encoding. These results are consistent with the findings of Unsworth and Brewer (2010) indicating that high ability participants are better able to monitor retrieval. Critically, these individuals were also more likely to engage in disqualifying monitoring. That is, they were better able to retrieve the compound words from study to reject the lure at test. However, because diagnostic monitoring was not assessed in this study, it is not entirely clear whether high and low ability participants differ in the efficacy of disqualifying monitoring or if they rely on qualitatively different types of information (i.e., disqualifying versus diagnostic details) to reject lures.

Current Study

The purpose of the current study was to determine whether a general memory monitoring process might underlie false memory across tasks with seemingly disparate processing demands. Participants performed multiple false memory tasks (DRM and MC) with and without warnings at encoding, along with several working memory and source monitoring tasks. During the false memory tasks, participants also reported the strategies used to reject lures (e.g., diagnostic monitoring, disqualifying monitoring, or lacks familiarity). Using this methodology, we hoped to improve on several theoretical and methodological shortcomings of prior experiments. First, using multiple performance indicators allows for the use of latent variable modeling. This approach is useful because it controls for measurement error while testing different theoretical predictions of the relation between false memory, working memory, and source monitoring. Second, the inclusion of the source memory tasks allows for a more direct assessment of the role of monitoring in false memory. Third, assessing rejection strategies allows us to determine whether high and low ability participants use quantitatively or qualitatively different information to reduce false memories.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

Regarding the generality of a memory monitoring mechanism, previous research is mixed. While in some cases false memory on one task (e.g., DRM) is correlated with false memory on another task (e.g., misinformation; Lovden, 2003; Platt et al., 1998; Meyersburg et al., 2009; Unsworth & Brewer, 2010; Zhu et al., 2013), other times it is not (Patihis et al., 2018; Ost et al., 2013; Monds et al., 2017; Salthouse & Siedleck, 2007; Wilkinson & Hyman, 1998). We test the generality claim by comparing the fit of a theoretical model in which all false memory tasks load onto a common factor (general model) to a model in which the different task types load onto separate factors (task-specific model). We anticipated that the general model would provide a more adequate account of the data, suggesting that there may be a general memory monitoring mechanism that contributes to both tasks. Regarding individual differences in performance, prior research suggests that high working memory participants may be better able to monitor retrieval to determine the source of a memory (e.g., McCabe & Smith, 2002; Gerrie & Garry, 2007; Leding, 2012; Unsworth & Brewer, 2010). We explicitly tested this claim by assessing whether the relation between working memory and false memory would remain after controlling for source memory. We anticipated that source memory would fully mediate this relation (Unsworth & Brewer, 2010). Finally, regarding what type of monitoring is used by individuals of differing ability, there simply is not enough research on the topic to make any clear predictions (Leding, 2012). To address this concern, we assessed the relation between source monitoring and the different rejection strategies. We anticipated that high ability participants would more often use disqualifying monitoring, whereas low ability participants would rely more on diagnostic monitoring.

Method

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

All research reported herein was conducted using appropriate ethical guidelines and was approved by the Institutional Review Board at Arizona State University. We report how we determined our sample size, all data exclusions, and all manipulations.

Participants and Design

For the no warning and warning conditions, respectively, 247 and 205 undergraduate participants were recruited from the Arizona State University participant pool. These sample sizes were selected based on previous research using a similar methodology (Unsworth and Brewer, 2010) and recommendations that at least 150 participants are needed to obtain stable and reliable correlations (Schonbrodt & Perugini, 2013). Data were excluded from 6 participants that were identified as multivariate outliers using Mahalanobis distance estimates. The final dataset consisted of 245 and 201 participants, respectively, in the no warning and warning condition. All participants were native English speakers and received course credit for their participation. Participants were tested in group laboratory sessions (from 1 to 7 participants) lasting approximately 2 hours.

Cognitive Battery

Participants completed two versions of DRM, MC, working memory, and source memory tasks¹. The DRM and MC tasks were nearly identical across conditions, except that in the warning condition participants were warned prior to study about the presence of critical lures at test. The working memory and source monitoring tasks were identical across conditions. Learning was intentional in all tasks.

Working Memory Tasks

¹ As part of a larger battery for an unrelated purpose, participants also completed several measures of cued recall, free recall, and recognition memory.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

Operation span (Ospan). Participants solved a series of math operations while trying to remember a set of unrelated letters (F, H, J, K, L, N, P, Q, R, S, T, Y). Participants were required to solve a math operation, and after solving the operation they were presented with a letter for 1 s. Immediately after the letter was presented the next operation was presented. Three trials of each list-length (3-7) were presented, with the order of list-length varying randomly. At recall, letters from the current set were recalled in the correct order by clicking on the appropriate letters (see Unsworth, Heitz, Schrock, & Engle, 2005 for more details). Participants received three sets (of list-length two) of practice. For all of the span measures, items were scored if the item was correct and in the correct position. The score is the proportion of correct items in the correct position.

Reading span (Rspan). Participants were required to read sentences while trying to remember a set of unrelated letters (F, H, J, K, L, N, P, Q, R, S, T, Y). For this task, participants read a sentence and determined whether the sentence made sense or not (e.g., “The prosecutor’s dish was lost because it was not based on fact.”). Half of the sentences made sense while the other half did not. Nonsense sentences were made by simply changing one word (e.g., “dish” from “case”) from an otherwise normal sentence. Participants were required to read the sentence and to indicate whether it made sense or not. After participants gave their response, they were presented with a letter for 1 s. At recall, letters from the current set were recalled in the correct order by clicking on the appropriate letters. There were three trials of each list-length with list-length ranging from 3–7. The same scoring procedure as Ospan was used.

