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Memory Distortions: Individual Differences and Paradigm Comparisons

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by

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ABSTRACT OF THE THESIS

Memory Distortions: Individual Differences and Paradigm Comparisons

By

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Decades of research on memory distortion have shown that false memories can be created in a variety of ways. But a question that remains unanswered is whether there is a certain type of person that is more prone to memory distortions than others. Is there a false memory trait? One way to address this question is to explore whether the same individuals who show false memories in one memory paradigm are also more likely to have false memories in other paradigms. Despite the several memory distortion paradigms that have been developed over the last 30 years, there has been little research comparing paradigms within subjects. In the present study, undergraduates (N = 393) participated in an experiment that included four paradigms: classic misinformation, crashing memory (with target event United 93), imagination inflation, and inconsistency in memory for emotion. After confirming that each paradigm worked in producing memory distortions, we found that susceptibility to false memory in one paradigm did not predict susceptibility in another. Patterns of individual differences predicting paradigms confirmed the weak interrelation between paradigms. For example, performance on a

classic misinformation experiment did not predict whether someone would be more likely to say they saw nonexistent footage of a plane crash 10 years ago.

Memory Distortions: Individual Differences and Paradigm Comparisons

Chapter 1: Introduction

Memory distortions have been studied extensively over the last three decades (for a review see Loftus, 2005). One frequently used paradigm for studying memory distortion has produced a phenomenon known as the "misinformation effect," where misleading post-event information distorts memory for a previously experienced event. Another popular paradigm, known as the "crashing memory" paradigm, has demonstrated that following suggestion, people falsely report remembering that they had seen footage for a widely reported news-related event, where in fact no footage exists. This is called the crashing memory paradigm because the target event that was initially used was a plane crash (see Crombag, Wagenaar, & van Koppen, 1996). Another memory distortion paradigm is imagination inflation, where the process of imagining a counterfactual event leads to increased confidence in a person that they actually experienced the imagined event (see Garry, Manning, Loftus, & Sherman, 1996). Although not traditionally considered a memory distortion paradigm, research has also suggested that memory for felt emotion is reconstructed, malleable, and related to current appraisals (Levine, 1997). Thus memory for previously felt emotions can also be distorted.

In the present study we investigate these four paradigms, to see if there is a false memory trait, that is, whether the same people who have false memories in one are more susceptible to others. If one paradigm does predict another, this could tell us something about the extent of shared underlying mechanisms. In this introduction, we first touch on

the theories that relate to memory distortion, past research on each of the four memory paradigms, how paradigms have compared, and then outline our present study.

Theory

There are a number of theories discussed in the literature that are related to the phenomenon of memory distortion.

Source monitoring. In source monitoring theory, false memories arise due to a difficulty in distinguishing the source of a memory or imagining (Johnson, Hashtroudi, & Lindsay, 1993). This theory can be used to explain why imagining an event that did not actually occur can lead to misremembering the event as actually happening. According to this theory we store traces of memories, events, imaginings, and knowledge, but in some circumstances we mistake the original source of those traces. This can be used to explain why post-event misleading information would produce false memories, because the person mistakes the source of the misinformation as coming from the original event.

Fuzzy-trace. In fuzzy-trace theory, false memories are produced when gist memory traces of original events are relied upon to recall the event (Reyna & Brainerd, 1995). Since the more detailed and factual verbatim memory trace fade away more quickly, after time passes, people only have gist memory to work with. Fuzzy trace theory can be used to explain the phenomena of the false recall of a word that was not actually presented, but was semantically related to words that were actually presented, as in the Deese-Roediger-McDermott test (DRM; Deese, 1959; Roediger & McDermott, 1995). It may also be used to explain why people report they had seen footage of a plane crash, when in fact the footage does not exist (as in crashing memory studies). People

may remember the gist of seeing a plane crash, or just a gist memory that a plane crashed, but the verbatim memory that contained knowledge of the actual details of the news-report (including the detail of actually not seeing footage) is lost to decay.

Spreading activation. Spreading activation theory states that information that is perceived triggers a cascade of associations of other similar objects, facts, knowledge, or memories (Quillian, 1967; Collins & Loftus, 1975). For example the words "fire engine" would activate the word "red" because it is closely associated to it in a web-like structure of associations. These associations affect how we perceive and remember things. This theory, like fuzzy-trace theory, can explain why people might falsely recall seeing nonexistent footage of a plane crash. The original news-report, though devoid of actual footage, would create strong associations with actual plane crash footage of previous or subsequent news-stories. If these activated associations remain strong, they may be used to reconstruct memory later.

Appraisal theory of emotion. Appraisal theory of emotion states that the intensity and type of emotion depends upon how we cognitively appraise the situation (see Lazarus, 1991; Frijda, 1987; Scherer, Schorr, & Johnstone, 2001). We appraise people, objects, or events, in terms of whether our goals are harmed or benefited, and we also assess our ability to cope. For example if there is a threat in which the goal of survival is blocked, that will create anger if it appraised as being blocked deliberately, and if the goal is still attainable (anger is a pre-goal emotion). This theory does a good job at explaining why memory for past emotion can be inconsistent, in keeping with our current reappraisals of the past event. Appraisal and the related theory of affective adaptation are discussed further in the memory for emotion section of this introduction.

Misinformation Paradigm

There is considerable support for the notion that post-event misleading information can distort the memory of the original event (for a review of the misinformation effect: see Loftus, 2005). In a typical misinformation experiment, participants first see some image, event, or series of events. Later they are given misleading information about what they had originally seen. In the final testing phase many participants incorporate the misinformation into their memory for the original event. For example, in one study (Powers, Andriks, & Loftus, 1979), college students looked at a series of photographs depicting a theft of a wallet. Some participants received misleading post-event information, while a control group received no misleading post-event information. Results showed those who received misinformation made more errors than those who had not.

More recently, as one of many other examples of a misinformation experiment, Okado and Stark (2005) showed participants photograph slideshows. For example, one showed a man breaking into a car or and another showed a woman having her wallet stolen by a man who seemed to be helping her. Participants assigned to the misinformation condition, for example received a post-event narrative that incorrectly said the man breaking into the car had used a coat-hanger (in the photographic slideshow he actually had used a credit card). Results showed that many of those given misinformation claimed to have seen the misinformation in the original slideshow.

Individual differences and misinformation. There have been several studies investigating individual differences in the misinformation paradigm. Measures related to intelligence have been found to either negatively correlate (Zhu et al., 2010b, used

the Weschler Adult Intelligence Scale, WAIS) or not correlate at all (Powers, Andriks, & Loftus, 1979; using an SAT-like pre-college Washington state test) with false memory arising from misinformation. While SAT-like scores correlate highly with the psychometric measure, g, general intelligence (Frey & Detterman, 2004), they may capture achievement as well as intelligence. On the other hand, administering intelligence tests such as the WAIS may lead to correlations related to the motivation, effort, or energy of participants throughout the time period of that particular study - and it is possible that those third variables may cause both less false memories and higher intelligence test scores.

Perceptual ability, performance in standard memory tests, and facial recognition have been found to negatively correlate with misinformation false memories (Zhu et al., 2010b; with effect sizes ranging from r = .08 to .29). This makes sense in that the more perceptual and memory ability/capacity a person has, the more likely they are to notice differences between misinformation narratives and the original event.

Some personality traits have been found to predict false memory from misinformation. Liebman et al. (2002) found that openness, modesty and altruism correlated positively with misinformation false memory. Zhu et al. (2010a) found that both self directedness and persistence traits correlated positively with false memories in a misinformation experiment.

Crashing Memory Paradigm

Crashing memory studies involve asking participants if they have seen footage for a widely reported news event, often involving a crash, when in fact no video footage of the event really exists. In one of the first crashing memory studies,

Crombag, Wagenaar, and van Koppen (1996) told participants there was videotape of a widely reported Boeing 747 crash into an apartment building in Amsterdam. Although the actual plane crash had not been filmed, an astonishing 55% in Study 1 and 66% in Study 2 of the participants reported seeing the footage and many reported details of its contents. In a similar type of study Ost, Vrij, Costall, and Bull (2002) asked participants if they had seen footage of the car crash in which Princess Diana was killed, and 44% reported they had. No footage of this crash actually exists. A memory characteristic questionnaire (MCQ) was administered to get detailed information about whether the memory was vivid, or whether it was just a belief without imagery. The MCQ scores did not reliably distinguish between the false memories and some true news-event memories that the participants were also asked about. This indicates that those participants who reported false memories did not indicate that those memories had the characteristics of merely imagined memories. Those false memories looked similar in nature to true memories.

