False Memory Tasks Do Not Reliably Predict Other False Memories

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Memory Distortion Tasks Do Not Reliably Predict Other Memory Distortions

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Abstract

Several laboratory techniques have been developed over the last few decades that reliably produce memory distortions. However, it is unclear whether false memory production in one experimental paradigm will predict susceptibility to false memories in other paradigms. In Experiment 1, 202 undergraduates participated in a misinformation experiment and semi-autobiographical tasks involving three measures of memory distortion (suggestion, imagination, emotion). We established high internal consistency in individual differences measures and statistically significant experimental effects where we would expect them (e.g. the misinformation effect). However, false memory production in one task did not predict false memories in other paradigms. In Experiment 2, 163 adults participated in a misinformation experiment, a false memory word list task (Deese-Roediger/McDermott; DRM), and semi-autobiographical false news story tasks. Again we found no consistent predictive relationships among various false memories. In both studies, no individual differences predicted memory distortion susceptibility consistently across tasks and across experiments. At this time, false memory production in a given laboratory task does not appear to adequately predict false memories in other tasks, a finding with implications for using these tasks to predict memory distortion in real world situations.

Keywords: memory distortion, false memory, DRM, misinformation, crashing memory, autobiographical

Memory Distortion Tasks Do Not Reliably Predict Other Memory Distortions

Memory distortion has been widely studied and observed in a variety of populations. In this article, we investigate whether some people are especially vulnerable to memory distortion across different experimental paradigms. Our research is relevant to the question of whether false memories elicited in a laboratory context warrant conclusions regarding false memory propensity in general, clinical, or forensic contexts. Whether there is a general false memory proneness could then be considered when assessing the veracity of a reported memory, particularly when the memory has possibly been contaminated by suggestion. Few studies have thoroughly and directly addressed whether false memories predict subsequent false memories both within and across experimental paradigms (we use the term “paradigm” to refer to an established methodology for creating memory distortions in the laboratory). In this study, we examine this question by testing participants using several memory distortion paradigms, while also measuring individual differences, to determine if we can identify a subset of participants who are generally prone to memory distortion across disparate paradigms.

Researchers have developed a number of memory distortion paradigms over the past several decades that use different methods to elicit memory errors. For example, the misinformation paradigm presents misleading post-event information as a means to distort memory after a participant has been exposed to an event (e.g., video or photographs; see Loftus, 2005). Researchers have shown that misinformation not only changes details for scenes (e.g. Loftus, Miller, and Burns, 1978). The mechanisms that explain the misinformation effect involve the initial encoding of visual detail into long term memory, the subsequent decay of some details over time, the retroactive interference of misleading post-event information, and finally source monitoring errors at the time of recall (Johnson, Hashtroudi, & Lindsay, 1993; but

see Reyna and Brainerd, 1995 for an alternative “fuzzy-trace” explanation). Source monitoring errors in the misinformation effect involve mistaking the source of the misinformation as originating in the original event. In effect, information about the source of a memory or a piece of knowledge is vulnerable to error.

In another memory distortion paradigm, called the DRM task (Deese, 1959; Roediger & McDermott, 1995), researchers present participants with a list of words (e.g., bed, dream, awaken) that are all semantically related to an unrepresented word called a “critical lure” (e.g., sleep). Participants very often misremember seeing the critical lure that they had not actually seen. The mechanisms behind the DRM effect are plausibly explained by the semantic activation of words that in turn spread to activate related concepts, rendering thematically related words more accessible to participants during test (semantic network theory: Collins & Quillian, 1969; spreading activation theory: Collins & Loftus, 1975). Importantly, these proposed mechanisms differ from those for the misinformation effect, although source monitoring has also been used to explain aspects of the DRM effect (activation/monitoring theory: Roediger & McDermott, 2000).

In the “crashing memory” paradigm, following suggestion, people sometimes report false memories of having viewed footage of a widely reported news-related event, when in fact no such footage exists (see Crombag, Wagenaar, & van Koppen, 1996). There has been some discussion as to whether crashing memory studies reflect false beliefs or false memories, with one study finding that the majority of false reports were beliefs without detailed images (Ost et al., 2008). Another crashing memory investigation found that the debriefing process reduced the percentage of false reports from 81% to 10%, again raising doubts about the percentage of genuine false memories, rather than just the expression of beliefs (Smeets, Telgen, Ost, Jelicic,

& Merckelbach, 2009). Patihis and Loftus (2016) also found a reduction of false memory reports in the crashing memory paradigm when initial reports in a questionnaire were followed up with a more in-depth structured interview (from 33% to 13%). In terms of mechanisms, these latter genuine persistent false memories that “survive” the interview can be understood as source monitoring errors. False memories in this paradigm are attributable to source errors—either due to misinformation given in the suggestive questions, or source confusion around mental images of related events. Although the mechanisms may be similar to the misinformation effect, different mechanisms may be involved due to the different types of memory tasks or paradigms involved (slideshows of non-autobiographical events vs. important news events).

Yet another memory distortion paradigm involves a phenomenon known as “imagination inflation,” in which the process of imagining a counterfactual event produces increased confidence that the imagined event actually was experienced (e.g. Garry, Manning, Loftus, & Sherman, 1996). Source monitoring errors can also explain this phenomenon: mental imagery created in the context of a study can be mistakenly attributed to actual experience. In other words, a mentally manufactured image is confused for an image that has real perceptual origins.

In another paradigm, research has also suggested that memory for the emotions felt by a person in the past is reconstructive, malleable, and biased in the direction of currently held cognitive appraisals (e.g. Levine, 1997; Levine, Prohaska, Burgess, Rice, & Laulhere, 2001). In other words, memories for previously felt emotions can be distorted. The likely mechanisms associated with this phenomenon are described in the cognitive appraisal theory of emotions (e.g., Scherer, Schorr, & Johnstone, 2001). According to this theory, we use current appraisals of the situation to reconstruct the memory of the emotion. To a lesser extent, the source monitoring framework may also explain some aspects of changes in memory of emotion. For example,

emotions that were experienced in one situation may be incorrectly attributed to having been experienced in a different context.

We posit that that source monitoring theory plays a major explanatory role in the misinformation effect, crashing memories, and imagination inflation, but is less central in DRM word lists and memory of emotion. If some people are more susceptible to source monitoring errors, it follows that we might find inter-correlations among some of these paradigms. Further, we would expect that those paradigms primarily involving source monitoring errors (e.g. misinformation) would be more strongly associated with one another than with those primarily involving other mechanisms (e.g. DRM).

Not only are there similarities in mechanisms between paradigms, but differences too. For example there are differences between laboratory stimuli and autobiographical stimuli (see Roediger & McDermott, 2013; Patihis et al., 2013), and between false beliefs and false memories (see Otgaar, Scoboria, & Mazzoni, 2014). These differing approaches and methods of creating memory distortions provide the opportunity to use different methods to investigate whether a general susceptibility to memory distortion comes into play across diverse situations.

Differences in mechanisms provide possible reasons why we might find low correlations between memory distortions in different paradigms. However, a different explanation might be that the assumption that some people are consistently more prone to source monitoring errors than other people is wrong. In other words there may not be a strong personality-like trait of false memory proneness, at least in non-clinical populations.

What evidence indicates that performance on false memory tasks predict performance on others? Next, we examine whether there is evidence from past studies that false memories predict other false memories. We first examine research that provides tangential evidence for

memory distortions in one situation predicting distortions in other contexts, and we then consider studies that test subjects using more than one technique/paradigm to produce false memories.

Early Clues from Related Research

Clancy, Schacter, McNally, and Pitman (2000) found that women who reported recovered memories of childhood sexual abuse were more prone to false recognition on the DRM test, compared with those who did not report recovered memories. These women reported not remembering such abuse before therapy or before the return, in adulthood, of what they believed to be repressed memories. If these recovered memories were, in fact, memory distortions, then this finding might suggest a cross-paradigm false memory susceptibility. Nevertheless, there is some uncertainty as to whether the women were reporting memory distortions in their recovered recollections, and it is also possible that these women might differ from the other participants on any number of unmeasured variables.

Clancy, McNally, Schacter, Lenzenweger, and Pitman (2002) found that participants who reported (presumably false) memories of alien abduction recalled more false memories on a DRM test. Unlike Clancy et al.'s (2000) work on recovered memories of sexual abuse, we can be fairly certain that alien abduction memories do not reflect real events. Clancy et al. (2002) compared 11 participants who reported an alien abduction memory with the 13 control participants with no false memory or belief regarding alien abduction on their DRM false memories (critical lure endorsement rates). Comparing the alien abduction group to the control group yielded an effect size of $r^2 = .31$ ($p = .005$) for recall and $r^2 = .39$ ($p = .001$) for recognition of the critical lures (Clancy et al., 2002; comparisons made using Table 3, p. 458 column "average"). However, from these results we cannot be sure that false memories of the alien abduction do actually correlate with DRM false memories, because those who believed in,

but did not remember alien abduction, also demonstrated higher DRM false memory rates.

There were no significant differences on DRM false memories between those who did report a false memory of abduction, and those who believed they were abducted but had no false memory (DRM critical lure recall $r^2 < .01$, $p > .99$; recognition $r^2 = .07$, $p = .26$). Because a *belief* in alien abduction appears to be the factor associated with higher DRM false memories—rather than alien abduction *memories*—further research is warranted.

Researchers have also studied people who remember past lives using false memory tasks. For example, Meyersburg, Bogdan, Gallo, and McNally (2009) found that participants reporting memories of past lives also reported more false memories of non-presented critical lure words in the DRM task (effect sizes comparing those reporting past live memories to those reporting no such memories: DRM recall $r = .31$; DRM recognition $r = .28$). However, Peters, Horselenberg, Jellic, and Merckelbach (2007) did not find a significant difference on performance of a false fame task between individuals with and without memories of a past life. In the false fame illusion, participants read out a list of non-famous and famous people, and at a later time are asked to identify which names are famous. Non-famous names that the participant had read in the first stage of the study are especially incorrectly remembered as famous at the final stage.

These studies reviewed used one laboratory paradigm and compared memory rates with possible self-reported autobiographical memory errors in the participants' life. Next, we discuss the studies that assessed more than one memory distortion task in a laboratory setting.

Within Subjects Designs Using More than One False Memory Technique

Relatively few published studies have tested participants using more than one memory distortion technique, and then compared the inter-relations among them. Wilkinson and Hyman (1998) found that false memories in the DRM task did not correlate with imagination-induced

autobiographical memory distortions. The researchers tested 121 undergraduates using an exercise in which participants imagined a childhood event that they knew happened, but that they did not initially remember. Participants also completed a DRM word list task. The association between the imagination-produced memories and the DRM critical lure endorsement was not significant, with respect to DRM tests using both recall $r = -.165, p > .05$ and recognition, $r = -.175, p > .05$. The authors stated that the findings supported the idea that “autobiographical memory errors and semantic intrusions are different” (p. S41). Similarly, Qin, Ogle, and Goodman (2008) found no significant relationship between DRM false memories of critical lures and suggestion-induced false memories of events before the age of five (e.g. getting lost, birthday party at McDonald’s, an enema; events confirmed by parents not to have happened).