Source Monitoring Tasks

Gender Source Recognition (GSM). Participants heard words (30 total words) in either a male or a female voice. Participants were explicitly instructed to pay attention to both the word

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

as well as the voice the word was spoken in. At test participants were presented with 30 old and 30 new words and were required to indicate if the word was new or old and, if old, what voice it was spoken in via key press. Participants had 5 s to press the appropriate key to enter their response. A participant's score was the proportion of correct responses.

Picture Source Recognition (PSM). Participants were presented with a picture (30 total pictures) in one of four different quadrants on screen for 1 s. Participants were explicitly instructed to pay attention to both the picture as well as the quadrant it was located in. At test participants were presented with 30 old and 30 new pictures in the center of the screen. Participants indicated if the picture was new or old and, if old, what quadrant it was presented in via key press. Participants had 5 s to press the appropriate key to enter their response. A participant's score was the proportion of correct responses.

False Memory Task Materials

DRM Word (DRMw). Participants studied eight lists of 8 words for a total of 64 words. Each list was comprised of semantically associated words that were all related to a critical word. These lists were taken from Ball (2011) Experiment 2A with the eight critical words being city, smoke, soft, sweet, foot, mountain, thief, and river. At test, participants were shown a total of 80 selected words (40 old and 40 new items) in a random order (see also Thomas & Sommers, 2005). For the primary analyses, the old items consisted of 5 words (e.g., bed, rest, tired, etc.) from each of the 8 lures sets, and the new items consisted of 8 critical lures (e.g., sleep) and 8 unrelated new items (e.g., horse). The d' lure value was calculated as a function of hits and lure false alarms, whereas d' new value was calculated as a function of hits and unrelated new false alarms. To allow for the calculation of d' values when hit or false alarm rates equaled 0 or 1, the Hautas (1995) correction was used for signal detection analyses. There were also 24 other new words that were

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

not included in the analyses, which included 4 new theme words (e.g., fork) and 5 words associated with each of these themes (e.g., spoon, knife, etc.).

DRM Sentence (DRMs). Participants studied eight lists of 8 sentences for a total of 64 sentences. In each list, the associate was embedded as the last word of the sentence and all revolved around a lure theme (e.g., *sleep* lure: “After work he laid down in bed”; “She had a frightening dream”, etc.). The 8 critical lures related to the sentences were cup, trash, window, doctor, cold, chair, sleep, and needle from the convergent condition of Ball (2011) Experiment 2A. The test procedure was identical to that of the DRMw task.

MC Word (MCw). In this task, participants were presented with 48 semantically unrelated (e.g., ragtime, tumbleweed; snowman, football) one at a time in a random order. Two of the compound words were related to one of 24 sets of semantically unrelated MC lures (e.g., ragweed; snowball) at study. These stimuli were provided by Matzen & Benjamin (2009). At test, participants were presented with 48 total words (24 old and 24 new items) in a random order. For the primary analyses, the old items consisted of 24 compound words (e.g., ragtime; 12 parent one and 12 parent two items), and the new items consisted of 12 critical lures (e.g., snowball) and 12 unrelated new words (e.g., bookbag). The 12 critical lures came from the parent items not presented at test, meaning that there was no overlap between old and new items (i.e., both the compound word ragtime and the critical lure ragweed were not presented). The d' lure value was calculated as a function of hits and lure false alarms, whereas d' new value was calculated as a function of hits and unrelated new false alarms using the Hautus (1995) correction.

MC Sentence (MCs). In this task, participants were presented with 48 semantically unrelated sentences containing compound words (e.g., bandwagon, kickstand; catwalk, shellfish)

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

one at a time in a random order. Two of the sentences were associated with one of 24 sets of semantically unrelated MC lures (e.g., bandstand; catfish) at study. The associate was embedded as the last word of the sentence (e.g., *bandstand* lure: “After the team won the championship hundreds of new fans jumped on the bandwagon”; “The girl propped her new bicycle on its kickstand”). The test procedure was identical to that of the MCw task.

False Memory Task Procedure

For all four of the false memory tasks, during study participants were presented with one stimulus at a time and instructed to subjectively rate the meaning of the words on a scale of 1 – 7 (1 = very meaningless, 7 = very meaningful). This orienting task was based on previous methodology from our laboratory where these materials were used (Ball, 2011). They were told that their memory would later be tested for these words. At test, participants were presented with one stimulus at a time and asked to choose if it was “old” or “new”. If determined “old”, they had to further categorize it as (a) know it’s familiar (i.e., familiarity), (b) remember details (i.e., recollection), or (c) guess. If determined “new”, participants were instructed to classify it as either (a) lacks familiarity, (b) recalled study information to reject it (i.e., disqualifying monitoring), or (c) would have remembered (i.e., diagnostic monitoring). Participants were provided with clear examples on what each classification reflected and were instructed to choose the one that best fit their memory for the event. Test instructions introduced an approximately 2-minute delay between study and test.

The examples provided to participants for the different classifications of the rejection strategies were as follows. *Lacks familiarity*: “The word did not seem or feel familiar because it lacked familiarity, thus one believes that it was not studied. This is similar to telling Person X that you don't remember meeting him because he just ‘doesn't look familiar to you’ and that you

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

do not recognize him”. *Recall to reject*: “One may feel that they searched memory and recalled something about the study phase that lead them to believe the word was not studied. In this way, the test item can be rejected because one searches and may find similar items, but not the specific test item. For example, if the test word is ‘train’, you may search your memory of the study phase and remember that you studied “plane”. This leads you to believe that you did not study the similar word, ‘train’”. *Would have remembered*: “One thinks that the word is so distinctive that if it was studied, it would have been remembered, and because it is not remembered it must not have been studied. For example, if your first name appeared on the test you might judge it as new because you feel that it would have been so distinctive to you that if you did study it, you would have remembered it”.