Other researchers have since replicated this remarkably high rate of false recall of nonexistent news footage. Granhag, Stromwall, and Billings (2003) found that 55% of respondents reported that they saw footage of a well-known incident involving a sinking ferry, again when no video recording actually exists. Wilson and French (2006) asked participants to recall the details of a total of five news events, only four of which have actual film footage, as well as recall the details of their whereabouts when the news footage was shown. In this case the non-filmed event was a bombing in a Bali nightclub, and 36% reported that they had seen the footage.

Ost, Granhag, Udell, and Hjelmsäter (2008) asked participants, 150 from Sweden and 150 from the United Kingdom to complete questionnaires about the explosion of the No. 30 bus in Tavistock Square, London. United Kingdom participants were more likely to say they had seen nonexistent computer-generated image of the explosion, and nonexistent television footage of the explosion, compared to the Swedish participants. United Kingdom patrons who claimed to have memories of seeing the bus explode self reported higher scores on the Dissociative Experiences Scale (DES-C; Wright & Loftus, 1999) which is a measure of self-reported lapses in memory and cognition.

Sjödén, Granhag, Ost, and Hjelmsäter (2009) asked 80 creative arts students and 80 other students of no preferred major if they had seen nonexistent footage of an attack on a Swedish foreign minister. They were then asked for more details of the footage if they answered yes. Although creative arts student did demonstrate more fantasy proneness, they were no more likely than the other students to exhibit false memories. Overall, 19% of the sample had false memories of the footage.

For a summary of most of the crashing memory studies published so far, see Table 1.1. As you can see, most of the published studies on the false recall of nonexistent news-footage have found that a large minority of participants not only reported having seen the video footage, but they were also willing to answer detailed questions about the video recordings.

Individual differences and crashing false memory. Not much research has been done investigating individual differences and crashing memories. In some studies, females were more prone to false report (Crombag et al., 1996; Jelicic et al,, 2006a,

2006b) but not in other studies (Ost et al., 2002, Granhag et al., 2003, Smeets et al., 2009). With regards to personality related measures, Ost et al. (2008) found that those scoring high on the Dissociative Experiences Scale (DES-C) or the Creative Experiences Scale (CEQ; Merckelbach, Horselenberg, & Muris, 2001) were more likely to give definitive details of nonexistent footage (of the bus moving in the London bus bombings).

Table 1.1

Descriptive Statistics for Various Crashing Memory Studies in Chronological Order

First author, year	Participants	Sample Size N	% "yes" saw footage	% of N gave details	Level of Misinformation	% Male	Mean age at time of news	Time since event (years)[a]	Type of News Event
Crombag 1996 (S1)	students	193	55.44	45.08	Medium-High	50.26	29.04	0.83	plane crash
Crombag 1996 (S2)	students	93	65.59	44.09	Medium-High	37.63	19.76	2.00	plane crash
Ost 2002	public	45	44.44	not measured	High	34.33	29.85	0.75	car crash
Granhag 2003 (S1)	students	107	38.32	19.63	Medium	36.45	18.50	8.00	sinking ship
Granhag 2003 (S2)	students	75	54.67	30.67	Medium	53.33	15.50	8.00	sinking ship
Ost 2006	students	48	39.58	not measured	Medium-High	60.42	21.33	0.38	Bali bombing
Jelicic 2006a	students	76	6.58	5.26	Low	48.68	21.02	0.58	assassination
Jelicic 2006b	students	83	62.65	22.89	Low-Medium	46.99	19.40	2.00	assassination
Smeets 2006 (C1)	public	30	63.00	33.33	Medium-High	43.30	36.00	3.00	assassination
Smeets 2006 (C2)	public	30	30.00	20.00	High	43.30	34.80	3.00	assassination
Smeets 2006 (C3)	public	30	30.00	23.33	Low	36.70	33.60	3.00	assassination
Smeets 2006 (C4)	public	30	27.00	6.66	None	40.00	35.60	3.00	assassination
Wilson 2006	public	100	36.00	35.00	Medium-High	42.00	30.40	3.00	Bali bombing
Ost 2008 (UK)	students	50	40.00	24.00	Low-Medium	46.94	20.29	0.25	bus bombing
Ost 2008 (Swedish)	students	50	16.00	6.00	Low-Medium	34.59	22.76	0.25	bus bombing
Smeets 2009	public	88	65.91	6.82	Medium	45.45	30.00	4.00	assassination
Sjödén 2009	students	160	64.00	18.75	High	40.67	21.42	3.25	assassination
Frenda 2010	students	143	50.35	34.97	High	8.39	10.75	9.00	plane crash

Note. [a] Years between original news event and experiment.

Imagination Inflation Paradigm

In this area of research, participants typically undergo an imagination exercise, much like guided imagery, in which they picture a counterfactual past event happening in their mind's eye. Later on, they sometimes come to recall an event that did not happen, or they increase their confidence that an event happened which they have previously said was unlikely to have happened. In line with the latter, one of the pioneering experiments found that participants would increase their confidence that uncommon childhood events had occurred on a Life Events Inventory (LEI) in response to an imagination exercise (Garry et al., 1996). Participants filled in an LEI two weeks before the imagination exercise, and then filled in the LEI again after the exercise. Subjects who received the imagination exercise showed greater increases in confidence that a given event had occurred in childhood, compared to a control group who did not receive an imagination exercise on those items. Such events included getting into trouble for calling 911, breaking a window with one's hand, or getting stuck in a tree.

Individual differences in imagination inflation. Paddock et al. (1998) found that scores on the Dissociative Experiences Scale (DES; Bernstein & Putman, 1986) correlated with imagination inflation (r = .35), as did locus of control (ANSIE; r = .22). Heaps and Nash (1999) found that hypnotic suggestibility and DES positively correlated with imagination inflation change scores (r = .35 and.34 respectively). However, Horselenberg et al. (2000) did not find significant correlations between the DES (r = -.03) nor social desirability (r = .04) and imagination inflation. They did find though, that those higher on imagery ability (Questionnaire upon Mental Imagery

scale; QMI; Sheehan, 1967) were significantly related to higher change scores on the LEI produced by imagination inflation.

Memory for Emotion Paradigm

Although there has long been good evidence that memory in general is reconstructed, up until recently there was little research on whether this was also true for memories of felt emotion. There is something particularly treasured about emotional memories, and it is particularly comforting to think that memory for our emotions are indelible and unchanging. Indeed, LeDoux, Romanski, and Xagoraris (1989) interpreted their neurobiological research on fear responses in rats as evidence for emotion indelibility. They reported that cortical ablations did not obliterate fear responses, but in fact prolonged extinction. They explained this by suggesting that sub-cortical brain structures formed an indelible store of emotional memory. LeDoux (1992) went on to suggest that other studies on emotion and the amygdala suggested that emotional memories are indelible and maintained by feedback loops in the limbic system. However, in contrast to this view of emotional memory indelibility, Ross (1989) found that personal histories are reconstructed and can change as people remember their autobiographical pasts in a way that helps them maintain an image consistent with their current self-appraisal. In addition, research on events that have emotional weight (such as weapons focus studies) reveal that memory during an emotional event can be unreliable, especially for peripheral details (Davis and Loftus, 2009).

Levine (1997) investigated the indelibility or inconsistency of emotion memory, and was one of the first to find that memory for emotions are reconstructed according to

present appraisals of the original event. In Levine's study, 227 Perot-supporters rated their initial emotional reactions (sad, anger, hope) 2 weeks after Ross Perot withdrew from the 1992 presidential race. Perot reentered the race in October, and after a relatively good showing in the November elections, 147 of the same supporters again indicated their memory of their initial emotion reactions to his withdrawal. Levine found that how the supporters now evaluated Perot influenced their memory for their initial emotions after he originally withdrew. For example, those who stayed loyal to Perot overestimated how hopeful they were when Perot withdrew. Those supporters that left the campaign and then returned to support Perot underestimated their initial anger. Those supporters who turned against Perot underestimated how hopeful and sad they were when he withdrew (in comparison to those loyal and returning supporters). These results suggested that LeDoux (1992) and other previous theorists may have been wrong when stating that the memories for the emotional significance of events are stored permanently.