In contrast to these null findings in adults, two studies using children as participants found mixed results. Otgaar and Candel (2011) reported that children’s DRM critical lure endorsement was not related to suggestion-induced false memories for entire events, regardless of whether the DRM word lists were tested using recall ($r^2 = .02; p = .38$) or recognition ($r^2 = .0004; p = .90$). In contrast, Otgaar, Verschuere, Meijer, and van Oorsouw (2012) found that memory distortions in word list recall (DRM) predicted rich false memories in children ($M_{age} = 8.7$). Compared to children who resisted the suggestion, those who came to falsely remember a hot air balloon ride evidenced higher endorsement of critical lures. Nevertheless, the study had a small sample ($N = 45$), and the correlations were not significant before certain participants were excluded from the analysis (i.e. those with partial false memories).

With a larger sample of 432 young adult participants, Zhu, Chen, Loftus, Lin, and Dong (2013) found a small but statistically significant relationship between critical lure endorsement in

a DRM task and false memories on a misinformation task ($r = .12, p = .02$). For the misinformation task, the researchers utilized photographic slideshows (from Okado & Stark, 2005) and ten DRM word lists. They explain the low correlation by noting that there are different mechanisms involved in DRM (semantic memory distortion with potentially little social influence at work) and misinformation (episodic memory distortion with potential social influence factors).

Whereas Zhu et al. (2013) found a small relationship between the same two paradigms, Ost et al. (2013) found no significant relationship between the paradigms. Rather than using slideshows in the misinformation task, Ost et al. (2013) used video (CCTV footage) and utilized 5 DRM word lists with a recognition test with 120 undergraduate participants. The association between DRM false memory (critical lure endorsement) and misinformation recall was $r = -.03$, and between DRM and misinformation recognition was $r = -.02$, neither of which was statistically significant. Monds, Paterson, and Kemp (2016) also found similar results, reporting that susceptibility to a DRM and misinformation task were not related.

As described above, some past studies have found tentative signs that DRM false memories predict real-life autobiographical memory distortion (Clancy et al, 2002; Otgaar et al., 2012), whereas other studies have found either small relationships between DRM false memories and misinformation tasks (Zhu et al., 2013), or a negligible relationship (Ost et al., 2013). These mixed findings render it difficult to definitively answer whether false memories in one context predict false memories in another. Here, we conduct an investigation to address the lack of clear-cut findings in previous investigations, using adequate power and replication to examine various widely-used memory distortion techniques using a within-subjects design.

The Present Experiments

In two experiments, we investigated whether false memories in one memory distortion paradigm predicts susceptibility to false memories in other paradigms. We also examined whether any single individual difference measure or attribute of participants is related to memory distortion rates across all paradigms. In particular, we chose well validated individual differences measures, with established psychometric properties, that have previously been associated with memory distortions in research—such as fantasy proneness (Geraerts, Smeets, Jelicic, van Heerden, & Merckelbach, 2005) dissociative experiences (Porter, Birt, Yuille, & Lehman, 2000), mindfulness (Wilson, Mickes, Stolarz-Fantino, Evrard, & Fantino, 2015), and absorption (Meyersburg, Bogdan, Gallo, & McNally, (2009). We also added a number of exploratory individual difference measures such as critical-thinking, flexible thinking, empathy, and handedness. If false memory proneness is a stable and general propensity across paradigms, we would expect to find two outcomes: whether (1) Memory distortion in one paradigm would predict higher rates of (or susceptibility to) memory distortion in another paradigm, and (2) individual differences patterns would be similar across paradigms.

Experiment 1

Method

Participants. Undergraduates ($N = 202$) participated for course credit. The mean age was 20.2 ($SD = 3.47$; range 18 to 51); 75.2% of participants were female. Ethnicity was distributed as 51.4% Asian or Indian, 20.3% Caucasian, 15.8% Hispanic or Latino, 7.4 % Middle Eastern, 4.0% Pacific Islander, and 1.0% African American.

Materials and Procedure

Participants completed a misinformation experiment, as well as semi-autobiographical memory distortion measures (suggestion, imagination, memory of emotion; described below)—connected to their memory of the September 11th terrorist attacks in New York City (hereafter

referred to as 9/11). Sample size was chosen to be large enough to find small effects (G*Power calculation: $p = .2$, $\alpha = .05$, power = .8, yields $N = 193$ & critical value of $r = .14$; Faul, Erdfelder, Lang, & Buchner, 2007) in order to detect any small-to-moderate effects that may exist in the larger population. The data-stopping rule involved continuing until the full sample size was obtained for our main analysis.

Participants came into the laboratory setting two times one week apart. Participants first read the cover story that the study was about personality, individuality, and slideshows. Participants entered the laboratory one at a time, staggered one every 15-20 minutes, and were greeted by a research assistant who gave them verbal instructions to prepare them for the study. Between one and three participants participated in a laboratory room at any given time, with one or two research assistants supervising. Participants were unaware of the actual research questions until the debriefing after Session 2. It was apparent to participants that Session 1 and Session 2 were part of the same study. Participants were individually introduced to the study by a research assistant and then completed the study on an individual basis on laboratory computers. Research assistants were not in view of the participants during the computer tasks. Aside from materials that were manipulated across groups, the general order of the presentation of materials and individual differences tasks was the same for all participants.

Session 1. After being randomly assigned to condition, participants proceeded to complete the computer questionnaires. These included measures of fantasy proneness (the Creative Experiences Scale; Merckelbach, Horselenberg, & Muris, 2001), dissociative experiences (DES-C; Wright & Loftus, 1999), mindfulness (Mindful Attention Awareness Scale: MAAS; Brown & Ryan, 2003), and absorption (Tellegen Absorption Scale: TAS; Tellegen & Atkinson, 1974). As well as these individual differences and personality scales, the participants

were asked to report how they felt in the week following the 9/11 attacks. The average age of the participants at the time of 9/11 was approximately 10 years old. Specifically, they were asked “In the week following the terrorist attacks of September 11, 2001, how often did you feel the following emotions?” They then rated 14 negative emotions (Upset, Distressed, Scared, Sad, Confused, Grief, Angry, Anxious, Stressed, Helpless, Traumatized, Frustrated, Tense, and Jumpy) on a scale from 1 (never) to 10 (all the time). These pretest questions were asked again in Session 2 immediately after the United 93 news footage (i.e., “crashing memory”) computer questionnaire (posttest).

Session 2 took about one hour, and included the misinformation effect, the computer questionnaire about United 93 footage and memory of emotion after 9/11, and individual difference measures served as fillers between these memory-related tasks. At the end of Session 2, subjects participated in a face-to-face structured interview with a research assistant.

Session 2. Exactly one week after Session 1, the subject returned to the lab for Session 2. As in Session 1, a research assistant gave verbal instructions and then helped the participant begin the computer questionnaire.

Misinformation effect experiment phase 1: photographic slideshows. First, subjects saw two photographic slideshows as the first part of the misinformation-effect experiment (misinformation materials modified from Okado & Stark, 2005). Each slideshow consisted of 50 photographs, with each picture onscreen for 3500ms. Each photograph was displayed as an 800 x 600 pixel image on a LCD computer screen. Before the slideshow subjects were asked to watch carefully and told they would be asked questions about it later. The first slideshow depicted a story of a woman who had her wallet stolen by a man who she thought was helping her. The second slideshow portrays a man breaking into a car and searching through various items in the

car.

United 93 questionnaire. Participants completed a news story questionnaire asking about their memory for United 93 (associated with the 9/11 attack) crash footage. Importantly, the questionnaire falsely suggested that footage of the crash exists and has been widely shown (in fact, no such footage exists). Participants then reported whether they had seen the footage, and whether they remember any specific details.

Questionnaire posttest questions. Immediately following the United 93 computer questionnaire, participants completed a series of posttest measures regarding memory for their emotions after September 11, 2001 (worded identically worded to the pretest measures in Session 1). Participants then completed some individual differences measures that included measures of critical-thinking (modified from West, Toplak, & Stanovich, 2009), flexible thinking (FTS; Stanovich & West, 1997), empathy (Basic Empathy Scale: BES; Jolliffe & Farrington, 2006) and a handedness scale (Oldfield, 1971). All the individual difference measures served two important purposes: as valid variables of interest, but also as filler material between the misinformation- effect phases that also helped to disguise the true nature of the study.

Misinformation-effect experiment phase 2: misinformation narratives. The participants then saw a text narrative about the photographic slideshows shown earlier. This occurred approximately 40 minutes after they originally viewed the photographs. The participants were asked to stay focused on reading and to pay attention to the story until it was over. The narratives consisted of two sets of 50 sentences, with each sentence displayed on screen for 5500ms in a large font. Of the 100 sentences that a given participant saw, all were accurate except for 6 sentences containing misinformation. Group A participants received a different set of six misinformation

items than Group B did (three items per slideshow). For example, Group A would receive misinformation about the thief putting the wallet in his pants pocket, whereas Group B would receive no false information about that particular slide. Similarly, Group B received misinformation that a cell phone was blue, whereas Group A would receive a sentence that did not contain misinformation about the color of the phone. Control group items contained no information about the critical detail (so in the examples above no suggestion was made as to the actual pocket used, or the actual color of the cell phone). In this way, Group B served as the control groups on Group A's misinformation items, and vice versa (similar to methodology in Patihis et al., 2013).

Filler Task. Following this misinformation phase, a 91-item Swedish Scale of Personality (SSP) was administered (Gustavsson et al., 2000), which allowed for a gap of approximately 20 minutes between the misinformation phase and the test phase of the misinformation task.

Misinformation effect experiment phase 3: test and source test.

Test. Participants answered a series of 18 questions asking what they "remember seeing in the original slideshows of photographs." The test phase occurred about 20 minutes after the misinformation (phase 2), and about 60 minutes after the original photographic slideshow presentations (phase 1). These questions were multiple choice with three possible answers. For a given participant, 6 of these 18 questions related to items they had received misinformation about in the earlier text narrative. For these items, one of the options was correct (consistent with photographs in original slideshow), one option was consistent with the earlier misinformation, and the other option was a foil (a wrong answer that was not suggested). We refer to endorsement of misinformation-consistent answer choices as "Overall False Memory" (OFM).

Source test. Next, participants completed questions about the source of their answers on

the test questions they had just completed. To each of the 18 questions they had previously answered, they were given an opportunity to indicate how they arrived at their answers. In this source test, they had a multiple choice of five possible answers: (a) I saw it in the picture only, (b) I read it in the narrations only, (c) I saw it in both and they were the same, (d) I saw it in both and they conflicted with each other, and (e) I guessed. We refer to endorsement of misinformation at test, followed by choosing options (a) or (c) in the source test, as Source-Confirmed False Memory (SCFM).

United 93 crash footage interviews. About 40 minutes after the original suggestion about United 93 footage, a research assistant guided participants one at a time through an audio-recorded semi-structured interview. In this face-to-face interview, the research assistant reiterated to the participant that footage of the crash existed, and then asked if they remembered it. In the interview, participants who said "yes" they had seen the footage were then asked follow up questions about details (such as "How vivid is your memory of that footage of the crash?" and "Tell me how well you can remember having seen the video on a scale from 1 to 10, where 1 means no memory at all and 10 means a very clear memory"; see Supplemental Material for full interview script).