The only difference between no warning and warning conditions was that in the former participants were told at encoding that their memory would be tested for the stimuli but were given no more information about the nature of the study or test materials. In the latter participants were additionally informed prior to study about the existence of critical lures. Following McCabe and Smith (2002), participants were given an example and then were instructed during study to try to identify the lures. They were also told that these lures would later appear on the test and they should avoid recognizing them. In the word and sentence DRM task participants were explicitly told that each list of eight trials (e.g., bed, rest, tired, etc.) was associated with one common word (e.g., sleep), and were instructed to try to determine what the common word was. In the word and sentence MC lure task participants were explicitly instructed that each of the study words (e.g., tumbleweed, ragtime) were compound words whose parts could be combined to form a conjunction word (e.g., ragweed), and were told to try to identify what the conjunction word was. Participants were warned prior to study that the DRM lures (e.g.,

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

sleep) and MC lures (e.g., ragweed) would be presented at test and that they should avoid calling them “old”.

Data Analysis

Matzen and Benjamin (2009) note that using standard false alarm rates to critical lures as a measure of false memory is only appropriate when participants adopt similar criterion across conditions. If criterion differs but memory is the comparable across conditions, then the more appropriate false memory measure is sensitivity between old and lure items. In the current study, because participants studied words and sentences in both DRM and MC tasks, we anticipated differences in both memory and criterion. In such instances, they argue that the most appropriate false memory measure is the difference ($\Delta d'$) between d' new (from hits and unrelated new false alarms) and d' lure (from hits and critical lures false alarms) measures ($\Delta d' = d' \text{ new} - d' \text{ lure}$). Thus, the primary measure for all analyses in the current study is the $\Delta d'$ value². A low value indicates that the participant tended to respond to lures and unrelated new items in a similar manner, whereas a high value indicates that the participant had difficulty in identifying lures as new and responded to them as if they were old items.

For the primary analyses, we use confirmatory factor analysis (CFA) to specify a theoretically derived model and compare this to the true variance-covariance matrix for the observed data (Kline, 2015). A chi-square test is used to determine how well the specified model reproduces the observed data, with a nonsignificant value indicating a good fit. We additionally report several other goodness-of-fit indices: root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), non-normed fit index (NNFI), and comparative fit index (CFI). The RMSEA and SRMR reflect the average squared deviation between the

² We also assessed discriminability of lure items from unrelated items, which is considered a measure of false memory while controlling for response bias. These analyses produced a similar pattern of results to the $\Delta d'$ analyses.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

observed and reproduced covariances, whereas the NNFI and CFI compare the fit of the specified model to a baseline null model. After identifying the best fitting theoretical model through a series of chi-square differences tests (notated as $\Delta \chi^2$ in the results section), we use latent variable structural equation model (SEM) to assess unique contributions of cognitive ability (i.e., working memory and source monitoring) in predicting false memories. Missing data was accounted for using maximum likelihood estimation.

Results

Descriptive statistics for overall hit and false alarm rates in the false memory tasks and overall memory performance in the working memory and source monitoring task can be found in Table 1. All measures had acceptable values of kurtosis (skew $< |3|$ and kurtosis $< |8|$; Kline, 2015). The primary dependent variable for all false memory tasks was $\Delta d'$ (see data analysis section in Method for details).

Table 1. *Descriptive Statistics and Reliability Estimates for all Measures.*

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

Condition	Task	DV	Mean	SD	Min	Max	Skew	Kurtosis	α
No Warning	DRMw	Hit	0.76	0.12	0.23	0.98	-1.29	1.87	0.81
		FA New	0.19	0.20	0.00	1.00	1.21	1.18	0.58
		FA Lure	0.56	0.21	0.13	1.00	-0.16	-0.58	0.45
	DRMs	Hit	0.70	0.12	0.40	0.95	-0.37	-0.01	0.67
		FA New	0.31	0.19	0.00	0.88	0.55	-0.07	0.53
		FA Lure	0.76	0.19	0.25	1.00	-0.67	-0.17	0.42
	MCw	Hit	0.89	0.11	0.42	1.00	-1.54	2.70	0.71
		FA New	0.13	0.16	0.00	0.92	2.06	5.15	0.73
		FA Lure	0.28	0.21	0.00	1.00	0.77	0.05	0.70
	MCs	Hit	0.74	0.15	0.25	1.00	-0.71	0.03	0.70
		FA New	0.21	0.22	0.00	1.00	1.18	0.98	0.78
		FA Lure	0.41	0.20	0.08	1.00	0.36	-0.28	0.58
	WM	SPANo	0.77	0.16	0.13	1.00	-1.07	1.22	0.98
		SPANr	0.66	0.21	0.01	1.00	-0.79	-0.03	0.98
	SM	SMg	0.53	0.16	0.12	0.92	0.01	-0.54	0.85
		SMp	0.65	0.22	0.03	0.98	-0.84	-0.09	0.95
Warning	DRMw	Hit	0.77	0.11	0.38	1.00	-1.19	1.80	0.76
		FA New	0.20	0.23	0.00	1.00	1.42	1.77	0.72
		FA Lure	0.55	0.23	0.00	1.00	-0.20	-0.64	0.57
	DRMs	Hit	0.70	0.13	0.25	0.95	-0.67	0.95	0.73
		FA New	0.31	0.19	0.00	1.00	0.89	0.87	0.53
		FA Lure	0.72	0.22	0.13	1.00	-0.56	-0.51	0.56
	MCw	Hit	0.87	0.12	0.17	1.00	-2.14	7.06	0.73
		FA New	0.13	0.17	0.00	1.00	2.06	4.88	0.78
		FA Lure	0.24	0.20	0.00	1.00	1.08	1.09	0.69
	MCs	Hit	0.76	0.15	0.00	1.00	-1.18	2.46	0.72
		FA New	0.20	0.21	0.00	0.83	1.17	0.67	0.77
		FA Lure	0.41	0.18	0.00	0.92	0.17	-0.59	0.52
	WM	SPANo	0.76	0.17	0.17	1.00	-1.02	0.76	0.98
		SPANr	0.66	0.22	0.01	1.00	-0.94	0.43	0.98
	SM	SMg	0.56	0.17	0.08	0.92	-0.05	-0.34	0.88
		SMp	0.62	0.26	0.00	0.97	-0.69	-0.66	0.96

Note. DRM = Deese-Roediger-McDermott paradigm MC = Memory Conjunction paradigm; w = word stimuli; s = sentence stimuli; WM = working memory measures; SM = source monitoring measures; SPANo = operation span; SPANr = reading span; SMg = gender source memory; SMp = picture source memory.