Appraisal theory of emotion. Levine's findings are more consistent with Ross' (1991) suggestion that emotions are not stored, rather reconstructed - much in keeping with the goal-based *appraisal theory* of emotions (see Lazarus, 1991; Frijda, 1987; Scherer, Schorr, & Johnstone, 2001). The tenets of appraisal theory involve an interplay of goals and the cognitive appraisal of those goals. The cognitive appraisal of the situation looks for objects or people who either block or help goal attainment. For example, anger is considered a pre-goal negative emotion, and is usually directed at an object or person who is appraised to block that goal.

Inconsistencies in memory for emotion can be explained by the fact that the appraisal of the situation has changed from one time-point to another. The change of

goals and motivations will certainly change your *current* emotions. If memory for felt emotions is reconstructed according to current appraisals, we would predict that memory for emotion will be inconsistent if there are any changes in appraisals over time.

More recent studies have reinforced Levine's (1997) finding that memory for emotion is reconstructed according to current appraisals. For example, Levine, Prohaska, Burgess, Rice, and Laulhere (2001) found that memory for happiness, anger, and surprise following the verdict of O.J. Simpson changed in a way consistent with participants' appraisals of Simpson's innocence or guilt at the time of recall. In addition, Levine, Whalen, Henker, and Jamner (2005) found that those who appraised the September 11, 2001 attacks as having less impact at the time of recall (adolescents) recalled lower negative emotion than those who reported more impact (parents). This is consistent with the aspect of appraisal theory of emotion that requires an event to be highly relevant to oneself and ones goals in order to elicit a strong affective reaction.

Affective adaptation theory. Affective adaptation is the process that leads to weakened affect about a stimulus after repeated exposures to the stimulus. For example if you ask people immediately after an event, their current emotion will be stronger then (initially), than if you ask them again 6 months later about how they currently feel about the event. Wilson and Gilbert (2008) sought to unify and add to these principles by proposing the Attend, React, Explain and Adapt (AREA) model. It posits that if an unexplained event happens that is relevant to one's goals, first you *attend* to the event. This evokes a strong affective *reaction* to the event, which in turn is attempted to be *explained*, or made sense of. If the explanation successfully makes sense of the emotion-arousing stimulus, the person *adapts* in a way that leads to a weaker affective reaction. In

this theory, novelty and surprise serve central roles in both the "attend" and the "react" stages. When an event is novel and/or surprising, it tends to elicit a stronger affective reaction. It is the explaining away of a novel event that reduces the intensity of affective reactions.

Affective adaptation theory, as well as explaining present and future affective phenomena, can also explain why the intensity of emotions recalled may diminish in time. In fact, the theory offers two possible mechanisms: that of novelty/surprise and that of making sense of the event. In a typical study that measures how memory for emotion changes, the same questions about how the participant felt immediately after the event are asked at two time points (this is similar to what we did in the current study, discussed below). For example, imagine that at Time 1, a person was asked "in the week immediately after the disaster how often did you feel the following emotions: sadness, anger...," using a Likert scale ranging from "not at all" to "all the time." At Time 2 the same questions are re-asked. When the questions are re-asked at Time 2, the question itself is no longer new or surprising, and affective adaptation theory would predict less *present* emotion. Since current affect is lower, and since emotion for memory is reconstructed using our current state (see Eich & Macaulay, 2000), one might expect the report of past felt emotion after a significant event to be less at Time 2.

An alternative explanation for the phenomena is that making sense of (or explaining) an event reduces recall of felt emotion from Time 1 to Time 2. At Time 1, when a participant is asked to remember how they felt immediately after an event, they then start a process of making sense or explaining the event, and it's relation to their goals. By the of Time 2, if the participant has processed and made sense of the original

event after Time 1, affective adaptation would predict that they will report remembering less emotion at Time 2.

Individual differences in inconsistency in memory for past emotion. There are few studies that investigate the role of individual differences in the stability of memory for emotion. Levine et al. (2005) found that adolescents and parents were both inconsistent in recalling their emotions, but adolescents decreased whereas parents increased their report of past emotion intensity. Therefore the age cohort of the participants will likely influence how they reappraise past events, and can modify change in emotion memory. Other research has found that those high on neuroticism have a tendency to overestimate past negative emotion (Safer & Keuler, 2002; Feldman, 1997). Safer, Levine, and Drapalski (2002) found that personality measures of neuroticism and depression was associated with *overestimating* negative emotion, whereas self esteem and optimism were associated with *underestimating* pre-exam negative emotions.

Paradigm Comparisons

Published studies that have put the same participants through more than one memory distortion paradigm, and then compared the inter-relations between paradigms are few and far between. Otgaar, Verschuere, Meijer, and van Oorsouw (2012) found that memory distortions in word list recall (DRM) predicted rich false memories in children (η^2_p = .14). Clancy, McNally, Schacter, Lenzenweger, and Pitman (2002) found that those who reported memories of alien abduction (presumably a rich false memory) tended to have more false memories on the DRM test. Clancy, Schacter, McNally, and Pitman (2000) also found that women who reported recovered memories of childhood sexual abuse were more prone to false recognition on the DRM test. However, Wilkinson and

Hyman (1998) found that false memory on the DRM and false autobiographical memories from an imagination exercise were not related.

At most, past studies have exposed subjects to two paradigms and explored whether susceptibility in the two was related. To our knowledge, within subjects comparisons between the four paradigms examined in the present study (misinformation, crashing, imagination, and memory for emotion) have not been done.

The Present Study

In this study we not only explored whether performance in one paradigm predicts susceptibility in another, but we also examined whether individual differences were related to the degree of memory distortion in all paradigms in the same way, or if they vary by paradigm. In this way, we attempted to test the hypothesis that there is a type of person who is especially prone to false memory. Put another way, we asked whether the same people are vulnerable to distortion in the different paradigms. If so, we would expect to find two results: 1. False memory endorsement in one paradigm would predict higher susceptibility in another paradigm, and 2. Individual differences patterns would be similar in all paradigms, and we would expect some characteristics to predict memory distortions in all four paradigms. If we find a false memory trait it may have implications in real world applications related to memory in the legal system and clinical psychology. Our findings may also give us clues as to whether there are mechanisms shared between paradigms. It may give us an indication as to whether multiple theories are still needed to explain memory distortions, or whether they can be unified.

Chapter 2: Method

Participants

Four hundred and seven undergraduate students participated for course credit, and 14 did not participate in the second session. Of the 393 participants who completed the study, 378 completed the misinformation effect experiment, 293 received a crashing memory interview, and 241 participated in a imagination inflation exercise in that interview. Of the 393 subjects, 74.8% were female. The ethnic distribution was 49.4% Asian/Indian, 21.1% Caucasian, 15.3% Hispanic/Latino, 7.6% Middle Eastern, 3.6% Hawaiian/Pacific Islander, 2.5% African American / Black, and .5% other. The mean age was 20.2 years (*SD* = 3.0; range 18 to 51 years). See Table 2.1 for the distribution of participants by their college major and year in college.

Table 2.1
Participant Characteristics: College Major and Year in College

	Frequency	Percent
Arts and Humanities	21	5.3
Biological Science	78	19.8
Business or Economics	26	6.6
Physical and Computer Sciences	23	5.9
Cognitive Sciences	29	7.4
Criminology, Law, and Society	19	4.8
Psychology and Social Behavior	120	30.5
Public Health	32	8.1
Sociology or Social Ecology	16	4.1
Undecided / Undeclared	29	7.4
Dichotomized:		
Psychology or Eyewitness Testimony Related Field	184	46.8
Non-Psychology Related Field	209	53.2
Year in College:		
Freshman [a]	153	38.9
Sophomore	70	17.8
Junior	108	27.5
Senior	62	15.8

Note. Total *N* = 393.
[a] Freshman, Sophomore, Junior, and Senior are typically, but not always, years 1, 2, 3, and 4 respectively.

Design: Brief Overview of the Basic Experiment

The main design of the study consisted of exposing every participant to two experiments, a misinformation effect experiment and a false recall of nonexistent news-footage experiment (also called a "crashing memory" experiment). Each participant was randomly assigned into one of two conditions in the misinformation experiment, and into one of three conditions in the crashing memory experiment.

Misinformation experiment. In this three-stage experiment, participants first saw two photographic slideshows, then 40 minutes later, they saw a text narrative which contained six items of misinformation, and then 20 minutes later were tested on their memory for the original photographic slideshow. In the misinformation effect experiment, participants were randomly assigned to either Group A or Group B. Group A participants received 6 narrative items that contain misinformation, whilst Group B received a different set of 6 misinformation narratives items. In this way, Group B served as the control groups on Group A's misinformation items, and vice versa.