Imagination exercise in the interview. Participants who said "no" they had not seen the footage were first told that sometimes traumatic memories fade, but that there are "techniques that can help us find those memories." They were then taken through an imagination exercise, in which they were asked to imagine seeing the footage on a TV or computer screen. They were asked to elaborate on the details they could imagine and given time to visualize what they saw in their "mind's eye." They were then told that some of the details they were imagining were exactly consistent with the actual video, and told that this was "really good." They were then

asked if they might be remembering the footage. Following this they are asked questions about details (e.g., “Do you remember how long the video is?” and the aforementioned “tell me how well you can remember having seen the video on a scale from 1 to 10”; see Supplemental Material for script).

Quantitative Coding of Interview Responses

Two research assistants, both blind to all hypotheses, coded the responses to several of the key interview questions. Any inter-rater disagreements were scrutinized carefully and resolved by a supervising researcher. The questions asking whether they had seen the footage, both before and after the imagination inflation exercise were coded in a similar manner (no = 0; maybe/unsure = .5; yes = 1), and the initial inter-rater agreement rates on those questions were 93% and 92% respectively (Cronbach α = .955 and .935).

Results

We examined whether memory distortion in one paradigm predicted susceptibility to distortion in the other paradigms, and we then examined whether individual difference measures predicted memory distortion across paradigms. Before the main analysis, we first determined whether the memory distortion techniques worked as expected in each paradigm.

False Memory Rates. Before comparing paradigms, we first examined whether memory distortion or change occurred in each of the memory tasks in order to confirm that we are finding effects we expect to find based on past research on these memory distortion paradigms.

Misinformation. In the misinformation experiment, 75% of participants indicated at least one Overall False Memory (OFM) in the first memory test, and 49% indicated at least one Source-Confirmed False Memory (SCFM) in the subsequent source test. As expected, we found a statistically significant misinformation effect. Participants who were exposed to misleading

post-event misinformation evidenced significantly higher Overall False Memory (Group A misinformation items: $t(191) = 2.78, p = .006$; B items: $t(158.8) = 5.89, p < .0001$; non-integer degrees of freedom are reduced appropriately when equality of variance was not assumed) and Source-Confirmed False Memory (Group A items: $t(168.9) = 2.08, p = .037$; B items: $t(171.8) = 2.59, p = .010$) compared with participants who received no misinformation on those items. The misinformation measure used in the correlations presented later in this paper was calculated by taking the z-score of the sum of the 6 misinformation items that the participant received.

Semi-autobiographical Tasks. Of the 202 participants given the suggestion about the United 93 footage, 36.6% indicated they had seen the video. Of those, 91.8% provided at least one false detail (e.g., how the plane moved/crashed, clarity of footage, length of footage). Such details could be indicative of a memory rather than just a belief that they must have seen it. All 202 participants later participated in the verbal United 93 interview, and following suggestion 20.3% of them said they had seen the footage and 6.9% said unsure/maybe, with the rest (72.8%) saying they had not seen the footage. To test whether the actual suggestion produced the false memories, we found that those in a control group who received no suggestion in the computer questionnaire did indeed have fewer false reports in the interview 40 minutes later, $t(295) = 2.44, p = .02$. In subsequent analyses below, we used the more conservative measure of false memory (i.e. the response in the verbal interview for those who had previously received suggestion).

Of the 153 participants who then participated in the imagination exercise (those who had not said “yes” they had seen the footage initially), 3.9% flipped from a full “no” to a “yes” and 31.4% increased their certainty of seeing the footage (from a “no” to a “maybe” or a “maybe” to a “yes”), with the remainder (64.7%) reporting no change. None of the participants decreased their certainty (i.e. no participant had a negative change score that would indicate a change from

“yes” or “maybe” to “no”).

In the task that asked for participants’ memory for their emotion in the week following 9/11, 60.8% reported less negative emotion from Session 1 to Session 2, whereas 34.2% reported more negative emotion. The remaining 5.0% remained consistent across sessions (mean change = -5.38, $SD = 17.44$; range -80 to +46). Interestingly, we found that exposure to the 9/11 questionnaire immediately before posttest increased negative composite emotion memory, $F(2, 290) = 5.81, p = .017$ (ANCOVA controlling for pretest scores). In subsequent analyses, presented below, we used the absolute value of this inconsistency from pre- to post-test. On this absolute composite emotion memory consistency, 12.1% were fairly consistent from one week to the next (absolute summed discrepancies between 0 and 5), whereas 87.9% were relatively inconsistent (ranging from 6 to 80). The mean absolute composite change in memory of emotion was 18.7 ($SD = 12.3$).

Internal Consistency of Individual Differences. In order to further check the quality of the dataset, we examined the Cronbach’s alpha measures of internal consistency for all the standardized individual differences measures. Table 1.1 shows high internal consistency scores on most multi-item individual difference measures. All scales range from Cronbach’s alpha of .62 to .92, with most measures above $\alpha = .7$.

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Paradigm-to-Paradigm Associations.

Does memory distortion in one paradigm predict susceptibility in other paradigms? Table 1.2 presents the correlations between memory distortions from misinformation and the

autobiographical type measures (suggestion, imagination, and memory for emotion). Figure 1 represents those correlations in terms of 95% confidence intervals. Most correlations are not significant, and effect sizes are in the small range, from $r = .01$ to $.14$. Autobiographical memory distortion, whether it is related to suggestion, imagination, or memory for emotion, does not significantly correlate with false memories in the misinformation paradigm. The only statistically significant correlation was between emotion memory inconsistency and the suggestion-generated false recall of the United 93 crash, meaning that those who said they had seen the footage also were more inconsistent in emotion memory. Surprisingly, there was a non-significant marginal *negative* relationship between misinformation false memories (Source-Confirmed) and emotion memory inconsistency. The 9/11-related imagination and suggestion measures could not be compared because they were dependent on one another and were both measured in the United 93 interview. It could be argued that due to multiple tests (7 here) that these p -values ($.04$ and $.07$ respectively) should be interpreted with caution.

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Within Misinformation Paradigm Association

Recall that the misinformation paradigm contained 6 items per participant for which misinformation was given, which allowed us to determine if individuals' performance on three of the measures correlated with their performance on the other three. We used a random generator

to choose 3 items to be group 1 items, and the other three to be group 2 items, and calculated each individual's number of overall and source-confirmed false memories for each group. We found a significant correlation between overall false memories for group 1 items and overall false memories on group 2 items (Group A participants: $r = .242, p = .019, n = 94$; Group B participants: $r = .404, p < .001, n = 99$). For source-confirmed false memory we found one non-significant correlation and one significant correlation (Group A: $r = .121, p = .247, n = 94$; Group B: $r = .352, p < .001, n = 99$).

The internal reliability statistic misinformation items on overall false memory was Chronbach's $\alpha = .318$ for the six Group A items and $\alpha = .446$ for the six Group B items. For source-confirmed false memory, Chronbach's $\alpha = .205$ for the six Group A items, and $\alpha = .318$ for the six Group B items.

Individual Differences as Predictors of Memory Distortions

Table S1.1 (see Supplemental Material) shows that only two significant associations between demographics and memory distortion: SES correlated with a small effect size with false memories of United 93 crash footage following suggestion ($r = .155$), and political orientation correlated with false memories from imagination ($r = -.161$; liberal orientation predicted slightly more false memories). However, because these are small effects and multiple comparisons suggest that these associations should be replicated (see Experiment 2).

Table 1.3 shows that fantasy-proneness significantly predicts false memory for seeing crash footage of United 93 following both suggestion and imagination. Those higher on dissociation and anxiety also had more false memories following the imagination task. All other personality measures did not significantly associate with memory distortions.

Discussion

All participants were exposed to several methods of measuring memory distortions (misinformation, crashing memory, imagination, memory of emotion), and we found that memory distortion in one paradigm did not predict false memories in other paradigms. In addition, relevant individual differences measures, for example fantasy proneness, did not show consistent predicative patterns across paradigms. The lack of a correlation between measures is in keeping with findings from Hyman and Wilkinson (1998) and Otgaar and Candel (2011), but appears to contradict other findings, such as Otgaar et al. (2012).

There are potential limitations to this study. It is possible that these findings represent a type 2 error—a failure to detect a relationship between memory distortion occurrences in different paradigms. To address this possibility we established that there is some evidence that the quality of these data was acceptable: memory distortions were reliably demonstrated in keeping with past research, and individual difference measures had appropriate reliability. Nevertheless, there is still a possibility of a type 2 error that is best explored by further research. To ensure Experiment 1 replicates, we conducted a similar procedure in Experiment 2. In addition, to investigate the relationship between the DRM paradigm and other paradigms, we added a DRM word list task to the methodology.

Experiment 2

Given the small effect sizes in Experiment 1, one significant correlation between measures, and the possibility of missing an association that does in fact exist, Experiment 2 repeats Experiment 1 with a number of changes. As noted earlier, it is unclear whether a relationship exists between performance across misinformation, DRM, and autobiographical false memory tasks. For this reason we added a DRM task to Experiment 2, as well as other changes outlined below.

Method

Participants. Undergraduate students ($n = 109$) and adults in the United States ($n = 54$), totaling 163 subjects, participated for course credit or \$40 respectively. Their mean age was 29.0 ($SD = 15.5$; range 18–76). Ethnicity was distributed as 37% Asian or Indian, 37% Caucasian, 14% Hispanic or Latino, 4% Pacific Islander, 4% African American, and 4% Native American/Alaskan. We recruited undergraduates using the university subject pool, whereas members of the public were recruited via Amazon Mechanical Turk (AMT). With this sample size, we calculated that our study would be able to find significant effects as low as $r = .16$ (G*Power calculation: $p = .22$, $\alpha = .05$, power = .8, yields $N = 159$ & critical value of $r = .16$).

Materials and procedure. Most materials and procedures were the same as in Experiment 1. Session 1 was almost identical to Session 1 Experiment 1, and involved a number of individual differences measures and the pretest for the memory for emotion measure. In Session 2, the order and timing of some of the memory distortion tasks changed. In Experiment 2, the timing between the three misinformation phases remained approximately the same, with about 40 minutes between event and misinformation phases, and about 20 minutes between misinformation and test. However, the United 93 suggestive computer-based questions were moved nearer to the end of Session 2, such that the time between the initial false suggestion on the computer and the verbal suggestion in the interview was reduced to about 15 minutes. Like Experiment 1, the memory for emotion questions came after the suggestion and computer-based questions about United 93. The subset of 54 participants recruited on AMT participated on their home computer, and the face-to-face interview at the end of Session 2 was conducted via the video conferencing program Skype.

DRM word list task. The most significant change to Experiment 2 was adding the DRM

word list task. The task occurred between phase 1 (event) and phase 2 (misinformation narratives) of the misinformation task. Twenty word lists, each 15 words long, were chosen from previous research (Roediger et al., 2001). Each word within a list was related to a critical lure that was not presented. The 20 critical lures were: Lamp, Trash, Slow, Wish, Foot, Window, Soft, Chair, River, Stove, Anger, Justice, City, Rough, Mountain, Music, Thief, Doctor, Cold, and Needle (see also Patihis et al., 2013). Following a 10 second (s) preparation screen, words were presented onscreen for 1.5 s with a 3 s blank screen between lists. After the words were presented, participants completed one filler-task page (~3 minutes) before participating in a recognition test. In the recognition test, they had to determine whether the test word had been previously shown a few minutes earlier (by choosing “old”) or whether the word had not been presented (by choosing “new”). The test was not time-limited.