Prior to reporting the primary analyses, for completeness we examined $\Delta d'$ across all task conditions (see Method for details). False memory sensitivity measures can be found in Table 2. Mean $\Delta d'$ was submitted to a linear mixed effect model with fixed effects of *paradigm* (DRM vs. MC), *stimulus type* (word vs. sentence), and *condition* (warning vs. no-warning), as

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

well as a random effect of participant. Discrimination of new items from lures was better in the DRM paradigm (*Paradigm*: $b = .91$, $SE = .10$, $p < .001$), and with word stimuli (*Stimulus Type*: $b = .21$, $SE = .10$, $p = .034$). There was also significant interaction between these factors (*Paradigm $\times$ Stimulus Type*: $b = -.36$, $SE = .14$, $p = .011$), such that the effect of stimulus type was larger in the MC paradigm compared to the DRM paradigm. No other main effects or interactions were significant (p 's $> .05$). These findings indicate clear differences in discriminability across paradigms and stimulus types, independent of warnings.

Table 2. *Sensitivity Measures for each False Memory Task.*

Task	<i>No Warning</i>			<i>Warning</i>		
	New	Lure	$\Delta d'$	New	Lure	$\Delta d'$
DRMw	1.62 (0.05)	0.60 (0.04)	1.03 (0.05)	1.65 (0.06)	0.64 (0.05)	1.01 (0.06)
DRMs	1.05 (0.04)	-0.18 (0.03)	1.22 (0.04)	1.05 (0.04)	-0.05 (0.04)	1.10 (0.05)
MCw	2.44 (0.06)	1.93 (0.06)	0.51 (0.04)	2.35 (0.07)	1.92 (0.06)	0.43 (0.04)
MCs	1.58 (0.06)	0.90 (0.05)	0.67 (0.04)	1.65 (0.07)	0.97 (0.05)	0.68 (0.04)

Note. DRM = Deese-Roediger-McDermott paradigm MC = Memory Conjunction paradigm; w = word stimuli; s = sentence stimuli.

Section 1: Do stable individual differences in false memories hold across different paradigms? To determine whether the rank ordering of performance within individuals changes across tasks or if there are stable individual differences in false memory, we specified two CFA models for each condition in which false memory, working memory, and source monitoring tasks loaded onto separate factors. The primary difference between the two models was the structure of the false memory tasks. In the three-factor model, all false memory tasks loaded onto a single false memory latent variable. This is a general false memory model, as it tests the hypothesis that the processes underlying false memory are largely invariant across task types. In the four-factor model, DRM (DRMw and DRMs) and MC (MCw and MCs) tasks loaded onto two separate factors. This is a task-specific model, as it tests the hypothesis that false memory differs as a function of task. In the factor analytic approach, the χ^2 statistic reflects how well the

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

specified model reproduces the variance-covariance structure of the observed data. A significant χ^2 test ($p < .05$) is undesirable because it means that the theoretical model does not accurately reflect the observed structure. Other measures of goodness-of-fit indices are also reported. CFI and NFI values greater than .90, and SRMR and RMSEA values less than .08, are indicative of acceptable fit (Kline, 2015). As can be seen in Table 3, both models provide an excellent fit to the data in with and without warnings.

Table 3. *Model Fits for Confirmatory Factor Analysis Across Conditions*

Condition	Model	df	χ^2	p	CFI	NNFI	SRMR	RMSEA [90% CI]
No Warning	3 Factor	17	18.64	0.350	>.99	0.99	0.03	.02 [.00, .06]
	4 Factor	14	16.83	0.265	0.99	0.98	0.03	.03 [.00, .07]
Warning	3 Factor	17	23.39	0.137	0.98	0.96	0.04	.04 [.00, .08]
	4 Factor	14	17.89	0.212	0.99	0.97	0.04	.04 [.00, .08]

Note. Model in **bold** is best fitting model. df = degrees of freedom, χ^2 = chi squared; p = p value; CFI = comparative fit index; NNFI = non-normed fit index; ; SRMR = standardized root mean square residual; RMSEA = root mean square error.

To determine the best fitting model, a series of χ^2 differences tests (notated as $\Delta \chi^2$) are performed. In the case of comparable fits among different theoretical models (i.e., no difference between $\Delta \chi^2$), it is customary to select the more parsimonious model (i.e., the simpler model with fewer factors). In the current study, there was no difference in model fit between the three-factor and four-factor models in either condition (*No Warning*: $\Delta \chi^2(6) = 1.81, p = .613$; *Warning*: $\Delta \chi^2(3) = 5.49, p = .139$). This indicates that specifying task-specific factors does not significantly improve model fit. The more parsimonious, and thus favored, general structure suggests there are stable individual differences in false remembering across tasks. As can be seen in Fig. 1³, working memory and source monitoring are positively correlated with one another and

³ As can be seen in Figure 1, the factor loading for the MCw task was not significant in either condition. Importantly, excluding this variable from the three-factor model did not significantly improve model fit (*No Warning*: $\Delta \chi^2(6) = 7.88, p = .246$; *Warning*: $\Delta \chi^2(6) = 9.06, p = .170$). We therefore elected to keep all variables in the model for all analyses.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

higher performance on both tasks is associated with better discriminability in the false memory tasks.