Crashing memory experiment. In this experiment, participants were randomly assigned into three conditions. Half the participants were assigned to the United 93 Footage condition in which they read in the computer questionnaire that there is footage of the United 93 plane crashing into a field on September 11, 2001, and asked about their memory for the *footage*. There is actually no footage of United 93 crashing. A quarter of the participants were assigned to the United 93 No Footage control condition and read that there was no footage and asked about their memory of the news story *event*. A quarter of participants were assigned to the Human Genome control condition and were asked about their memory of the 2001 Human Genome news-story event. Pretest and

posttest measures of various variables were taken one week before the news-story questionnaire, and immediately after the news-story questionnaire (for more details, see Materials and Procedures, below).

Forty minutes after the computerized news-story questionnaire, those in the United 93 Footage and the Human Genome condition participated in a follow-up 5-10 minute recorded interview. In the person-to-person audio-recorded interview, they were verbally told about the crashes on September, 11, 2001, and were told that there is footage for the United 93 crash into a field. They are then asked if they remember seeing the footage. Those who said "yes" they remember the footage were asked follow-up questions about the details. Those who said "no" were taken through an imagination inflation exercise in which they imagined seeing the footage on a TV or computer. They then were asked if they now remember seeing the footage, and were then asked questions about what details they can remember. All interview participants were asked at the end of the interview to rate how well they remember the footage on a scale from 1 (no memory) to 10 (a very clear memory).

Materials and Procedure

When participants signed up for the study online, they read the cover story that the study was about personality, individuality, and slideshows. Participants came into 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 8-computer laboratory room at any given time, with two research assistants supervising. The lab room was windowless and mostly silent. Random assignment was determined ahead of time using the random

sequence generator at the website random.org. The research assistants who interacted with the participants were kept blind to the conditions by numbering conditions from 1 to 6, and by not explaining that numbering to the research assistants. Research assistants were kept blind to the precise hypotheses during data collection, although all research assistants understood it was a memory distortion experiment.

Session 1. Once assigned a participant number, and randomly assigned to condition, the participant proceeded to fill out the computer questionnaires. They answered demographic questions and self-reported their Scholastic Assessment Test (SAT) scores and current college grade point average (GPA) scores.

SAT scores as a proxy for cognitive ability. SAT scores were collected to serve as a proxy for cognitive capacity/ability, in a similar way to was done by Stanovich and West's (1997, 2007) work investigating cognitive ability and rationality. Using the SAT as a proxy measure of cognitive ability is reasonable because it correlates highly with working memory, which is a key indicator of cognitive ability (Colom, Rebollo, Palacios, Juan-Espinosa, & Kyllonen, 2004; Conway, Kane, & Engle, 2003; Engle, 2002; Engle, Tuholski, Laughlin, & Conway, 1999; Kane, Hambrick, Tuholski, Wilhelm, Payne, & Engle, 2004; as cited in Stanovich & West, 2007). SAT scores are also highly related (r = .82) to the psychometric measure of g, general intelligence (Frey & Detterman, 2004).

The mean reported SAT score were verbal/reading 580.33 (SD = 80.18), mathematical 612.035 (SD = 102.00), writing 591.97 (SD = 100.64). These self-reported scores approximately match the averages for this university (580, 624, and 586, respectively for students who entered the university in 2010; UC Irvine Office of

Institutional Research, 2011). Therefore, we have no reason to believe self report unduly inflated or deflated participants' estimates of their SAT scores.

The writing requirement for the SATs was added in 2006, which changed the way one can calculate the total possible points. However, the average SAT scores on the math and verbal/reading sections have been consistently close to 500, by design, every year since 1972 (College Board, 2010). These facts were taken into account in the analysis, for example care was taken to ensure the scores we analyzed were not confounded by having different total possible scores. Almost all participants took their SATs after 2006, so this was not difficult to achieve.

Pretest questions. These pretest measures asked about political orientation and views towards terrorism; air travel anxiety (a subscale from the Air-Travel Stress Scale; Bricker, 2005); Belief in a Dangerous World Scale (BDWS, 12 item; Altemeyer, 1988, p. 195-196), and memory for felt emotion and behaviors in the week following September 11, 2001. These pretest questions were asked again in Session 2 immediately after the crashing memory computer questionnaire (posttest).

Individual differences and personality measures. In addition to those pretest questions, participants also completed the Instructional Manipulation Check (Oppenheimer, Meyvis, & Davidenko, 2009), Alcohol Use Scale (modified from LaBrie, Hummer, Grant, & Lac, 2010), Creative Experiences Scale (fantasy proneness; Merckelbach, Muris, & Rassin, 1999; Merckelbach, Horselenberg, & Muris, 2001), media exposure questions, Dissociated Experiences Scale (DES-C; Wright & Loftus, 1999), Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003), and the

Tellegen Absorption Scale (Tellegen & Atkinson, 1974). Session 1 typically took participants about 35 minutes to complete.

Sleep log. After finishing Session 1, participants were given a sleep-log sheet which they filled out each morning for seven days. Each day's sleep log contained questions related to the length of sleep, naps, awakenings, etc. These sleep logs typically took a couple of minutes to complete each morning. This measure was taken because previous research has shown a relationship between sleep and false memories (see Diekelmann, Born, & Wagner, 2010).

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 get started on 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. See Appendix A for the misinformation materials we used.

Crashing memory questionnaire. Depending on which condition they were assigned to, participants either completed a news story questionnaire asking about their

memory for United 93 crash footage (experimental condition), the United 93 news event (a control group), or the Human Genome news event (a second control group). Each questionnaire was similar in construction and length and differed only in the memory recall target (i.e. the targets were United 93 crash footage, United 93 news-event, and the Human Genome news-event). See Appendix B for the crashing memory materials used in the computer questionnaire.

United 93 Crash Footage condition. In this condition, participants were told that footage of the crash exists and has been widely shown, and were then asked whether they had seen the footage. They were then asked to indicate details of the footage, and then proceeded to fill out a Memory Characteristics Questionnaire about their memory for the footage (MCQ, modified from Johnson, Foley, Suengas, & Raye, 1988; Laney, 2006). This condition acted as the experimental condition, simulating the crashing memory manipulations of previous studies.

United 93 News Event condition. In this condition participants received the same materials, except they were told there was no crash footage, and were instead asked about their memory for the United 93 news-*event.* This condition acted as a control condition, in which there is no suggestion, but still exposure to similar questions about the United 93 crash. This condition helped us to distinguish the effect of answering questions about United 93 and the suggestion that there is footage of the crash.

Human Genome condition. In this condition neither United 93 nor September 11, 2001 were mentioned at all. Instead, participants were asked a similar set of questions about their memory for the Human Genome news-event that was reported in 2001. This condition acted as a control condition that both has no suggestion of nonexistent footage

(as the United 93 News Event condition), but also does not stimulate any imagery of United 93 or 9/11. This condition, in combination with the other two, helps us distinguish between the effect of priming 9/11 imagery from the suggestion of nonexistent footage. Having these three conditions was particularly important for pretest to posttest comparisons.

Crashing memory posttest questions. Immediately following the crashing memory questionnaire, participants completed a series of posttest measures on politics, air travel anxiety, belief in a dangerous world, and memory for felt emotion and behavior after September 11, 2001 (identically worded questions to the pretest measures in Session 1).

Individual differences and personality measures: Filler 1. Subjects then completed a series of rationality/critical-thinking measures (West, Toplak, & Stanovich, 2009; but also see Kirkpatrick & Epstein, 1992; Levesque, 1986, 1989; Tversky & Kahneman, 1974; Stanovich, 2009) and the Flexible Thinking Scale (FTS; Stanovich & West, 1997). See Appendix E for the critical and flexible thinking questions that were used. After those questions came the 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 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 the photographs were shown originally.

The participants were asked to stay focused on reading and to follow the story for the whole time. 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 6 misinformation items. Group A participants received a different set of six misinformation items than Group B did. 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 gave no misinformation about the color. 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). So in effect Group A and Group B served as control groups for one another.

Swedish Universities Scale of Personality (SSP): Filler 2. This 91-item personality scale was administered between the misinformation stage and the test phase of the misinformation experiment. The SSP is based on the Karolinska Scales of Personality (Schalling & Edman, 1993) and was improved by reducing the number of items, and increasing validity, reliability, and response spread (Gustavsson et al., 2000). The SSP contains 13 subscales measuring traits that are summarized in Table 2.2. An example of one of the seven items measuring social desirability is "I'm always polite and self-controlled, regardless of whom I talk to." The participant then indicated how much the statement fits with their personality on a Likert scale from 1 to 4, where 1 is anchored as "does not apply at all" and 4 as "applies completely." The SSP was chosen due to its good psychometric properties and because we wanted to use a different personality scale

than used previously in memory distortion research. This was done to see if past correlations with false memory were due to an artifact or limitation of a given scale, or actually a robust correlation truly related to a trait regardless of the instrument used.