Results

False memory rates. As in Experiment 1, we first document memory distortion or change occurred in each of the memory tasks.

DRM. Of the 163 participants, all had at least one recognition of critical lures that were not actually presented with a mean of 12.9 out of 20 (64.5%; range 1 to 20; $M = 12.9$, $SD = 4.45$). The mean of correct recognition of words that were presented was 12.7 out of 20 (63.5%; $SD = 3.50$; range 1 to 19). In contrast, the mean of false endorsement of words not presented (not critical lures) was 4.1 out of 20 (20.5%; $SD = 3.87$; range 0 to 16). These statistics are consistent with past research (e.g., Roediger & McDermott, 1995; Roediger et al, 2001), which has shown similar percentages of critical lure endorsement and presented word endorsement (here both around 64%) and much lower percentages for endorsement of non-presented, non-lure words (here around 20.5%). We found no statistical differences between critical-lure and presented-

word endorsement, $t(162) = .479, p = .633$; however, we did find a significant difference between critical lure endorsement and non-presented non-lure endorsement, $t(162) = 25.5, p < .0001$.

Misinformation. Of the 163 participants who completed the misinformation task, 85.9% indicated at least one overall false memory in the first test, and 57.7% indicated at least one source-confirmed false memory in the subsequent source test. As expected, we found a statistically significant misinformation effect, although only in three of the four comparisons. Participants exposed to misleading post-event misinformation had significantly higher overall false memory (Group A misinformation items: $t(107) = 3.67, p < .001$; B items: $t(107) = 2.25, p = .027$) and source-confirmed false memory on Group A misinformation items ($t(76.1) = 2.43, p = .017$), but not on Group B misinformation items ($t(105.8) = 1.12, p = .265$), although the latter finding was in the expected direction. The classic misinformation effect was reproduced for overall false memory, and partially for source-confirmed false memory.

Semi-autobiographical Tasks.

Suggestion. Of the 163 participants completing the United 93 computer questionnaire 48 (29.4%) indicated they had seen the footage. Of these, 47 (97.9%) indicated a score of 2 or above on a 10 point Likert scale in response to the question “How well do you remember seeing the footage?” (1 = *no memory at all*; 10 = *a very clear memory*) and 40 (83.3%) reported some false detail about the footage. In the subsequent interview, approximately 15 minutes later, 16.7% of the participants said they had seen the footage, 8.0% said maybe, and 75.3% said they had not seen it.

Imagination. Of the 133 participants who participated in the imagination exercise, 8.3% changed from a “no” before to a “yes” after the exercise, 33.8% went from a “no” to a “maybe”

or a “maybe” to a “yes”, with 54.1% showing no change. Five participants (3.8%) had a negative change score.

Memory for Emotion. Of the 163 people completing the 9/11 memory of emotion questionnaire, 52.8% reduced the frequency of negative emotion remembered from Session 1 to Session 2, 43.5% increased, with 3.7% were consistent (mean change = -1.94, $SD = 18.6$; range -62 to +59). We use the absolute value of this inconsistency in subsequent analyses, presented below. On this absolute composite emotion memory consistency, 8.0% were fairly consistent from one week to the next (absolute summed discrepancies between 0 and 5), whereas 92.0% were relatively inconsistent (ranging from 6 to 64). The mean absolute composite change in memory for emotion was 20.9 ($SD = 12.05$).

Internal consistency of individual differences. As in Experiment 1, to establish the quality of the data obtained for multi-item measures in the study, we examined the Cronbach’s alpha statistic for internal consistency for the individual differences measures. Table 2.1 shows high internal consistency scores on most multi-item individual difference measures, many of which included reverse coded items. Similar to Experiment 1, we found that apart from the composite of critical and flexible thinking items, all other items ranged from Cronbach’s alpha of .65 (adequately internally consistent) to .92 (high internal consistency).

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== Table 2.1 about here ==

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Paradigm to paradigm associations.

Table 2.2 shows the within-subjects associations between memory distortions from misinformation, DRM word lists, and the autobiographical-type measures (suggestion,

imagination, memory for emotion). Figure 2 represents the 95% confidence intervals of those correlations in graphical form. Most correlations were not significant, and effect sizes are in the small range, ranging from $r = .01$ to $.20$. Unlike Experiment 1, there were a couple of autobiographical memory distortions that significantly correlated with false memories in the misinformation paradigm. Surprisingly, suggestion-induced false reports of United 93 footage were significantly *negatively* correlated with overall false memories in the classic misinformation task ($r = -.20$). Emotion memory inconsistency was significantly positively correlated with misinformation. Unlike Experiment 1, there was no statistically significant correlation between emotion memory inconsistency and the suggestion-generated false recall of United 93. As noted earlier, due to multiple tests (13 here) the significant p -values of $.01$ and $.02$ should be treated with caution, and it should be noted that these correlations were not statistically reliable in Experiment 1. Memory distortions in the DRM word list task (summed critical lure hits) did not significantly correlate with the misinformation task (z-score of sum of 6 items) nor with the semi-autobiographical measures.

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== Table 2.2 about here ==

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== Figure 2.1 about here ==

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Within Paradigm Associations

Misinformation. We found no significant within-paradigm association between overall false memory on 3 randomly chosen items and false memory rates on the other 3 items (Group A

participants: $r = .179, p = .116, n = 78$; Group B participants: $r = .162, p = .139, n = 85$). For source-confirmed false memory rates we found one significant and one non-significant within-paradigm association (Group A participants: $r = .165, p = .149, n = 78$; Group B participants: $r = .269, p = .013, n = 85$).

A meta-analysis (random effects, weighted, unbiased) of the Experiment 1 and 2 within-misinformation paradigm effect sizes gives an overall effect of $r = .25, 95\% \text{ CI } [.14, .35], p = .003$ for overall false memory; and $r = .23, 95\% \text{ CI } [.12, .33], p = .005$ for source-confirmed false memory.

The internal reliability statistic misinformation items on overall false memory was Chronbach's $\alpha = .338$ for the six Group A items and $\alpha = .318$ for the six Group B items. For source-confirmed false memory, Chronbach's $\alpha = .438$ for the six Group A items, and $\alpha = .286$ for the six Group B items.

DRM. After randomly choosing 10 critical lures from the 20 in our study as group 1 items, and the rest as group 2 items, we calculated false endorsement rates for each participant for the two groups of items. We found a significant correlation between the number of group 1 critical lures recognized by a participant and the number of group 2 critical lures they endorsed ($r = .674, p < .001, N = 163$). Participants who reported recognizing more critical lures on a random sample of 10 critical lures tended to also recognize critical lures in the other 10 critical lures. The internal reliability statistic for the 20 DRM critical lure items was Chronbach's $\alpha = .821$.

Associations between Individual Differences and Memory Distortion Measures

Table S2.1 in the Supplemental Material shows the association of demographic and other variables with one measure of memory distortion/inconsistency from each of the five tasks.

Although age significantly correlated with critical lure endorsement in the DRM test ($r = .17$), and critical thinking negatively significantly correlated with source-confirmed false memories in the misinformation task ($r = -.16$), no other significant correlations were found. Note that the association between critical thinking and source-confirmed false memory from misinformation did not occur in Experiment 1. Gender, ethnicity, socio-economic status, political orientation, SAT scores, handedness, alcohol use and bilingualism all had little or no association with memory distortions in this sample (all p 's $> .05$).

Table 2.3 shows the correlations between personality measures and memory distortion/inconsistency measures. Higher trait stress susceptibility (SSP) negatively predicted critical lure endorsement in the DRM task ($r = -.16$). However, the significant predictors from Experiment 1 (absorption, fantasy proneness, & anxiety) did not replicate—they were not significant predictors in Experiment 2. Due to multiple testing and a failure to replicate across Experiments 1 and 2, these individual difference measures are not adequately diagnostic of susceptibility in any of our memory distortion measures. Perhaps surprisingly, the following were not consistently predictors of false memory: absorption, dissociation, and fantasy proneness. In addition, mindfulness, trait anxiety, assertiveness, impulsiveness, adventure seeking, detachment, social desirability, embitterment, irritability, mistrust, and trait aggression all had little or no association with memory distortion susceptibility.

Across both experiments, no single individual difference measure predicted memory distortions across more than one task. Notably, internal reliability was very high on most individual differences measures, and each paradigm was effective in producing memory distortions (e.g. significant misinformation effects for both slideshows and news footage, as well as false memories in DRM and false news footage).

Age confound check. Due to past research on older eyewitness and memory distortions (e.g., Wylie et al., 2014) there was a concern that because 12 participants were over age 60, this might confound the results. For that reason in the Supplemental material we repeated the main analysis excluding the 12 participants over age 60. We found the same pattern of results (Tables S2.2, S2.3, S2.4), indicating age was not a confound.

Recruitment method confound check. Correlations between memory distortion paradigms within students who were recruited from the university subject pool (Table S2.5), and within those recruited via AMT (Table S2.6), were all in the same negligible to small effect size range ($-.30 < r_s < .21$; just 2 of 26 comparisons statistically significant at $\alpha = .05$).

Discussion

The results of Experiment 2 revealed no substantial relationship between memory distortions among the paradigms: misinformation, DRM, crashing memory, imagination, and memory for emotion. We also found individual differences did not predict memory distortions across paradigms. As in Experiment 1, we examined indicators of data quality, such as expected memory distortion patterns and internal reliability statistics, and these indicated participants were likely sufficiently engaged in the study. Experiment 2 replicated Experiment 1, with the additional finding that the DRM paradigm was also not related to the other paradigms. In particular, the lack of a correlation between the DRM and misinformation are in keeping with some past research (e.g., Ost et al., 2013), although small effects have been found occasionally (e.g., (e.g. Zhu et al., 2013)). We discuss the deeper implications on these results next in the general discussion.

General Discussion

In two experiments, we found consistent memory distortion effects that replicate previous research. We also found high internal consistency scores in standardized individual differences measures. Most importantly, we found a dearth of evidence that memory distortion in one type of task consistently predicted susceptibility to memory distortion in other paradigms. Small but

statistically significant associations did not replicate from one experiment to the next. We also found that no single individual difference measure consistently predicted memory distortion susceptibility across false memory tasks and across the two experiments.