Fig. 1. Confirmatory factor analysis of the best-fitting 3 factor model (left) and scatter plots of latent correlations (right) without (upper) and with (lower) warnings. Solid lines in factor analysis indicate significant paths at $p < .05$.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

Finally, we tested for measurement invariance to ensure that the loadings onto the factors were roughly equal across warning conditions. To do so, we set “condition” (warning vs. no-warning) as a grouping factor for the best fitting (three-factor) model and compared it to a model that had an additional constraint that the factor loadings be equal across conditions. Doing so did not significantly affect model fit ($\Delta \chi^2(5) = 8.82, p = .116$). This suggests that warnings did not change the factor structure.

Section 2: Does source monitoring mediate the relation between working memory and false memory? To determine whether the correlations between working memory and source monitoring with the general false memory factor were shared or unique, we tested a mediation model where working memory predicted source monitoring, working memory predicted false memories, and source monitoring predicted false memories. As can be seen in Fig. 2, the relation between working memory and false memory was fully mediated by source monitoring ability in both conditions (*No Warnings*: indirect effect = .23, $p = .001$; *Warnings*: indirect effect = .24, $p = .001$). Replicating Unsworth and Brewer (2010), these findings suggest that individuals with higher working memory did better on the false memory tasks because they were better able to monitor for the origin of a memory.

Fig. 2. Mediation analysis without (left) and with (right) warnings of false memory ($\Delta d'$), working memory, and source monitoring ability. Solid lines in factor analysis indicate significant paths at $p < .05$, whereas dashed lines reflect non-significant paths. Source monitoring fully mediated the relation between working memory and false memory.

Section 3: Is the source monitoring advantage associated with more effective lure

rejection strategies? To determine whether the better discriminability for high source monitoring ability participants was driven by qualitatively different lure rejection strategies, we submitted mean rates of rejection strategy (i.e., “recall-to-reject”, “would have remembered”, or “lacks familiarity”) to separate linear mixed effect models, with fixed effects of source monitoring ability and condition and a random effect of subject (see Fig. 3). We collapsed across task because previous analyses indicated all false memory tasks loaded onto a single factor. Disqualifying “recall-to-reject” strategies were utilized more by high ability participants (*Source Monitoring*: $b = .04$, $SE = .02$, $p = .013$), whereas diagnostic “would-have-remembered” strategies tended to be utilized more by low ability participants (*Source Monitoring*: $b = -.03$, $SE = .02$, $p = .102$). Usage of the “lacks familiarity” strategy was not associated with source monitoring ability (*Source Monitoring*: $b = -.01$, $SE = .02$, $p = .522$). The only other significant effect was that disqualifying monitoring was more often used following warnings (*Condition*: $b = .04$, $SE = .02$, $p = .035$; all other main effects and interactions p 's $> .05$). These findings indicate that high ability participants were able to recall information from study lists to determine that critical lures were not members of that list.

Fig. 3. Rejection strategies following critical lure rejection as a function of source monitoring ability (z-scored) in each condition.

General Discussion

The current study leveraged experimental and individual differences methodology to determine if a general framework could account for false memories across two seemingly different false memory paradigms, specify the processes underpinning false remembering, and understand the strategies that are employed to successfully avoid false remembering. There was clear evidence for consistency in false remembering across tasks, independent of warnings, that was predicted by both working memory capacity and source monitoring abilities. However, working memory capacity was no longer associated with false remembering after controlling for source monitoring. The superior performance for high source monitoring ability participants appears to be driven by the efficient usage of disqualifying monitoring processes. Below we discuss the theoretical and applied ramifications of these findings.

The first aim of the current study was to examine whether two widely used false memory paradigms were similar in their induction of memory errors. The results found that, at the task level, the ability to discriminate new items from critical lures was greater in the DRM compared to the MC paradigm. The two most prominent accounts of false memories in these paradigms (Brainerd & Reyna, 2001; Gallo, 2010) suggest that errors are jointly determined by processes at encoding (lure activation or gist extraction) and retrieval (monitoring or recollection rejection). The semantic/associative nature of the DRM task may have made it more likely that the lure was activated, or a gist trace was formed, during encoding, making DRM lures more accessible. Alternatively, phonological familiarity may have decayed more rapidly than semantic familiarity (Matzen et al., 2011), making MC lures less compelling over time. It is therefore not entirely surprising that we found differences in discriminability across tasks. Critically, despite substantial differences at the *task* level, performance within an individual was relatively stable

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

across tasks. That is, those who were more susceptible to false remembering in one task type were also more likely to falsely remember in other tasks.

The finding that there were stable individual differences in false remembering across tasks is important for theory development. To reject critical lures, participants must decide whether the item was previously seen (e.g., *bed*; *tailspin*), merely imagined (e.g., *sleep*), or contained some but not all elements from study (e.g., *tailgate*; Johnson et al., 1993). The results from the current study indicated that individuals higher in source monitoring ability were better able to discriminate studied from unstudied items regardless of the types of details weighing into the decision (e.g., semantic vs. phonological; internal source vs. external source). We argue that the commonality across tasks is due, at least in part, to a general memory monitoring mechanism (Gallo, 2010). As described previously, however, not all studies have found correlations between different task types (Patihis, Frenda, & Loftus, 2018; Ost et al., 2013; Monds, Paterson, & Kempt, 2017; Salthouse & Siedleck, 2007; Wilkinson & Hyman, 1998). It may be the case that a common mechanism operates differently across in some paradigms (e.g., DRM and MC) than others (e.g., misinformation; Patihis et al., 2018). Another possibility is that prior research using only a single indicator of false memory or not accounting for potential response bias differences across tasks may preclude reliably finding correlations. At least with the task used in the current study, however, our results argue against the idea that there is not a general monitoring mechanism or that monitoring is not a stable individual differences factor (Patihis et al., 2018).