Table 2.2
Subscales of the Swedish Scales of Personality (SSP)

SSP Personality Trait Subscale	Description of participants scoring high on subscale
Somatic trait anxiety	Autonomic disturbances, restless, tense
Psychic trait anxiety	Worrying, anticipating, lacking self-confidence
Stress susceptibility	Easily fatigued, feeling uneasy when urged to speed up
Lack of assertiveness	Lacks ability to speak up and to be self-assertive in social situations
Impulsiveness	Acting on the spur of the moment, non-planning, impulsive
Adventure seeking	Avoiding routine, need for change and action
Detachment	Avoiding involvement in others, withdrawn, 'schizoid'
Social desirability	Socially conforming, friendly, helpful
Embitterment	Unsatisfied, blaming and envying others
Trait Irritability	Irritable, lacking patience
Mistrust	Suspicious, distrusting people's motives
Verbal trait aggression	Getting into arguments, berating people when annoyed
Physical trait Aggression	Getting into fights, starts fights, hits back

Note. Wording used in right column are the original descriptions from Gustavsson et al. (2000).

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. Each question contained one answer choice that was correct (actually shown in the original photographic slideshows), and two incorrect items. For a given participant, 6 of these 18 questions related to items they had received

misinformation about in the text narrative. On those items, one of the options was correct (consistent with photographs in original slideshow), one option was the misinformation (incorrect because not shown in photographic slideshow, but was embedded as misleading text in the narratives), and the other option was a foil (a wrong answer that was not suggested). If participants endorsed the misinformation item in this test, it was considered a possible memory distortion, and is called an Overall False Memory (OFM).

Source test. After all the test questions were answered, participants moved onto a page asking about the source of their answers on the previous page. To each of the 18 questions they had previously answered, they were given an opportunity to indicate where they had seen that detail. 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. If participants both endorse an misinformation item in the test, and then go on to choose options (a) or (c) in the source test, it is considered a Robust False Memory (RFM). We can be more confident that a Robust False Memory is an actual memory distortion, compared to an Overall False Memory.

United 93 crash footage interviews. In this audio-recorded structured interview, participants were taken away from the other participants into a sound proof room. In an one-on-one conversation with the research assistant, face-to-face, participants were told that there is footage for the crash of United 93, and then asked if they remember it. No such footage actually exists. See Appendix C for the interview script. Since subjects in the United 93 News-Event condition were previously told there is no footage of the crash, they did not participate in this interview. Therefore, only those assigned to the United 93

Crash Footage condition or the Human Genome condition participated in the interview (in other words three-quarters of the sample). In the interview, those participants who said "yes" they had seen the footage were then asked follow up questions about details.

Imagination inflation exercise in the interview. Those 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 are then taken through an imagination inflation 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 "so that's really good." They are then asked if they might be remembering the footage. They are then asked follow up questions about details of the footage.

All participants, regardless of whether the said "yes" or "no" to the critical question, were asked at the end of the interview to say how well they remember seeing the footage on a scale from 1 to 10 (where 1 means no memory at all, and 10 means a very clear memory). A minority of the subgroup participants who had indicated they had seen the footage in the computer questionnaire, but then said "no" to the same question in the interview, were asked why their answer had changed.

Last step and debriefing. Participants then completed some questions on the computer about what they thought the true purpose of the study was. They were asked to indicate if and when they became suspicious of the study's cover story. Next, they answered 9 questions about to what degree they agreed with a series of statements about the working of memory. For example, they were asked memory with memory reliability,

hypnotic retrieval, permanent storage, photographic memories, and memory repression. On the next page of the computer questionnaire, participant were asked if they had enrolled in classes related to memory distortion. Then came the debriefing, which revealed that the study was actually about memory distortions, and that there is no footage of the United 93 crash. The typical duration of Session 2 was between 60 and 75 minutes.

Quantitative Coding of Interview Responses

Two research assistants, both blind to the experimental conditions and blind to the non-obvious hypotheses in the study, coded the responses to several of the key interviews questions. All interviews were coded by two independent coders (research assistants), and any inter-rater disagreements were scrutinized carefully and resolved by a supervising researcher and one of the research assistants. The question asking about whether the participant was familiar with United 93 was coded as 0 = no, .5 = unsure/maybe, and 1 = yes, and the initial inter-rater agreement rate was 78% (66 disagreements out of 297; Cronbach $\alpha = .839$). Whether someone was familiar with the United 93 news event was not always easy to code, because sometimes participants would start out by saying "a bit" but then go on to give details to demonstrate that they were fully familiar. These difficult-to-code cases were carefully recoded whenever research assistant's initial coding did not match. 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 $\alpha = .955$ and .935). The question asking how well the participants remember the video on a scale from 1 to

10 was straightforward to code, and the inter-rater agreement rate was 99% (Cronbach α = .996).

Chapter 3 - Results

In order to be sure that the paradigm comparisons have any meaning, we first have to establish that each of the four paradigms successfully produced evidence of memory distortion. We do so in the following order: the misinformation effect, crashing memory, imagination inflation, and then memory for felt emotion. It will become clear that we were able to produce memory distortions in each of the paradigms. Having established that the paradigms worked, we then examined which individual difference variables predict susceptibility in each paradigm, and whether a given individual difference measure predicted more than one paradigm. We then compared the paradigms to see if performance in one predicts performance in others.

Misinformation Experiment

Misinformation main analysis. Of the 378 who completed the misinformation experiment, 74.6% endorsed at least one misinformation item (Overall False Memory, OFM) at the test phase, and 47.4% of participants indicated at least one Robust False Memory (RFM) by specifically indicating they had seen it in the original slideshows. As a reminder, OFM means that when asked what was in the original slideshows participant incorrectly indicate the misinformation, and RFM means the participant not only did that, but they also went on in follow-up source-test questions to explicitly indicate that they had seen the misinformation in the original photographic slideshows. Figure 3.1 shows the frequency distribution of both OFM and RFM. These results indicated that the

misinformation effect seemed to work in broad sense. We next compared experimental and control group performance.

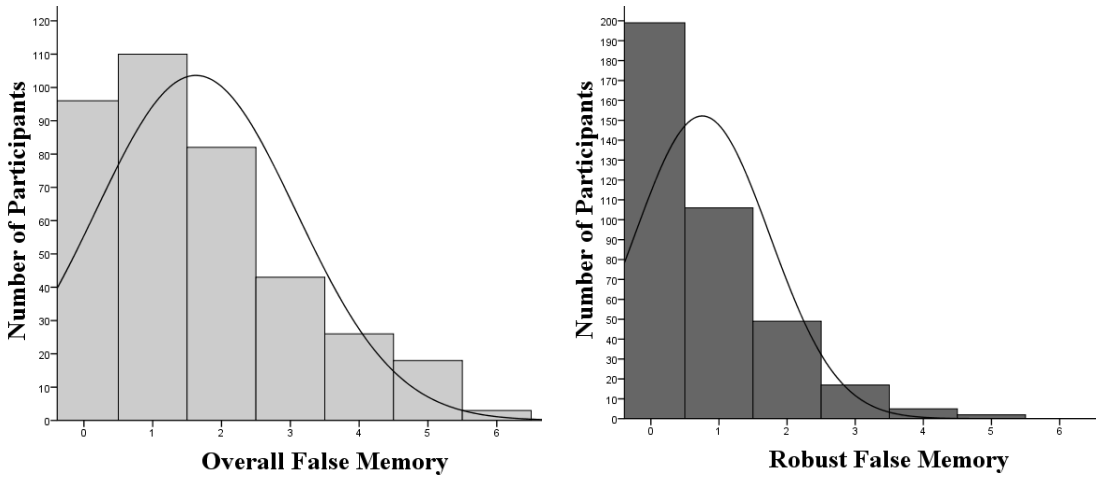

Figure 3.1. Frequency distribution of how many misinformation items were endorsed at test (left: Overall False Memory, OFM), and subsequently endorsed as being seen specifically in the original slideshow (right: Robust False Memory, RFM).