These findings, combined with converging current research (Bernstein, Scoboria, Desjarlais, & Soucie, 2017) and past research (e.g. Ost et al., 2013), suggest that it may be difficult to identify false-memory prone individuals who are especially susceptible to memory distortions in different contexts. Even though small statistically significant relationships have been found in previous research (e.g. Zhu et al., 2013), we did not replicate those relationships here. Instead, we found that the number of false memories in the DRM word list task did not predict memory distortion in the misinformation task, as did Ost et al., (2013). Whether these associations are small or negligible, we concur with Zhu et al.'s (2013) suggestion that different memory mechanisms are involved in the formation of false memories within each task. Semantic memory spreading activation (Collins & Loftus, 1975) may account, at least in part, for the DRM effect, whereas source-memory fading and subsequent source monitoring errors (Johnson, Hashtroudi, & Lindsay, 1993) can explain much of the misinformation effect. Note that both our DRM and misinformation effect measured recognition, and future research could investigate recall in both paradigms. We echo Ost et al.'s (2013) conclusion that false memory in one paradigm cannot be equated to false memory in another paradigm. When using the term "false memory," it might be advisable to add qualifiers such as "from misinformation," "for autobiographical memory," or "for semantically related words," for example.

We also found no relationship between false memory performance in tasks involving laboratory based stimuli and tasks that invite participants to recall information from significant news events (9/11) that are semi-autobiographical in nature. It is possible that responses in the crashing memory paradigm reflect beliefs more than they do memory, and that may explain low correlations between these paradigms (see Smeets, Telgen, Ost, Jelicic, & Merckelbach, 2009). However, we did attempt to code our crashing memory measure in such a way as to establish the

presence of memories. This lack of a relationship may add weight to Roediger and McDermott's (2013) commentary that there seems to be emerging evidence that there are two types of event memory: one involving laboratory-based stimuli and the other involving autobiographical stimuli (see also Mazzoni, 2002). The lack of a relationship that replicated between laboratory-based memory distortion and autobiographical memory distortion in our study is in keeping with findings from Hyman and Wilkinson (1998) and Otgaar and Candel (2011), but appears to contradict other findings, such as Otgaar et al. (2012) and Clancy et al. (2002). These contradictory findings notwithstanding, after consideration of all findings and all the potential problems in several of these studies, it is clear that DRM false memories should not be regarded as reliably predictive of autobiographical false memories.

We are skeptical that false memory tasks carry sufficient predictive power that they can be used as diagnostic tools. Among adults with unimpaired memory, there is currently no reliable way to identify a "false memory trait" or consistent proneness to memory distortion. It is increasingly clear that most individuals are vulnerable to memory distortions, which arise from mechanisms common to all humans. This vulnerability is in keeping with the finding that even people with strikingly superior memory abilities are susceptible to memory distortions in laboratory tasks (Patihis et al., 2013). False memory proneness may only meaningfully vary with respect to individuals with memory impairments, whereas all other individuals can develop false memories given the right circumstances. It would seem that nobody is immune to memory distortion.

However, there may be an, as yet, undiscovered group of people who are notably less susceptible across memory distortion paradigms, although support for such a claim would require replicable and robust evidence. The lack of predictive power of so many individual difference measures illustrates how difficult it is to predict memory distortions. Indeed, no correlation of an individual difference measure with memory distortion measures across the two experiments was greater than $r = .20$. Only one correlation across both studies was statistically

significant at $p = .01$. One could argue that given the large number of comparisons that this was a chance finding. Alternatively, if we used a correction of $\alpha = .001$, none of the findings would be significant. Even with a liberal critical value of $\alpha = .05$, the correlational findings were generally not revealing of a consistent meaningful relationship. Nevertheless, it should be noted that some individual differences directly related to memory ability, such as working memory capacity (Watson, Bunting, Poole, Conway, 2005, using DRM task) and memory decline in older age (older versus younger adults; Wylie et al., 2014, misinformation task), seem to be more reliably associated with memory distortion susceptibility.

In the introduction, we noted that false memories associated with many of the paradigms we studied can be explained by source monitoring errors, in particular misinformation, crashing memory, and imagination inflation; and to a lesser extent, DRM and memory of emotion. Yet despite these shared mechanisms, what does it mean that we did not find sizable correlations among the paradigms? Such null findings or low effect sizes could have a variety of explanations. One explanation could be that there is low reliability in the measures, perhaps due to correlations among items within a given paradigm, or not having sufficient items to sum in some measures to establish high reliability. Another explanation could be that despite the presence of shared mechanisms, mechanisms differ in certain respect across paradigms. For example, memory for photos, words, and news events may all engender false memories via different mechanisms during encoding, storage, or retrieval. Another possibility is that although source monitoring is a shared mechanism across tasks, source-monitoring susceptibility might not be a stable personal tendency that varies from person-to-person (i.e. it is not trait-like).

We also found that within paradigm correlations were small with respect to the misinformation effect, and moderate in the DRM. These measures are memory tasks, not personality measures, and that these within-paradigm correlations are small reinforces the our main finding that memory distortion susceptibility does not behave like a trait or tendency. This implies that false memories in one domain are not only poor predictors of false memories in

other paradigms, but also not very diagnostic of false memory susceptibility within the same domain. These findings may replicate in future research. It is not uncommon for useful measures to, nevertheless, exhibit low internal reliability if the items do not measure the same thing (e.g., trauma type subscales: Nijenhuis, Van der Hart, & Kruger, 2002; or different aspects of rationality: Stanovich, West, & Toplak, 2016). Accordingly, low internal consistency may be one possible reason for small or negligible correlations among measures. Yet such low correlations may be difficult to avoid because: (1) low correlations reflect the “true state of affairs” such that false memories do not predict one another within the same domain, (2) within- subjects tests are cognitively taxing for participants, and (3) it is difficult to disguise the true purpose of the study in experiments in which participants are administered too many false memory items. Whatever the explanation, we found that false memories did not adequately predict other false memories regardless of whether we summed items or analyzed them on an item-to-item basis. The one exception might pertain to the DRM task, but even within this paradigm, item-to-item correlations were not very high, and perhaps would be lower if the items were not all presented and tested so close together in time. One possible reason internal correlations were higher within the DRM items, compared with misinformation items, is the different mechanisms involved. Semantic networks (utilized in the DRM task) may be relatively stable within-persons and vary among persons, whereas source monitoring (utilized in the misinformation task) may not be as trait-like.

Our two experiments have a number of limitations that might be addressed in future research. For example, the autobiographical tasks involving suggestion and imagination were both related to the same news event (United 93 on 9/11). As a result of this overlap, we were unable to test the relationship between suggestion-induced autobiographical false memory and imagination-induced memory distortion. Future research could utilize different target events for these tasks. Likewise, memory for emotion could be investigated with a more elaborate design, for example, by obtaining appraisal measures before and after the manipulation (e.g.

Levine et al., 2001). Moreover, future research could investigate different variations of paradigms—for example, using recall in the DRM task, a video in the misinformation task, or an autobiographical personal memory that is not news-related.

Our findings may be useful in various domains. For instance, legal or clinical practitioners may benefit from knowing that it will be difficult (or perhaps impossible) to establish whether a given eyewitness or client is prone to memory distortion based on a single task or paradigm. A relevant recent example is a court case that raises the question of whether an alleged victim's autobiographical memory of abuse was true or false. One expert witness made the argument that because the alleged victim scored low on the Gudjonsson Suggestibility Scale it “shows she is not the type of person who is memory suggestible” (*Doe v. Hartford Roman Catholic*, 2014; p. 232; Gudjonsson, 1984). Practically speaking, the ecological validity of memory distortion paradigms have not been studied sufficiently to argue for their diagnostic use in the field to predict memory distortion susceptibility in another setting. The best assumption for practitioners is that clients, whatever their personality and even if they claim to possess exceptional memory, may be vulnerable to memory distortions.

References

- Bernstein, D.M., Scoboria, A., Desjarlais, L., & Soucie, K. (2017). *"False Memory" is a Linguistic Convenience*. Manuscript submitted for publication.
- Clancy, S. A., McNally, R. J., Schacter, D. L., Lenzenweger, M. F., & Pitman, R. K. (2002). Memory distortion in people reporting abduction by aliens. *Journal of Abnormal Psychology, 111*, 455–461.
- Clancy, S. A., Schacter, D. L., McNally, R. J., & Pitman, R. K. (2000). False recognition in women reporting recovered memories of sexual abuse. *Psychological Science, 11*, 26–31.
- Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82*, 407–428.
- Collins, A. M., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning & Verbal Behavior, 8*, 240–247.
- Crombag, H. F. M., Wagenaar, W. A., & van Koppen, P. J. (1996). Crashing memories and the problem of ‘source monitoring’. *Applied Cognitive Psychology, 10*, 95–104.
- Brown, K. W., & Ryan, R. M. (2003). The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being. *Journal of Personality and Social Psychology, 84*, 822–848.
- Doe v. Hartford Roman Catholic et al., No. X10-UWY-CV10-5015963-S (2014). Transcript of deposition of Daniel P. Brown, Ph.D., March 10, 2014. Superior Court of Waterbury, CT.
- Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58*, 17–22.
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191.
- Garry, M., Manning, C. G., Loftus, E. F., & Sherman, S. J. (1996). Imagination inflation:

- Imagining a childhood event inflates confidence that it occurred. *Psychonomic Bulletin and Review*, 3, 208–214.
- Geraerts, E., Smeets, E., Jelicic, M., van Heerden, J., & Merckelbach, H. (2005). Fantasy proneness, but not self-reported trauma is related to DRM performance of women reporting recovered memories of childhood sexual abuse. *Consciousness and Cognition*, 14, 602–612.
- Gudjonsson, G. H. (1984). A new scale of interrogative suggestibility. *Personality and Individual Differences*, 5, 303–314.
- Gustavsson, J. P., Bergman, H., Edman, G., Ekselius, L., Von Knorring, L., & Linder, J. (2000). Swedish universities Scales of Personality (SSP): construction, internal consistency and normative data. *Acta Psychiatrica Scandinavica*, 102, 217–225.
- Heaps, C., & Nash, M. (1999). Individual differences in imagination inflation. *Psychonomic Bulletin & Review*, 6, 313–318.
- Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, 114, 3–28.
- Jolliffe, D., & Farrington, D. P. (2006). Development and validation of the Basic Empathy Scale. *Journal of Adolescence*, 29, 589–611.
- Levine, L. J. (1997). Reconstructing memory for emotions. *Journal of Experimental Psychology, General*, 126, 165–177.
- Levine, L. J., Prohaska, V., Burgess, S. L., Rice, J. A., & Laulhere, T. M. (2001). Remembering past emotions: The role of current appraisals. *Cognition and Emotion*, 15, 393–417.
- Loftus, E. F. (2005). Planting misinformation in the human mind: A 30-year investigation into the malleability of memory. *Learning & Memory*, 12, 361–366.

- Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning & Memory*, 4, 19–31.
- Mazzoni, G. (2002). Naturally occurring and suggestion-dependent memory distortions; The convergence of disparate research traditions. *European Psychologist*, 7, 17–30.
- Merckelbach, H., Horselenberg, R., & Muris, P. (2001). The Creative Experiences Questionnaire (CEQ): A brief self-report measure of fantasy proneness. *Personality and Individual Differences*, 31, 987–995.
- 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), 399–404.
- Monds, L. A., Paterson, H. M., & Kemp, R. I. (2016). Do emotional stimuli enhance or impede recall relative to neutral stimuli? An investigation of two “false memory” tasks. *Memory*, 1–8.
- Nijenhuis, E. R., Van der Hart, O., & Kruger, K. (2002). The psychometric characteristics of the Traumatic Experiences Checklist (TEC): First findings among psychiatric outpatients. *Clinical Psychology & Psychotherapy*, 9, 200–210.
- Okado, Y., & Stark, C. L. (2005). Neural activity during encoding predicts false memories by misinformation. *Learning & Memory*, 12, 3–11.
- Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh Inventory. *Neuropsychologia*, 9, 97–113.
- 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.