The current study also provides insights into the previously observed relations between working memory and false memory. Although the typical interpretation is that individuals with higher working memory are better able to monitor retrieval (Leding, 2012; Unsworth and Brewer, 2010), Watson et al. (2005) instead suggest that they are better able to maintain goals

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

(i.e., “ignore lures). This is based on the fact that in their study working memory was only predictive of performance when participants were warned about the illusion during encoding. Our results are inconsistent with the attention account, as warnings did not change the relation between working memory and false memory and this relation was fully mediated by source monitoring. It should be noted, however, that warnings had little influence on discriminability at the task level. Prior literature on the efficacy of warnings generally shows that warnings prior to encoding reduce errors (Gallo, Roberts, & Seamon, 1997; Gallo, Roediger, & McDermott, 2001; McDermott & Roediger, 1999). It may be that the inclusion of rejection strategies at test (i.e., monitoring) along with performing multiple tasks (i.e., practice) reduced the efficacy of warnings to some degree. Future research should assess both attention and source monitoring abilities in the same group of participants and try different types of warnings at encoding or retrieval.

Phenomenological reports following correct rejections of critical lures further suggest that variability in source monitoring ability was associated with differing quality of retrieved details. In particular, high source monitoring ability participants were more likely to use a disqualifying monitoring strategy, whereas those lower in source monitoring ability tended to use a diagnostic monitoring strategy. These results are generally consistent with those from Leding (2012) that showed that high ability participants were more likely to rely on diagnostic monitoring. Presumably, individuals with higher source monitoring ability are better able to retrieve studied items or associated contextual features to reject critical lures. Low ability participants may have greater difficulty in retrieving this contextual information. In cases in which retrieval fails, they may tend to rely more on heuristic decisions based on beliefs or

plausibility. The current study is consistent with previous research indicating that disqualifying monitoring is critical for reducing false memories (Gallo, 2004), regardless of task type.

Conclusions

The results from the current study suggest that the ability to retrieval contextual information from a previous learning episode is integral to rejecting false memories. Although we examined two commonly used and robust paradigms for eliciting false memories, research suggests that similar monitoring mechanisms may be critical in other domains, including eyewitness suggestibility (Lindsay & Johnson, 1989), misinformation (Mitchell, Johnson, & Mather, 2003; Moore & Lampinen, 2016), unconscious plagiarism (Marsh, Landau, & Hicks, 1997), and social contagion (Meade & Roediger, 2002). In each of these instances, source confusions (e.g., did I see the perpetrator or was he described to me?) may be more likely if contextual information (e.g., facial features) cannot be retrieved during recall. Monitoring deficits with increased age (Hashtroudi, Johnson, & Chrosniak, 1989; Henkel, Johnson, & De Leonardis, 1998; Pierce et al., 2008) may also contribute to greater susceptibility to false remembering (Gallo, Bell, Beier, & Schacter, 2006) and fake news (Brashier & Schacter, 2020). Thus, future work aimed at improving recollection-based monitoring processes may go far in reducing errors across a variety of important domains.

References

- Anderson, J. R. (1983). A spreading activation theory of memory. *Journal of Verbal Learning & Verbal Behavior*, 22(3), 261-295.
- Arndt, J., & Jones, T. C. (2008). Elaborative processing and conjunction errors in recognition memory. *Memory & Cognition*, 36(5), 899-912.
- Arndt, J., & Reder, L. M. (2003). The effect of distinctive visual information on false recognition. *Journal of Memory and Language*, 48(1), 1-15.
- Ball, B. H. (2011). The influence of semantic context on false memories (*Master's Thesis, University of Georgia*).
- Benjamin, A. S. (2001). On the dual effects of repetition on false recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(4), 941.
- Brainerd, C. J., & Reyna, V. F. (2001). *Fuzzy-trace theory: Dual processes in memory, reasoning, and cognitive neuroscience*. In H. W. Reese & R. Kail (Eds.), *Advances in child development and behavior* (p. 41–100). Academic Press.
- Brainerd, C. J., & Reyna, V. F. (2004). Fuzzy-trace theory and memory development. *Developmental Review*, 24(4), 396-439.
- Brainerd, C. J., Wright, R., Reyna, V. F., & Mojardin, A. H. (2001). Conjoint recognition and phantom recollection. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(2), 307.
- Brashier, N. M., & Schacter, D. L. (2020). Aging in an Era of Fake News. *Current Directions in Psychological Science*, 0963721420915872.
- Calvillo, D. P., & Parong, J. A. (2016). The misinformation effect is unrelated to the DRM effect with and without a DRM warning. *Memory*, 24(3), 324-333.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, 82(6), 407-428.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, 58(1), 17-22.

Dodson, C. S., & Schacter, D. L. (2001). "If I had said it I would have remembered it: Reducing false memories with a distinctiveness heuristic. *Psychonomic Bulletin & Review*, 8(1), 155-161.

Engle, R. W., & Kane, M. J. (2003). Executive attention, working memory capacity, and a two-factor theory of cognitive control. *Psychology of Learning and Motivation*, 44, 145-199.

Gallo, D. A. (2004). Using recall to reduce false recognition: diagnostic and disqualifying monitoring. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30(1), 120.

Gallo, D. A. (2006). *Associative illusions of memory: False memory research in DRM and related tasks*. New York, NY US: Psychology Press.

Gallo, D. A. (2010). False memories and fantastic beliefs: 15 years of the DRM illusion. *Memory & Cognition*, 38(7), 833-848.

Gallo, D. A., Bell, D. M., Beier, J. S., & Schacter, D. L. (2006). Two types of recollection-based monitoring in younger and older adults: Recall-to-reject and the distinctiveness heuristic. *Memory*, 14(6), 730-741.