As expected, Group A scored significantly higher on OFM summed scores (M = .92, SD = .99) than Group B (M = .48, SD = .68) on items that only Group A received misleading post-event information about $t(327.07) = 4.98$, $p < .0001$, $r_{pb}^2 = .06$. See Figure 3.2 (left). Similar results were found for RFM, Group A (M = .40, SD = .66) scored higher than Group B (M = .20, SD = .46) on Group A misinformation items, $t(329.61) = 3.41$, $p = .0007$, $r_{pb}^2 = .03$. These results confirmed that the six misinformation items that Group A were exposed to worked well when summed together.

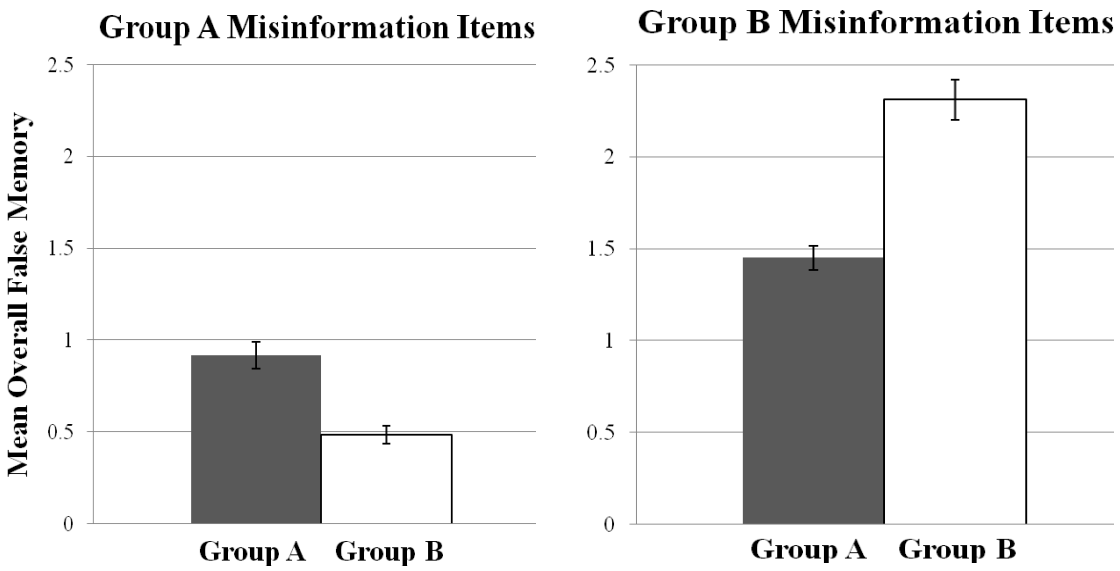

Figure 3.2. Means of the summed Overall False Memories for the six Group A misinformation items (left) and the six Group B misinformation items (right). Standard errors are represented in the figure by the error bars attached to each column. The two graphs are shown side by side to not only illustrate the misinformation effect, but to also show that Group B misinformation items were endorsed more than Group A items.

For an item by item chi-squared (χ^2) analysis of which Group A misinformation items were most effective in distorting memory, see Table 3.1. The χ^2 figure in the table gives the chi-squared test-statistic, and when illustrated with one or more asterisk it means Group A had significantly more false memories than Group B on that item. Three of the items worked particularly well for both OFM and RFM measures, and 11 of the 12 tests revealed negative effect sizes which indicates they are in the expected direction (i.e. higher proportion of false memory scores in Group A).

Table 3.1

Group A Misinformation Items: Chi-squared χ2(1, N = 378) Analysis Comparing Group A to Group B on Overall and Robust False Memory

	Overall False Memory			Robust False Memory		
	χ^2	*p*	φ	χ^2	*p*	φ
Which DVD is does Jane show her friend?	7.36**	.007	-.14	2.08	.24	-.07
After he takes wallet where does he hide it?	9.48**	.003	-.16	5.34*	.03	-.12
What color backpack did other woman have?	12.35**	.0006	-.18	4.65*	.04	-.11
What object was used to break into the car?	3.01	.10	-.09	2.08	.24	-.07
What did the man find in the trunk?	10.20**	.002	-.16	9.80**	.002	-.16
What did the man find in the sunshade?	.01	1.00	-.006	.64	.51	.04

Note. The *p*-values are Fisher's exact (two-sided). The size of the phi coefficient, φ, approximates to Cramer's V (φ_c) to 3 decimal places in all cases. Negative values of φ indicate Group A had a higher proportion of false memory.

Similarly, Group B scored significantly higher on OFM summed scores (M = 2.31, SD = 1.51) than Group A (M = 1.45, SD = .90) on items that only Group B received misleading post-event information about, $t(313.46) = 6.76$, $p = 7.3 \times 10^{-11}$, $r_{pb}^2 = .11$. See Figure 1 (right) for a graphical representation. For RFM, Group B (M = 1.10, SD = 1.13) scored higher than Group A (M = .87, SD = .83) on Group B misinformation items $t(330.13) = -10.66$, $p = 5.5 \times 10^{-23}$, $r_{pb}^2 = .23$. These results confirmed that in combination the six Group B misinformation items produce the expected misinformation-effect. For an item by item χ^2 analysis of which Group A misinformation items worked best, see Table 3.2. Three of the six items worked well on OFM, and two worked well on the RFM measure. Ten of the 12 items showed effects in the expected direction.

Table 3.2

Group B Misinformation Items: Chi-squared χ2(1, N = 378) Analysis Comparing Group A to Group B on Overall and Robust False Memory

	Overall False Memory			Robust False Memory		
	χ^2	*p*	φ	χ^2	*p*	φ
Which hand did the man use to take wallet?	2.00	.16	.07	1.43	.24	-.06
What color is the cell phone Jane takes out?	49.66**	7.8×10^{-14}	.36	17.71**	.00002	.22
Where does the man come out from at end?	38.87**	2.5×10^{-10}	.32	16.19**	.00002	.21
What type of bills did the man find in car?	14.08**	.0001	.19	1.95	.50	.07
What happened when he closed the trunk?	2.05	.16	.07	1.37	.26	.06
Which shoe did he bend down to tie?	1.16	.33	.06	.00002	1.00	-.0002

Note. The *p*-values are Fisher's exact (two-sided). The size of the phi coefficient, φ, approximates to Cramer's V (φ_c) to 3 decimal places in all cases. Positive values of φ indicate Group B had a higher proportion of false memory.

In Figure 3.2 the two graphs are placed side by side to illustrates that the OFM rates for Group B misinformation items (M = 2.31, SD = 1.21) were higher than Group A misinformation items (M = .92, SD = .99), $t(330.13) = 10.66$, $p < .0001$, $r_{pb}^2 = .23$. A similar pattern was true for RFM too, RFM rates for Group B misinformation items (M = 1.20, SD = 1.13) were higher than Group A misinformation items (M = .40, SD = .66), $t(309.83) = -10.66$, $p < .0001$, $r_{pb}^2 = .13$. For this reason, for the purposes of some of the individual differences and paradigm comparisons, we calculated z-score adjusted values of Overall False Memory and Robust False Memory (henceforth denoted as OFM_z & RFM_z), according to whether a participant was in Group A or Group B. To clarify, the

mean and standard deviation of Group A items were used to calculate the z-scores for participants in Group A, and the mean and standard deviation of Group B items was used for Group B participants. By using these z-score adjusted scores, we eliminate the variance due to Group B misinformation items having higher endorsement rates than Group A misinformation items.

Accuracy measures (no-misinformation). On five objective memory accuracy tests on items involving no misinformation, Group A (M = 4.39, SD = .74) showed no significant difference to Group B (M = 4.50, SD = .79), $t(376) = -1.44$, $p = .15$, $r_{pb}^2 = .005$. Therefore, there was no sign of differences in memory ability between participants in Group A compared to Group B, confirming that there is no confound in this respect.

Misinformation-effect summary. We found that the misinformation experiment worked, with reliable differences between groups as expected.

Crashing Memory Experiment

The same students who participated in the misinformation-effect (above), also participated in a crashing memories experiment. Half were randomly assigned to receive misleading information in the computer questionnaire that there is crash footage of United 93 (United 93 Crash Footage condition). The other half of participants were split between the two control groups: United 93 No Footage where they were told there was no footage, but asked to remember the news story, and Human Genome who were not reminded of September 11, 2001 at all but instead asked to remember the Human Genome news story of 2001.