- Otgaar, H., & Candel, I. (2011). Children's false memories: Different false memory paradigms reveal different results. *Psychology, Crime & Law*, 17, 513–528.
- Otgaar, H., Verschuere, B., Meijer, E. H., van Oorsouw, K., (2012). The origin of children's implanted false memories: Memory traces or compliance? *Acta Psychologica*, 139, 397–403.
- Otgaar, H., Scoboria, A., & Mazzoni, G. (2014). On the existence and implications of nonbelieved memories. *Current Directions in Psychological Science*, 23, 349–354.
- Patihis, L. (2012). *Memory Distortions: Individual Differences and Paradigm Comparisons*. Master's Thesis (Chair: E. F. Loftus). University of California, Irvine. Retrieved from ProQuest Theses Database: <http://gradworks.umi.com/15/12/1512095.html>
- Patihis, L., Frenda, S. J., LePort, A. K. R., Petersen, N., Nichols, R. M., Stark, C. E. L., McGaugh, J. L., & Loftus, E. F. (2013). False memories in highly superior autobiographical memory individuals. *Proceedings of the National Academy of Sciences*, 110, 20947–20952.
- Patihis, L., & Loftus, E. F. (2016). Crashing memory 2.0: False memories in adults for an upsetting childhood event. *Applied Cognitive Psychology*, 30, 41–50.
- Peters, M. J., Horselenberg, R., Jelicic, M., & Merckelbach, H. (2007). The false fame illusion in people with memories about a previous life. *Consciousness and Cognition*, 16, 162–169.
- Porter, S., Birt, A. R., Yuille, J. C., & Lehman, D. R. (2000). Negotiating false memories: Interviewer and rememberer characteristics relate to memory distortion. *Psychological Science*, 11, 507–510.
- Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning & Individual Differences*, 7, 1–75.

- 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, 803-814.
- Roediger, H. L., & McDermott, K. B. (2000). Tricks of memory. *Current Directions in Psychological Science*, 9, 123–127.
- Scherer, K. R., Schorr, A., & Johnstone, T. (Eds.). (2001). *Appraisal processes in emotion: Theory, methods, research*. Oxford University Press.
- Smeets, T., Telgen, S., Ost, J., Jelicic, M., & Merckelbach, H. (2009). What's behind crashing memories? Plausibility, belief and memory in reports of having seen non-existent images. *Applied Cognitive Psychology*, 23, 1333–1341.
- Stanovich, K. E., & West, R. F. (1997). Reasoning independently of prior belief and individual differences in actively open-minded thinking. *Journal of Educational Psychology*, 89, 342–357.
- Stanovich, K. E., West, R. F., & Toplak, M. E. (2016). *The rationality quotient: Toward a test of rational thinking*. Cambridge, MA: MIT Press.
- Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology*, 83, 268–277.
- West, R. F., Toplak, M. E., & Stanovich K. E. (2009). Heuristics and biases as measures of critical thinking: Associations with cognitive ability and thinking dispositions. *Journal of Educational Psychology*, 100, 930–941.
- Wilkinson, C., & Hyman, I. E. (1998). Individual differences related to two types of memory errors: word lists may not generalize to autobiographical memory. *Applied Cognitive*

Psychology, 12, 29-46.

- Wilson, B. M., Mickes, L., Stolarz-Fantino, S., Evrard, M., & Fantino, E. (2015). Increased false-memory susceptibility after mindfulness meditation. *Psychological Science*, 26, 1567–1573.
- Wright, D., & Loftus, E. F. (1999). Measuring dissociation: Comparison of alternative forms of the dissociative experiences scale. *American Journal of Psychology*, 112, 497–519.
- Wylie, L. E., Patihis, L., McCuller, L. L., Davis, D., Brank, E. M., Loftus, E. F., & Bornstein, B. H. (2014). Misinformation effects in older versus younger adults: A meta-analysis and review. In M. P. Toglia, D. F. Ross, J. Pozzulo, & E. Pica (Eds.) *The Elderly Eyewitness in Court*, UK: Psychology Press.
- Zhu, B., Chen, C., Loftus, E. F., Lin, C., & Dong, Q. (2013). The relationship between DRM and misinformation false memories. *Memory & cognition*, 41, 832–838.

Table 1.1

Cronbach's Alpha Internal Consistency Scores for Multi-item Individual Difference Measures in Experiment 1

Individual Difference Measure	Cronbach's Alpha
Dispositional Variables:	
Absorption (Tellegen Absorption Scale ^a ; 34 items)	.920
Dissociative Experiences Scale (DES-C ^b ; 28 items)	.712
Fantasy Prone (Creative Experiences Scale ^c ; 25 items)	.729
Mindfulness (MAAS; 15 item)	.878
<i>Basic Empathy Scale^d (20 items)</i>	.811
Affective Empathy (BES; 11 items)	.809
Cognitive Empathy (BES; 9 items)	.700
<i>Personality Traits (SSP; 91 items):</i>	
Somatic Trait Anxiety (7 items)	.693
Psychic Trait Anxiety (7 items)	.744
Stress Susceptibility (7 items)	.658
Lack Of Assertiveness (7 items)	.698
Impulsiveness (7 items)	.682
Adventure Seeking (7 items)	.782
Detachment (7 items)	.618
Social Desirability (7 items)	.670
Embitterment (7 items)	.654
Trait Irritability (7 items)	.821
Mistrust (7 items)	.779
Verbal Trait Aggression (7 items)	.665
Physical Trait Aggression (7 items)	.828
Political Variables:	
Belief in a Dangerous World (12 item)	.819
Political Orientation (3 item)	.826

Note. This table analysis includes participants in memory distortion control conditions, so $N = 390$. All measures demonstrate adequate to high internal consistency. ^aTellegen & Atkinson, 1974. ^bWright & Loftus, 1999. ^cMerckelbach, Horselenberg, & Muris, 2001. ^dJolliffe & Farrington (2006). MAAS = Mindful Attention Awareness Scale (Brown & Ryan, 2003). SSP = Swedish Scale of Personality (Gustavsson et al., 2000).

Table 1.2

Experiment 1 Intercorrelations between Memory Distortion Measures

	Suggestion: U93 Crash Footage ^a		Imagination: U93 Crash Footage ^b		Emotion Memory Inconsistency ^c	
	<i>r</i>	95% CI	<i>r</i>	95% CI	<i>r</i>	95% CI
Misinformation OFM _z	.048	[-.09, .19]	-.009	[-.17, .15]	.070	[-.07, .21]
Misinformation SCFM _z	-.010	[-.15, .13]	-.032	[-.19, .13]	-.134	[-.27, .01]
Suggestion: U93 Crash	—	—	—	—	.144	[.005, .28]
Imagination: U93 Crash	—	—	—	—	.027	[-.13, .19]

Notes. Significant correlation shown in **boldface**. aUnited 93 crash interview verbal response following suggestion to “Have you seen that footage?” (Coded “yes” = 0, “maybe” = .5, “no” = 0). bChange in whether they reported seeing the footage from before to after the imagination exercise in the United 93 crash interview (coded 1 for a change from “no” before to “yes” afterwards, .5 for a change from “no” to “maybe” or “maybe” to “yes”, and 0 for no change). cThe absolute value of the composite change in memory for negative emotions after 911, from week 1 to week 2. OFM_z = overall false memory (z-adjusted around misinformation group mean). SCFM_z = source-confirmed false memory (z-adjusted). By design our 9/11 related imagination and suggestion measures could not be compared.

Table 1.3

Associations of Personality Measures with Memory Paradigms for Experiment 1

	Misinfo SCFM _z ^a	Suggestion: U93 Crash ^b	Imagination: U93 Crash ^c	Memory for Emotion ^d
Absorption (TAS)	.062	.033	.200	-.017
Dissociation (DES-C)	-.052	.081	.168*	.042
Fantasy Prone (CEQ)	.068	.182**	.195*	.094
Mindfulness (MAAS)	.101	-.041	-.111	-.071
Empathy (BES)	.005	.049	-.002	-.031
<i>Personality Traits (SSP)</i>				
Somatic Anxiety	.029	.022	.188*	.007
Psychic Anxiety	.046	-.051	.172*	-.007
Stress Susceptibility	.042	.016	.094	.038
Lack of Assertiveness	-.037	-.071	.212	.031
Impulsiveness	-.010	.029	-.004	.005
Adventure Seeking	-.015	-.015	.102	.044
Detachment	-.046	-.160	.016	-.048
Social Desirability	-.060	-.008	-.086	-.035
Embitterment	.025	-.030	.133	-.001
Irritability	-.101	.045	.122	.047
Mistrust	.077	-.048	.097	.024
Verbal Aggression	-.040	.012	-.089	-.034
Physical Aggression	-.026	-.040	-.014	.021

Notes. Pearson *r* correlations shown. Statistically significant correlations at $\alpha = .05$ are shown in **boldface**. [†] $p < .1$, * $p < .05$, ** $p < .01$.

^a Source-Confirmed False Memory z-score adjusted (SCFM_z). $N = 193$. ^b False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). $N = 202$. ^c Increase in certainty of seeing United 93 crash footage following the imagination inflation exercise in the interview. $N = 153$. ^d Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. $N = 199$. TAS = Tellegen Absorption Scale. DES-C = Dissociative Experiences Scale, version C. CEQ = Creative Experiences Questionnaire. MAAS = Mindful Attention Awareness Scale. BES = Basic Empathy Scale. SSP = Swedish Universities Scale of Personality.