Gallo, D. A., Roberts, M. J., & Seamon, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories?. *Psychonomic Bulletin & Review*, 4(2), 271-276.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Gallo, D. A., & Roediger III, H. L. (2002). Variability among word lists in eliciting memory illusions: Evidence for associative activation and monitoring. *Journal of Memory and Language*, 47(3), 469-497.
- Gallo, D. A., Roediger, H. L., & McDermott, K. B. (2001). Associative false recognition occurs without strategic criterion shifts. *Psychonomic Bulletin & Review*, 8(3), 579-586.
- Gerrie, M. P., & Garry, M. (2007). Individual differences in working memory capacity affect false memories for missing aspects of events. *Memory*, 15(5), 561-571.
- Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1989). Aging and source monitoring. *Psychology and Aging*, 4(1), 106.
- Hautus, M. J. (1995). Corrections for extreme proportions and their biasing effects on estimated values of d' . *Behavior Research Methods, Instruments, & Computers*, 27(1), 46-51.
- Hege, A. C., & Dodson, C. S. (2004). Why distinctive information reduces false memories: evidence for both impoverished relational-encoding and distinctiveness heuristic accounts. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30(4), 787.
- Henkel, L. A., Johnson, M. K., & De Leonardis, D. M. (1998). Aging and source monitoring: Cognitive processes and neuropsychological correlates. *Journal of Experimental Psychology: General*, 127(3), 251.
- Hicks, J. L., & Marsh, R. L. (1999). Attempts to reduce the incidence of false recall with source monitoring. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 25(5), 1195-1209.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Hintzman, D. L., & Curran, T. (1994). Retrieval dynamics of recognition and frequency judgments: Evidence for separate processes of familiarity and recall. *Journal of Memory and Language*, 33(1), 1-18.
- Holden, L. R., Conway, A. R., & Goodwin, K. A. (2020). How Individual Differences in Working Memory and Source Monitoring matter in Susceptibility to False Memory. *Unpublished*.
- Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language*, 30(5), 513-541.
- Jaschinski, U., & Wentura, D. (2002). Misleading postevent information and working memory capacity: An individual differences approach to eyewitness memory. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, 16(2), 223-231.
- Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, 114(1), 3.
- Jones, T. C., & Jacoby, L. L. (2001). Feature and conjunction errors in recognition memory: Evidence for dual-process theory. *Journal of Memory and Language*, 45(1), 82-102.
- Joormann, J., Teachman, B. A., & Gotlib, I. H. (2009). Sadder and less accurate? False memory for negative material in depression. *Journal of Abnormal Psychology*, 118(2), 412.
- Kane, M. J., & Engle, R. W. (2003). Working-memory capacity and the control of attention: the contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General*, 132(1), 47.
- Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- LaTour, K. A., LaTour, M. S., & Brainerd, C. (2014). Fuzzy trace theory and “smart” false memories: Implications for advertising. *Journal of Advertising*, 43(1), 3-17.
- Lampinen, J. M., Odegard, T. N., & Neuschatz, J. S. (2004). Robust recollection rejection in the memory conjunction paradigm. *Journal of experimental psychology. Learning, memory, and cognition*, 30(2), 332.
- Leding, J. K. (2012). Working memory predicts the rejection of false memories. *Memory*, 20(3), 217-223.
- Leding, J. K., & Lampinen, J. M. (2009). Memory conjunction errors: The effects of presentation duration and study repetition. *Memory*, 17(5), 597-607.
- Lindsay, D. S., & Johnson, M. K. (1989). The eyewitness suggestibility effect and memory for source. *Memory & Cognition*, 17(3), 349-358.
- Lloyd, M. E. (2007). Metamemorial influences in recognition memory: Pictorial encoding reduces conjunction errors. *Memory & Cognition*, 35(5), 1067-1073.
- Lloyd, M. E. (2013). Reducing the familiarity of conjunction lures with pictures. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 39(5), 1609.
- Loftus, E. F. (1975). Leading questions and the eyewitness report. *Cognitive Psychology*, 7(4), 560-572.
- Loftus, E. F. (2019). Eyewitness testimony. *Applied Cognitive Psychology*, 33(4), 498-503.
- Lövdén, M. (2003). The episodic memory and inhibition accounts of age-related increases in false memories: A consistency check. *Journal of memory and language*, 49(2), 268-283.
- Marsh, R. L., Landau, J. D., & Hicks, J. L. (1997). Contributions of inadequate source monitoring to unconscious plagiarism during idea generation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 23(4), 886.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Matzen, L. E., & Benjamin, A. S. (2009). Remembering words not presented in sentences: How study context changes patterns of false memories. *Memory & cognition*, 37(1), 52-64.
- Matzen, L. E., Taylor, E. G., & Benjamin, A. S. (2011). Contributions of familiarity and recollection rejection to recognition: Evidence from the time course of false recognition for semantic and MC lures. *Memory*, 19(1), 1-16.
- McCabe, D. P., & Smith, A. D. (2002). The effect of warnings on false memories in young and older adults. *Memory & Cognition*, 30(7), 1065-1077.
- McDermott, K. B., & Roediger III, H. L. (1998). Attempting to avoid illusory memories: Robust false recognition of associates persists under conditions of explicit warnings and immediate testing. *Journal of Memory and Language*, 39(3), 508-520.
- Meade, M. L., & Roediger, H. L. (2002). Explorations in the social contagion of memory. *Memory & Cognition*, 30(7), 995-1009.
- Meade, M. L., Watson, J. M., Balota, D. A., & Roediger, H. (2007). The roles of spreading activation and retrieval mode in producing false recognition in the DRM paradigm. *Journal of Memory and Language*, 56(3), 305-320.
- Mitchell, K. J., & Johnson, M. K. (2000). *Source monitoring: Attributing mental experiences*. The Oxford handbook of memory, 179-195.