Computer questionnaire. Of the 202 assigned to the United 93 Crash Footage condition, when asked "have you seen the video?" 36.6% indicated "yes," they had seen the United 93 crash footage. Of those 36.6% who said "yes," 62.2% gave a detail about the plane moving, 60.8% gave a detail about after the impact, 68.9% gave some detail about the clarity of the footage, and 51.4% gave a detail about the length of the footage (see Appendix B for question wording on the 4 detail questions). Of the 36.6% who indicated "yes," they had seen the footage, 91.8% gave at least one detail.

Of all the 202 participants, 41.1% gave some detail of the nonexistent plane crash footage (how the plane moved, clarity of footage, or length of footage).

When asked "how well can you remember having seen the video?" 59.4% indicated 1 (no memory at all) on the scale from 1 to 10, and 40.3% indicated a 2 or above. 9.9% indicated a score of 5 or above, with one participant (.5%) indicating 10 (a very clear memory).

Excluding those not familiar with the United 93 news story. Of those 142 participants who were familiar with the United 93 news story, 42.3% indicated they had seen the crash footage of United 93 in the questionnaire. On the scale asking how well they remember seeing the footage, 54.6% indicated 1 (no memory at all) on the scale from 1 to 10, which means 45.4% indicated a 2 or above. 12.8% indicated a score of 5 or above, with one participant (.7%) indicating 10 (a very clear memory).

Interview. About 40 minutes after the computer questionnaire, those in the United 93 Crash footage condition, and the Human Genome condition participated in the one on one recorded interview. Of these 297 participants, 57.6% indicated they were

familiar with the United 93 news event, 8.1% said maybe, and 34.3% indicated they were not familiar with the United 93 story.

Of the 297 participants who participated in the crashing memory interview, 16.2% said they had seen the footage, 7.7% said unsure/maybe, and 76.1% said they had not seen crash footage of United 93. This figure of 16.2% in the interview compares to 36.6% that indicated they had seen the United 93 crash footage in the computer questionnaire. This difference could possibly be because the interview made it abundantly and repetitively clear that we were not asking about the other crashes on 9/11. Perhaps the one-on-one interview made participants focus and think more carefully in the interview than they did in the computer questionnaire.

In the interview, when asked how well they remembered having seen the video on a scale from 1 to 10, 37.0% (110 out of 297) indicated 1 (no memory at all) on the scale from 1 to 10, and 63.0% indicated a 2 or above. Of these 297, 15.8% indicated a score of 5 or above, with one participant (.3%) indicating 10 (a very clear memory).

Excluding those not familiar. Of the 195 participants who said they were familiar with the United 93 event, 23.1% said in the interview that they had seen the nonexistent news footage of the crash. These rates (42.3% in the questionnaire and 23.1% in the interview) are more directly comparable to past crashing memory studies that usually involved events the participants were familiar with (see Table 1.1). The drop could possibly be an indication that one-on-one interviewing may get to more accurate measures. Qualitatively, some participants we asked who were not consistent seemed to indicate they had not answered as carefully in the computer questionnaire, compared to the interview.

With regard to the question asking how well they remember the footage 30.3% (59 out of 195) indicated 1 (no memory at all) on the scale from 1 to 10, which means 69.7% indicated a 2 or above. 17.9% indicated a score of 5 or above, with one participant (.5%) indicating 10 (a very clear memory). As we can see, eliminating those who are not familiar increases the percentage of participants choosing 1 "no memory at all," which is surprising as you would expect those not familiar would be more likely to choose "1 = no memory at all."

Of those 141 familiar, we found 21.3% reduced their 1-10 score from the computer questionnaire to the interview, 35.5% did not change their score, and 43.3% increased their score of how well they remembered the footage.

Consequences of indicating a crashing false memory on pretest-posttest changes. We compared whether those who indicated in the computer questionnaire that they had seen the crash footage for United 93, to those who indicated "no," on subsequent changes in pretest to posttest measures. Table 3.3 summarizes several *t*-tests of interest, comparing means on those who indicated a false memory, to those who didn't. Those who indicated they had seen the footage tended to move toward a more conservative foreign policy, whereas those who indicated no false memory moved in the liberal foreign policy direction. This might be because the process of visualizing the footage may result in security concerns leading to an increased wish for a more hawkish foreign policy. The other measures on the liberal to conservative scale, such as social and fiscal orientation, are not as concerned with protection from foreign attack, and indeed were not affected. Other *t*-tests on change scores were not statistically significant.

Table 3.3

Consequences of a False Crashing Memory on Pretest to Posttest Change Scores

	False Memory M_{yes} *(SD)*	No False Memory M_{no} *(SD)*	*t*	r_{pb}	*p*	*N*
Change in foreign policy orientation.[1]	.12 (.78)	-.23 (.81)	-3.00**	.21	.003	202
Change in whether mosque should be built near World Trade Center.[2]	.04 (.20)	-.02 (.27)	-1.80†	.13	.07	202
Change in belief in a dangerous world.[3]	-2.58 (7.45)	-.78 (7.78)	1.59	-.11	.11	202
Change in memory of frequency of having flashbacks of planes crashing after 9/11.[4]	.49 (1.80)	.26 (1.71)	-.90	.06	.37	199
Change in memory for eating comfort food after 9/11. [5]	.01 (1.54)	-.41 (1.60)	-1.84†	.13	.07	199

† p < .1, * p < .05, ** p < .01.

Note. [1] Positive mean values indicate change in conservative direction. [2] Coded 1 = yes, 0 = no; this means a positive mean change score indicates some students changed from 0 (no) in session 1 to 1 (yes) in session 2. [3] Negative means indicate less belief in a dangerous world in Session 2, compared to Session 1. [4] Positive means indicate an increase in memory for flashback in the week after 9/11. [5] Positive mean indicates an increase in memory for eating comfort food. In the independent variable, "yes" they had seen United 93 crash footage was coded 1, "no" was coded 0.

Crashing memory group comparisons.

Pretest to Posttest Changes in Politics, Air Travel Anxiety, Memory for Behavior, etc. Participants filled out questions on politics, air travel, BDWS, and memory for emotion/behavior both in Session 1 (pretest) and then again one week later in Session 2 immediately after their exposure to one of three news-story conditions (United 93 Crash Footage, United 93 No Footage, or Human Genome condition). We will now examine whether exposure to these crashing memory questionnaires influenced the various pretest posttest questionnaires.

Pretest-posttest political orientation/attitudes. Although pretest/posttest changes in social and fiscal political orientation did not vary by condition, foreign policy political orientation did. Those who were in the United 93 Crash Footage condition (M = -.10, SD = .81) moved in a more liberal direction compared the Human Genome condition (M = .19, SD = .95) who moved in a comparatively conservative direction from Session 1 to 2, $F(2, 393) = 3.76$, $p = .02$, $\eta_p^2 = .02$ (Tukey HSD post hoc indicates United 93 Crash Footage reliably less than Human Genome, $p = .02$). It appears that those asked to think about and remember a terrorist-led plane crash actually became slightly more liberal of foreign policy at posttest, compared to controls, which is not what we expected. We had expected reminders of terrorism to increase conservatism, not reduce it. Our findings may be because a lot has happened in foreign policy since 9/11, and some students may perceive that the conservative/hawkish reactions to 9/11 did not always produce favorable outcomes. It should be noted, however, those who said they had actually seen the footage moved in the conservative direction (as seen earlier on pages 39-40). Having an actual memory of the footage seems to have a different effect that merely being reminded of the news event.

There were no significant differences between the three crashing memory conditions and the change in political attitudes towards terrorism, patriotism, or out groups. We might have expected those primed with imagery of 9/11 plane crash(es) to become more harsh towards terrorism suspects and out-groups, and become more patriotic, but there were no group differences.

Pretest/posttest changes in Air Travel Anxiety. We found no differences between the three groups (United 93 Crash Footage, United 93 No Footage, Human Genome) and

the changes in air travel related items (preference to drive instead of fly, overall score on the Air Travel Anxiety (ATA) scale, and an ATA item measuring concern that other passengers will do harm), $F(2, 392) \leq 1.76$, p's $\geq .17$.

Pretest to posttest changes in Belief in a Dangerous World scale (BDWS). An ANOVA revealed omnibus group differences between the crashing memories groups for the BDWS, $F(2, 292) = 3.50$, $p = .03$, $\eta_p^2 = .02$. Tukey HSD post-hoc analysis revealed that belief in a dangerous world decreased more from Session 1 to 2 in the Human Genome condition ($M = -2.15$, $SD = 7.16$) than in the United 93 No Footage condition ($M = .55$, $SD = 7.17$), $p = .03$.