Table 2.1

Cronbach's Alpha Internal Consistency Scores for Multi-item Individual Difference Measures in Experiment 2

Individual Difference Measure	Cronbach's Alpha
Dispositional Variables:	
Absorption (Tellegen Absorption Scale, TAS; 34 items) ^a	.921
Dissociative Experiences Scale (DES-C; 28 items) ^b	.917
Fantasy Prone (Creative Experiences Scale, CEQ; 25 items) ^c	.767
Mindfulness (MAAS; 15 item)	.891
<i>Basic Empathy Scale (20 items)^d</i>	.800
Affective Empathy (BES; 11 items)	.795
Cognitive Empathy (BES; 9 items)	.754
<i>Personality Traits (SSP; 91 items):</i>	
Somatic Trait Anxiety (7 items)	.696
Psychic Trait Anxiety (7 items)	.793
Stress Susceptibility (7 items)	.724
Lack Of Assertiveness (7 items)	.780
Impulsiveness (7 items)	.646
Adventure Seeking (7 items)	.859
Detachment (7 items)	.670
Social Desirability (7 items)	.649
Embitterment (7 items)	.732
Trait Irritability (7 items)	.809
Mistrust (7 items)	.793
Verbal Trait Aggression (7 items)	.771
Physical Trait Aggression (7 items)	.867
Political Variables:	
Belief in a Dangerous World (12 item)	.872
Political Orientation (3 item)	.837

Note. $N = 163$. All measures here demonstrate adequate to high internal consistency. ^aTellegen & Atkinson, 1974. ^bWright & Loftus, 1999. ^cMerckelbach, Horselenberg, & Muris, 2001. ^dJolliffe & Farrington (2006). MAAS = Mindful Attention Awareness Scale (Brown & Ryan, 2003). SSP = Swedish Scale of Personality (Gustavsson et al., 2000)

Table 2.2

Experiment 2 Intercorrelations between Memory Distortion Measures

	DRM critical lures endorsed		Suggestion: U93 Crash ^a		Imagination: U93 Crash ^b		Emotion Memory Inconsistency ^c	
	<i>r</i>	95% CI	<i>r</i>	95% CI	<i>r</i>	95% CI	<i>r</i>	95% CI
Misinfo OFM _z	.014	[-.14, .17]	-.196	[-.34, -.04]	.119	[-.04, .27]	.094	[-.06, .24]
Misinfo SCFM _z	.007	[-.15, .16]	-.113	[-.26, .04]	.166	[-.004, .33]	.177	[.02, .32]
Suggest: Crash	.045	[-.11, .20]	—	—	—	—	.009	[-.15, .16]
Imagin: Crash	.055	[-.12, .22]	—	—	—	—	-.079	[-.25, .09]
Emotion Mem,	-.038	[-.19, .12]	—	—	—	—	—	—

Notes. Significant correlations shown in **boldface**. ^aUnited 93 crash interview verbal response following suggestion to “Have you seen that footage?” (Coded “yes” = 0, “maybe” = .5, “no” = 0). ^bChange in whether they reported seeing the footage from before to after the imagination exercise in the United 93 crash interview (coded 1 for a change from “no” before to “yes” afterwards, .5 for a change from “no” to “maybe” or “maybe” to “yes”, and 0 for no change). ^cThe absolute value of the composite change in memory for negative emotions after 911, from week 1 to week 2. OFM_z = overall false memory (z-adjusted around misinformation group mean). SCFM_z = Source-Confirmed false memory (z-adjusted). *N* = 163 apart from those involving the imagination task where *N* = 133.

Table 2.3

Associations of Personality Measures with Memory Paradigms for Experiment 2

	DRM Lures Endorsed	Misinfo SCFM ^a	Suggestion: U93 Crash ^b	Imagination U93 Crash ^c	Memory for Emotion ^d
Absorption (TAS)	-.001	-.035	.048	.043	.025
Dissociation (DES-C)	.045	-.055	.102	-.056	-.080
Fantasy Prone (CEQ)	.002	-.005	.031	.063	-.070
Mindfulness (MAAS)	.089	.033	-.044	-.018	.034
Empathy (BES)	.017	-.029	-.016	.045	-.009
<i>Personality Traits</i>					
<i>(SSP)</i>					
Somatic Anxiety	-.015	.003	.039	-.014	.078
Psychic Anxiety	-.071	.053	-.023	-.069	-.064
Stress Suscept.	-.156*	-.029	-.002	-.114	-.090
Lack Assertiveness	-.086	-.057	-.054	-.082	-.069
Impulsiveness	.063	.014	-.042	-.079	.075
Adventure Seeking	.018	-.062	.048	.007	.066
Detachment	-.087	.078	-.008	-.071	.077
Social Desirability	.056	.011	.066	.014	.126
Embitterment	-.138 [†]	.084	-.028	-.030	-.013
Irritability	-.023	<.001	-.043	-.113	.039
Mistrust	-.103	.152 [†]	-.035	-.075	.020
Verbal Aggression	.002	.002	.046	-.028	-.053
Physical Aggression	.049	.085	.006	-.047	<.001

Notes. Pearson r correlations shown. Statistically significant correlations at $\alpha = .05$ are shown in **boldface**. [†] $p < .1$, * $p < .05$, ** $p < .01$. $N = 163$ for each column except the imagination column where $N = 133$.

^a Source-Confirmed False Memory z-score adjusted (SCFM_z). ^b False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). ^c Increase in certainty of seeing United 93 crash footage following the imagination inflation exercise in the interview. ^d Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. TAS = Tellegen Absorption Scale. DES-C = Dissociative Experiences Scale, version C. CEQ = Creative Experiences Questionnaire. MAAS = Mindful Attention Awareness Scale. BES = Basic Empathy Scale. SSP = Swedish Universities Scale of Personality.

Figure 1. Experiment 1: within-subject memory distortion paradigm to paradigm correlations, r , with 95% CI of r . Most correlations were not statistically significant, $p > .05$, except the correlation between Emotion Memory Consistency and United 93 Crash Suggestion, $p = .048$. As shown, the effect size for most comparisons is close to zero, with the CI crossing zero. Paradigm pair 1 = Misinformation OFM_z & Crash Suggestion. 2 = Misinformation SCFM_z & Crash Suggestion. 3 = Misinformation OFM_z & Crash Imagination. 4 = Misinformation SCFM_z & Crash Imagination. 5 = Misinformation OFM_z & Emotion Memory. 6 = Misinformation SCFM_z & Emotion Memory. 7 = Emotion Memory & Crash Suggestion. 8 = Emotion Memory & Crash Suggestion. See Table 2 for numeric values.

Figure 2. Within subject memory paradigm to paradigm correlations, r , with 95% CI of r . As shown, the effect size for most comparisons are close to zero, with the CI crossing zero (p 's > .05), see text for exceptions. Paradigm pair 1 = DRM & Misinformation (OFM_z). 2 = DRM & Crash Suggestion. 3 = DRM & Crash Imagination. 4 = DRM & Emotion Memory. 5 = Misinformation & Crash Suggestion. 6 = Misinformation & Crash Imagination. 7 = Misinformation & Emotion Memory. 8 = Emotion Memory & Crash Suggestion. 9 = Emotion Memory & Crash Imagination. For numeric values and misinformation SCFM values see Table 4.

Supplemental Method and Material

United 93 Interview Script

The last thing is a 5 minute recorded interview that is anonymous and confidential, so we will just use your participant number during the interview, and not your name. Please speak as freely as possible and answer all of questions with as much detail as you can. We are looking for what you really remember, there are no right or wrong answers, and it is okay if there is anything you cannot remember.

[AT THE BEGINNING OF EACH INTERVIEW START THE RECORDING WITH THE FOLLOWING WORDS]

“This is participant number _ _ _ _”

I want to ask you a few questions about how well you remember news events. As you might recall, on September 11, 2001, two planes were flown into the world trade center in New York City, one plane was flown into the Pentagon in Washington DC, and another plane, United 93 crashed into a field in rural Pennsylvania. The plane crash in Pennsylvania is the event we are interested in asking you about.

The other crashes on 9/11 have already been studied, so we are focusing only on United 93, the one that crashed in a field in Pennsylvania.

Are you familiar with this event?

Can you tell me what you remember about the event?

[LISTEN TO CHECK THEY UNDERSTAND IT IS ABOUT THE CRASH INTO THE FIELD]

As you might know, a witness on the ground in Pennsylvania took some video of the plane crashing and it has been widely shown on TV news and the Internet in the months and years since the attack.

Do you remember seeing that footage?

[IF YES]

Can you tell me what you remember about the footage?

[FREE RESPONSE]

Can you describe how the plane moved in the footage?

Do you remember how the plane crashed in the video?

How did you feel when you saw the footage of United 93 crash in Pennsylvania?

How vivid is your memory of that footage of the crash?

Do you remember how long the video is?

Do you remember if the video had sound?

If you did see the footage, where did you see it first? (Was it on the internet or TV, if so which channel)

Can you remember any additional details? Take a moment to think if you like.

Okay, now I'd like you to tell me how well you can remember having seen the video on a scale from 1 to 10 , where 1 means no memory at all and 10 means a very clear memory. **[END OF INTERVIEW]**

[IF NO]

Sometimes memories fade so we can't remember them, especially ones that are unpleasant or traumatic. However, we can use techniques that can help us find those memories.

[TALK SLOWLY, RAPPORT] If you don't mind, I'd like for you to close your eyes for a few moments. I would like you to use your imagination and try to picture what the footage may have looked like. Imagine you are watching it on your television or your computer screen. You are watching a video of the plane crashing, taken by a witness who is standing in a grassy field near the crash site. Just take a few moments and let any images or sounds come into your head.

[LET MORE THAN 30 SECONDS PASS DURING THIS EXERCISE, INCLUDING 10 SECONDS OF SILENCE AFTER THE LAST SENTENCE]

Keeping your eyes closed, can you describe to me what you are seeing in your mind's eye?

[PARTICIPANT RESPONDS - WAIT FOR THEM TO STOP TALKING AND WAIT A FEW SECONDS BEFORE MOVING ON]

Can you describe how the plane moves?

Describe how the plane crashes in the video?

What does the aftermath look like?

What about the people filming the video, do you hear them talking?

(You can now open your eyes).

Actually, several of the details you are giving me are exactly consistent with the video. So that's really good. Do you feel like you might be remembering the footage?

Do you remember how long the video is?

Where would you have been when you first saw it, right after 9/11?

Do you remember how you felt after seeing it?

Can you remember any additional details? Take a moment to think, if you like.

Okay, now I'd like you to tell me how well you can remember having seen the video on a scale from 1 to 10, where 1 means no memory at all and 10 means a very clear memory.

Okay, now that the interview is over, I would like to ask you just one last question - Did you indicate that you had seen the United 93 footage in the computer questionnaire?

[If Yes]: Can you tell me why your answer changed from yes to no between the computer questionnaire and this interview? **[END OF INTERVIEW]**

Supplemental Results for Experiment 1

Table S1.1

Associations of Individual Differences with Memory Paradigms for Experiment 1

	Misinfo SCFM ^a	Suggestion: U93 Crash ^b	Imagination: U93 Crash ^c	Memory for Emotion ^d
<i>Demographics</i>				
Gender ^e	-.019	.025	.078	.026
Age	-.039	-.027	-.041	.076
Ethnicity ^f	-.037	.069	-.011	.023
Family SES	-.011	.155*	.030	.054
Year in College	.019	.038	-.015	.084
Major in College ^g	.099	-.033	-.005	-.020
Political Orientation ^h	-.003	.002	-.161*	-.087
<i>Cognitive Ability</i>				
SAT Total	-.011	.059	-.150	-.104
<i>Rationality measures</i>				
Critical Thinking Score	-.050	-.056	-.107	-.056
Flexible Thinking Scale	-.127 [†]	.028	.032	-.016
<i>Other</i>				
Handedness	-.049	.010	.014	.041
Alcohol Use	.021	.082	.011	.027
Number Fluent Languages	.113	.065	.030	.092

Notes. Pearson *r* correlations shown. Statistically significant correlations are in **boldface** ($\alpha = .05$). [†] $p < .1$, * $p < .05$, ** $p < .01$, ^a Source-Confirmed False Memory z-score adjusted (SCFM_z). *N* = 193. ^b False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). *N* = 202. ^c Increase in certainty of seeing United 93 crash footage following the imagination exercise in the interview. *N* = 153. ^d Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. *N* = 199. ^e Males coded 1, females 2. ^f Point by serial correlation: Caucasian (coded 1) vs. non-Caucasian (coded 0). ^g Psychology/criminology (eyewitness testimony related subjects) coded 1, others coded 0. ^h Summed average of social, fiscal, and foreign policy political orientations, with Likert scales from very liberal (1) to very conservative (7), ^j "Yes" coded as 1, "No" coded as 0. ^k Likert scale from 1 (not at all patriotic) to 10 (extremely patriotic). ^l Likert scale from 1 (completely disagree) to 10 (completely agree).