- Mitchell, K. J., Johnson, M. K., & Mather, M. (2003). Source monitoring and suggestibility to misinformation: Adult age-related differences. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, 17(1), 107-119.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Mitchell, K. J., & Johnson, M. K. (2009). source monitoring 15 years later: what have we learned from fMRI about the neural mechanisms of source memory?. *Psychological bulletin*, 135(4), 638.
- Mitchell, K. J., Johnson, M. K., & Mather, M. (2003). Source monitoring and suggestibility to misinformation: Adult age-related differences. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, 17(1), 107-119.
- Monds, L. A., Paterson, H. M., & Kemp, R. I. (2017). Do emotional stimuli enhance or impede recall relative to neutral stimuli? An investigation of two “false memory” tasks. *Memory*, 25(8), 945-952.
- Moore, K. N., & Lampinen, J. M. (2016). The use of recollection rejection in the misinformation paradigm. *Applied Cognitive Psychology*, 30(6), 992-1004.
- Meyersburg, C. A., Bogdan, R., Gallo, D. A., & McNally, R. J. (2009). False memory propensity in people reporting recovered memories of past lives. *Journal of Abnormal Psychology*, 118(2), 399.
- Neuschatz, J. S., Benoit, G. E., & Payne, D. G. (2003). Effective warnings in the Deese-Roediger-McDermott false-memory paradigm: The role of identifiability. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 29(1), 35.
- Neuschatz, J. S., Payne, D. G., Lampinen, J. M., & Toggia, M. P. (2001). Assessing the effectiveness of warnings and the phenomenological characteristics of false memories. *Memory*, 9(1), 53-71.
- Odegard, T. N., & Lampinen, J. M. (2005). Recollection rejection: Gist cuing of verbatim memory. *Memory & cognition*, 33(8), 1422-1430.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Odegard, T. N., Lampinen, J. M., & Toggia, M. P. (2005). Meaning's moderating effect on recollection rejection. *Journal of Memory and Language*, 53(3), 416-429.
- Ost, J., Blank, H., Davies, J., Jones, G., Lambert, K., & Salmon, K. (2013). False memory ≠ false memory: DRM errors are unrelated to the misinformation effect. *PloS one*, 8(4), e57939.
- Parker, S., Garry, M., Engle, R. W., Harper, D. N., & Clifasefi, S. L. (2008). Psychotropic placebos reduce the misinformation effect by increasing monitoring at test. *Memory*, 16(4), 410-419.
- Patihis, L., Frenda, S. J., & Loftus, E. F. (2018). False memory tasks do not reliably predict other false memories. *Psychology of Consciousness: Theory, Research, and Practice*, 5(2), 140.
- Peters, M. J., Jelicic, M., Verbeek, H., & Merckelbach, H. (2007). Poor working memory predicts false memories. *European Journal of Cognitive Psychology*, 19(2), 213-232.
- Pierce, B. H., Waring, J. D., Schacter, D. L., & Budson, A. E. (2008). Effects of distinctive encoding on source-based false recognition: further examination of recall-to-reject processes in aging and Alzheimer disease. *Cognitive and behavioral neurology: official journal of the Society for Behavioral and Cognitive Neurology*, 21(3), 179.
- Platt, R. D., Lacey, S. C., Iobst, A. D., & Finkelman, D. (1998). Absorption, dissociation, and fantasy-proneness as predictors of memory distortion in autobiographical and laboratory-generated memories. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, 12(7), S77-S89.
- Pope, K. S. (1996). Memory, abuse, and science: Questioning claims about the false memory syndrome epidemic. *American Psychologist*, 51(9), 957.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Reyna, V. F., Corbin, J. C., Weldon, R. B., & Brainerd, C. J. (2016). How fuzzy-trace theory predicts true and false memories for words, sentences, and narratives. *Journal of Applied Research in Memory and Cognition*, 5(1), 1-9.
- Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology-learning memory and cognition*, 21(4), 803-814.
- Roediger, H. L., & McDermott, K. B. (1999). False alarms and false memories. *Psychological Review*, 106(2), 406-410.
- Salthouse, T. A., & Siedlecki, K. L. (2007). An individual difference analysis of false recognition. *The American journal of psychology*, 120(3), 429.
- Schönbrodt, F. D., & Perugini, M. (2013). At what sample size do correlations stabilize?. *Journal of Research in Personality*, 47(5), 609-612.
- Smith, R. E., & Hunt, R. R. (1998). Presentation modality affects false memory. *Psychonomic Bulletin & Review*, 5(4), 710-715.
- Thomas, A. K., & Sommers, M. S. (2005). Attention to item-specific processing eliminates age effects in false memories. *Journal of Memory and Language*, 52(1), 71-86.
- Underwood, B. J. (1975). Individual differences as a crucible in theory construction. *American Psychologist*, 30, 128-134.
- Unsworth, N., & Brewer, G. A. (2010). Individual differences in false recall: A latent variable analysis. *Journal of Memory and Language*, 62(1), 19-34.
- Unsworth, N., & Engle, R. W. (2007). The nature of individual differences in working memory capacity: active maintenance in primary memory and controlled search from secondary memory. *Psychological Review*, 114(1), 104.

INDIVIDUAL DIFFERENCES IN FALSE MEMORY

- Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods*, 37(3), 498-505.
- West, E., & Meterko, V. (2015). Innocence project: DNA exonerations, 1989-2014: review of data and findings from the first 25 years. *Albany Law Review*, 79, 717.
- Wilkinson, C., & Hyman Jr, I. E. (1998). Individual differences related to two types of memory errors: Word lists may not generalize to autobiographical memory. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, 12(7), S29-S46.
- Zhu, B., Chen, C., Loftus, E. F., Lin, C., & Dong, Q. (2013). The relationship between DRM and misinformation false memories. *Memory & cognition*, 41(6), 832-838.
- Zhu, B., Chen, C., Loftus, E. F., Lin, C., He, Q., Chen, C., ... & Dong, Q. (2010). Individual differences in false memory from misinformation: Cognitive factors. *Memory*, 18(5), 543-555.