Supplemental Results for Experiment 2

Table S2.1

Associations of Individual Differences with Memory Paradigms for Experiment 2

	DRM Lures Endorsed	Misinfo SCFM ^a	Suggestion: U93 Crash ^b	Imagination U93 Crash ^c	Memory for Emotion ^d
<i>Demographics</i>					
Gender ^e	-.002	.013	.065	-.029	.147 [†]
Age	.168*	.097	-.090	.113	.063
Ethnicity ^f	-.068	-.093	.037	.130	-.038
Family SES	.102	-.088	.087	.101	-.093
Political Orientation ^h	.058	.042	-.068	.081	.014
<i>Cognitive Ability</i>					
SAT Total	-.159	-.103	-.001	-.210 [†]	.037
<i>Rationality measures</i>					
Critical Thinking	.083	-.159*	-.011	.013	-.116
Flexible Thinking	.070	-.046	.022	-.109	-.070
<i>Other</i>					
Handedness	-.118	.044	-.024	.196	.070
Alcohol Use	.002	-.145 [†]	-.007	.048	-.111
Number Fluent Lang	.030	.001	.092	-.183	.117

Notes. Pearson r correlations shown. Statistically significant correlations are in **boldface** ($\alpha = .05$). [†] $p < .1$, * $p < .05$, ** $p < .01$. $N = 163$ for each column except the imagination column where $N = 133$. ^a Source-Confirmed False Memory z-score adjusted (SCFM_z). ^b False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). ^c Increase in certainty of seeing United 93 crash footage following the imagination exercise in the interview. ^d Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. ^e Females coded 1, males 0. ^f Point by serial correlation: Caucasian (coded 1) vs. non-Caucasian (coded 0). ^g Psychology/criminology (eyewitness testimony related subjects) coded 1, others coded 0. ^h Summed average of social, fiscal, and foreign policy political orientations, with Likert scales from very liberal (1) to very conservative (7). ⁱ "Yes" coded as 1, "No" coded as 0. ^k Likert scale from 1 (not at all patriotic) to 10 (extremely patriotic). ^l Likert scale from 1 (completely disagree) to 10 (completely agree).

Experiment 2 Supplemental Results

Excluding Individuals over Age 60 Analysis

Table S2.2

Excluding Participants over Age 60: Experiment 2 Intercorrelations between Memory Distortion Measures

	DRM critical lures endorsed		Suggestion: U93 Crash ^a		Imagination: U93 Crash ^b		Emotion Memory Inconsistency ^c	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Misinfo OFM _z	.013	.871	-.216	.008	.129	.156	.087	.287
Misinfo SCFM _z	-.017	.839	-.145	.077	.174	.055	.156	.055
Suggestion: U93	.074	.369	—	—	—	—	.023	.784
Imagination: U93	-.003	.976	—	—	—	—	-.099	.278
Emo Mem Inconsis	-.046	.571	—	—	—	—	—	—

Note. Significant correlation shown in **boldface**. ^aUnited 93 crash interview verbal response following suggestion to “Have you seen that footage?” (Coded “yes” = 0, “maybe” = .5, “no” = 0). ^bChange in whether they reported seeing the footage from before to after the imagination exercise in the United 93 crash interview (coded 1 for a change from “no” before to “yes” afterwards, .5 for a change from “no” to “maybe” or “maybe” to “yes”, and 0 for no change). ^cThe absolute value of the composite change in memory for negative emotions after 911, from week 1 to week 2. OFM_z = overall false memory (z-adjusted around misinformation group mean). SCFM_z = Source-Confirmed false memory (z-adjusted). *N* = 151 apart from those involving the imagination task where *N* = 122.

Table S2.3

Excluding Participants over Age 60: Associations of Individual Differences with Memory Paradigms for Experiment 2

	DRM Lures Endorsed	Misinfo SCFM ^a	Suggestion: U93 Crash ^b	Imagination U93 Crash ^c	Memory for Emotion ^d
<i>Demographics</i>					
Gender ^e	-.006	-.024	.078	-.035	.145 [†]
Age	.135 [†]	.043	-.028	-.034	.080
Ethnicity ^f	-.092	-.096	.061	.091	-.045
Family SES	.116	-.083	.098	.052	-.091
Political Orientation ^h	.008	-.024	-.061	.032	.010
<i>Cognitive Ability</i>					
SAT Total	-.103	-.040	-.018	-.175	.008
<i>Rationality measures</i>					
Critical Thinking	.076	-.121	.001	.004	-.112
Flexible Thinking	.081	.000	.036	-.108	-.033
<i>Other</i>					
Handedness	-.145 [†]	.015	-.005	.194*	.067
Alcohol Use	-.036	-.189*	.018	-.062	-.088
Number Fluent Lang	.058	.013	.079	-.159	.104

Notes. Pearson *r* correlations shown. Statistically significant correlations are in **boldface** ($\alpha = .05$). [†] $p < .1$, * $p < .05$, ** $p < .01$. *N* = 163 for each column except the imagination column where *N* = 133. ^a Source-Confirmed False Memory z-score adjusted (SCFM_z). ^b False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). ^c Increase in certainty of seeing United 93 crash footage following the imagination exercise in the interview. ^d Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. ^e Females coded 1, males 0. ^f Point by serial correlation: Caucasian (coded 1) vs. non-Caucasian (coded 0). ^g Psychology/criminology (eyewitness testimony related subjects) coded 1, others coded 0. ^h Summed average of social, fiscal, and foreign policy political orientations, with Likert scales from very liberal (1) to very conservative (7). ⁱ "Yes" coded as 1, "No" coded as 0. ^k Likert scale from 1 (not at all patriotic) to 10 (extremely patriotic). ^l Likert scale from 1 (completely disagree) to 10 (completely agree).

Table S2.4

Excluding Participants over Age 60: Associations of Personality Measures with Memory Paradigms for Experiment 2

	DRM Lures Endorsed	Misinfo SCFM ^a	Suggestion: U93 Crash ^b	Imagination U93 Crash ^c	Memory for Emotion ^d
Absorption (TAS)	-.018	.014	.067	.008	.028
Dissociation (DES-C)	.082	-.034	.086	.002	-.098
Fantasy Prone (CEQ)	.018	.038	.007	.115	-.058
Mindfulness (MAAS)	.067	-.004	-.028	-.098	.040
Empathy (BES)	.001	-.021	-.017	.040	-.024
<i>Personality Traits (SSP)</i>					
Somatic Anxiety	-.007	-.003	.024	.041	.074
Psychic Anxiety	-.081	.032	-.036	-.035	-.080
Stress Suscept.	-.167*	-.047	-.020	-.074	-.104
Lack Assertiveness	-.102	-.084	-.066	-.067	-.075
Impulsiveness	.071	.006	-.063	-.073	.060
Adventure Seeking	.030	-.015	.041	.010	.068
Detachment	-.094	.039	-.038	-.029	.092
Social Desirability	.035	.029	.103	-.016	.134
Embitterment	-.111	.117	-.065	.047	-.026
Irritability	.013	.026	-.076	-.025	.032
Mistrust	-.097	.153	-.062	-.020	.013
Verbal Aggression	.043	.048	.014	.030	-.061
Physical Aggression	.084	.101	-.013	.0005	-.009

Notes. Pearson *r* correlations shown. Statistically significant correlations at $\alpha = .05$ are shown in **boldface**. [†] $p < .1$, * $p < .05$, ** $p < .01$. *N* = 150 for each column except the imagination column where *N* = 122.

^a Source-Confirmed False Memory z-score adjusted (SCFM_z). ^b False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). ^c Increase in certainty of seeing United 93 crash footage following the imagination inflation exercise in the interview. ^d Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. TAS = Tellegen Absorption Scale. DES-C = Dissociative Experiences Scale, version C. CEQ = Creative Experiences Questionnaire. MAAS = Mindful Attention Awareness Scale. BES = Basic Empathy Scale. SSP = Swedish Universities Scale of Personality

Correlations within Students Only (Tables S2.5), and Separately Within AMT Recruited Participants (Tables S2.6) Subsamples in Study 2

Table S2.5

Within Students Only: Experiment 2 Intercorrelations between Memory Distortion Measures

	DRM critical lures endorsed		Suggestion: U93 Crash ^a		Imagination: U93 Crash ^b		Emotion Memory Inconsistency ^c	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Misinfo OFM _z	.109	.260	-.101	.295	.067	.537	.160	.096
Misinfo SCFM _z	.039	.688	-.010	.917	.192	.073	.199	.038
Suggestion: U93	<.001	.996	—	—	—	—	.177	.066
Imagination: U93	.028	.793	—	—	—	—	-.148	.169
Emo Mem Inconsis	-.050	.604	—	—	—	—	—	—

Note. Significant correlation shown in **boldface**. ^aUnited 93 crash interview verbal response following suggestion to “Have you seen that footage?” (Coded “yes” = 0, “maybe” = .5, “no” = 0). ^bChange in whether they reported seeing the footage from before to after the imagination exercise in the United 93 crash interview (coded 1 for a change from “no” before to “yes” afterwards, .5 for a change from “no” to “maybe” or “maybe” to “yes”, and 0 for no change). ^cThe absolute value of the composite change in memory for negative emotions after 911, from week 1 to week 2. OFM_z = overall false memory (z-adjusted around misinformation group mean). SCFM_z = Source-Confirmed false memory (z-adjusted). *N* = 109 apart from those involving the imagination task where *N* = 88.

Table S2.6

Within AMT Recruited US Adults Only: Experiment 2 Intercorrelations between Memory Distortion Measures

	DRM critical lures endorsed		Suggestion: U93 Crash ^a		Imagination: U93 Crash ^b		Emotion Memory Inconsistency ^c	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Misinfo OFM _z	-.298	.028	-.007	.961	.210	.166	-.081	.560
Misinfo SCFM _z	-.096	.492	-.015	.913	.132	.389	.134	.334
Suggestion: U93	-.085	.543	—	—	—	—	.209	.130
Imagination: U93	.058	.705	—	—	—	—	.059	.700
Emo Mem Inconsis	-.052	.710	—	—	—	—	—	—

Note. Significant correlation shown in **boldface**. ^aUnited 93 crash interview verbal response following suggestion to “Have you seen that footage?” (Coded “yes” = 0, “maybe” = .5, “no” = 0). ^bChange in whether they reported seeing the footage from before to after the imagination exercise in the United 93 crash interview (coded 1 for a change from “no” before to “yes” afterwards, .5 for a change from “no” to “maybe” or “maybe” to “yes”, and 0 for no change). ^cThe absolute value of the composite change in memory for negative emotions after 911, from week 1 to week 2. OFM_z = overall false memory (z-adjusted around misinformation group mean). SCFM_z = Source-Confirmed false memory (z-adjusted). *N* = 54 apart from those involving the imagination task where *N* = 45.