Pretest to posttest changes in memory for experiences/behaviors in the week following September 11, 2001. An ANOVA revealed an omnibus crashing memory group difference on the change in memory for having flashbacks of planes crashing in the week after 9/11, $F(2, 389) = 5.30$, $p = .005$, $\eta_p^2 = .03$. Tukey HSD post-hoc analyses revealed that those in the United 93 Crash Footage condition (M = .35, SD = 1.74) showed a significantly higher pretest to posttest increase in memory for flashbacks than the Human Genome condition (M = -.35, SD = 1.76), $p = .004$. This indicates that the suggestion of crash footage, and the attempts at remembering details of the crash, led to participants remembering having experienced more flashbacks of planes crashing *in the week following September 11, 2001*, ten years earlier.

Group effects were also found for the change in memory for frequency of *thinking* about the attacks in the week after 9/11, where those in the Human Genome condition ($M = -.99$, $SD = 2.08$) showed significantly more reduction than the United 93 No Footage condition ($M = -.13$, $SD = 1.89$), $F(2, 389) = 4.22$, $p = .02$, $\eta_p^2 = .02$ (Tukey HSD post-

hoc p = .01). A similar pattern was found for the change in memory for frequency of *talking* about the attacks, where those in the Human Genome condition (M = -1.17, SD = 2.24) showed significantly more reduction than the United 93 No Footage condition (M = -.43, SD = 2.08), $F(2, 389) = 3.05$, $p = .049$, $\eta_p^2 = .02$ (Tukey HSD post-hoc p = .04). Both these results suggest that those reminded of the plane crash on 9/11, and those asked to remember details of the news-event led to remembering a higher frequency of talking and thinking about the attacks due to either the increased salience of the event or perhaps the exercise of trying to remember details of 9/11 (a rehearsal effect).

No other group differences were found for other pretest/posttest change for memory for several behaviors in the week following 9/11: crying, drinking alcohol, telephoning family, emailing family, eating comfort food, compulsive checking, missing sleep, and following news of the disaster, $F(2, 389) \leq 1.85$, p's $\geq .16$.

To summarize, the finding of most note is that those participants who were told there is United 93 crash footage, and then asked a series of questions to remember details of the crash, were more likely to increase their report of how often they remember having flashbacks of planes crashing in the week following 9/11, compared to those in the control group (Human Genome). In other words, the consequence of suggesting the existence of a potentially traumatic event (seeing footage of a plane crashing, a false memory in this case), and asking participants to remember details of that memory, was to change memory of how often flashbacks occurred during a week-long period ten years ago.

Interview: Comparing those who were previously told there is United 93 footage to those who were not. Those randomly assigned to United 93 Crash Footage condition

were told in the computer questionnaire (40 minutes before the interview) that there is footage for the crash of United 93, whereas those in the Human Genome condition were told nothing about United 93 or 9/11. In the interview, everyone was told there was footage immediately before being asked whether they had seen it. Those who had also been told 40 minutes earlier that there is United 93 crash footage reported being familiar with the news event at a higher rate (M = .66, SD = .43) than those in the Human Genome condition (M = .52, SD = .47), $t(295) = 2.44$, p = .02, r_{pb}^2 = 0.02. This can be explained by understanding that those who had read something about United 93 earlier were reminded of the event, so that they were more likely to say they were familiar in the later interview. This effect is relatively small.

Those individuals who received the suggestion in the computer questionnaire that there is United 93 crash footage, reported in the interview 40 minutes later a higher rate of having seen crash footage for United 93 (M = .29, SD = .41) than those in the control Human Genome condition (M = .12, SD = .29), equal variances not assumed $t(248.92) = 2.83$, p = .005, r_{pb}^2 = .02. The repetition of the suggestion that there is footage in the experimental condition accounts for the difference. Those in the United 93 Crash Footage condition received the suggestion that there is crash footage for United 93 both in the questionnaire and 40 minutes later in the interview. Those in the control condition (Human Genome) only received the suggestion once - in the interview. This suggests that multiple suggestions of a false memory can boost false memory rates - including false memories for nonexistent news footage as in the crashing memories paradigm.

However, those who received prior suggestion in the questionnaire 40 minutes earlier reported no statistical differences in the 1-10 rating of how well they can

remember the event in the interview, compared to those who received no suggestion in the questionnaire 40 minutes earlier, $t(295) = -.21$, $p = .83$, $r_{pb}^2 = .0001$.

Excluding those not familiar. As before exclusions, those individuals who were randomly assigned into the experimental United 93 condition in the questionnaire went on in the interview (40 minutes later) to report a higher certainty of having seen crash footage for United 93 ($M = .32$, $SD = .45$) than those in the control Human Genome condition ($M = .15$, $SD = .34$), $t(116.96) = 2.68$, $p = .009$, $r_{pb}^2 = 0.03$.

Similarly, those who received prior suggestion in the questionnaire 40 minutes earlier reported no statistical differences in the 1-10 rating of how well they can remember the event in the interview, compared to those who received no suggestion in the questionnaire 40 minutes earlier, $t(169) = -.70$, $p = .48$, $r_{pb}^2 = .003$. These results compare closely to the analysis before exclusion of those not familiar (see above).

Crashing memory summary. The crashing memory experiment worked well in several respects. It produced false memory reports in a sizable minority of subjects in both the computer questionnaire, and in our more rigorous follow-up interview that took pains to be clear about what crash we were referring to. Moreover, we found that there was a consequence of having a false memory of United 93 crash footage; it was associated with increased foreign policy conservatism. We also found consequences to being exposed to the United 93 crash condition, such as an increased memory for experiencing flashbacks in the week after 9/11. In addition, suggestion 40 minutes earlier in the questionnaire had an additive effect on false report rates in the interview.

Imagination Inflation

Of the 297 who participated in the crashing memories interview, 241 indicated they had not seen the footage (or were unsure) and were then taken through the imagination inflation exercise. Of those 241 participants, 5.8% responded to the imagination exercise by afterwards saying "yes" they now thought they remembering the footage, 33.6% indicated maybe/unsure after the exercise, and 60.6% maintained that they had not seen the footage. In terms of changing their answer from immediately before the imagination exercise, 3.7% responded to the imagination exercise by flipping from a full “no” to a “yes”, 30.7% increased their certainty of seeing the footage (from a no to a maybe or a maybe to a yes), and 65.6% did not change their initial report of having not seen the footage, or of being unsure.

Whether participants received a prior suggestion (United 93 Crash Footage condition) or not (Human Genome condition) in the questionnaire 40 minutes earlier did not significantly affect susceptibility to the imagination inflation exercise in the interview, $t(239) = .38$, $p = .70$, $r_{pb}^2 = .0006$.

Excluding those not familiar. The 146 participants who were familiar with the United 93 event *and* who did not say "yes" to the first question "have you seen that footage," are analyzed here. 5.1% flipped from a “no” before the imagination inflation exercise to a “yes” they had seen the footage after the exercise. 35.6% indicated a less dramatic increase uncertainty (from no to maybe or maybe to yes), and 57.5% indicated no change in response to the imagination inflation exercise.

As before exclusions, whether participants received a prior suggestion (United 93 Crash Footage condition) or not (Human Genome) did not significantly affect susceptibility to the imagination inflation exercise.

Imagination inflation summary. The imagination inflation exercise worked in a similar way to previous research in the paradigm, in that it succeeded in creating increased confidence for a false memory in a significant minority of participants.

Memory for Felt Emotion in the Week Following September 11, 2001

Participants were asked identical questions in both Session 1 and 2 about how often they felt a range of negative emotions in the week following the terrorist attack of September 11, 2001 (see Appendix D for wording of questions). As a reminder, there were 14 emotion questions, and each had a Likert scale from 1 (never) to 10 (all the time). In Session 2, the memory for emotion questions were asked immediately after the crashing memories questionnaire, and are these are referred to as the posttest measures. The distribution of change scores for composite negative emotion is shown in Figure 3.3. A pattern emerged where the frequency of negative emotion remembered *reduced* from Session 1 to Session 2. As seen in Table 3.4, the means of the change scores are negative in all conditions. This was true of all four subtypes of negative emotion, grouped according to appraisal theory. Since the change scores were calculated by subtracting Session 1 memory for emotion scores from Session 2's scores, a negative number indicates Session 1 had higher scores, and the amount of negative emotion decreased from Session 1 to 2. This is consistent with affective adaptation theory, which states that

affect often decreases when either the stimulus is less novel or surprising, or when the source of the emotion is processed or explained-away.

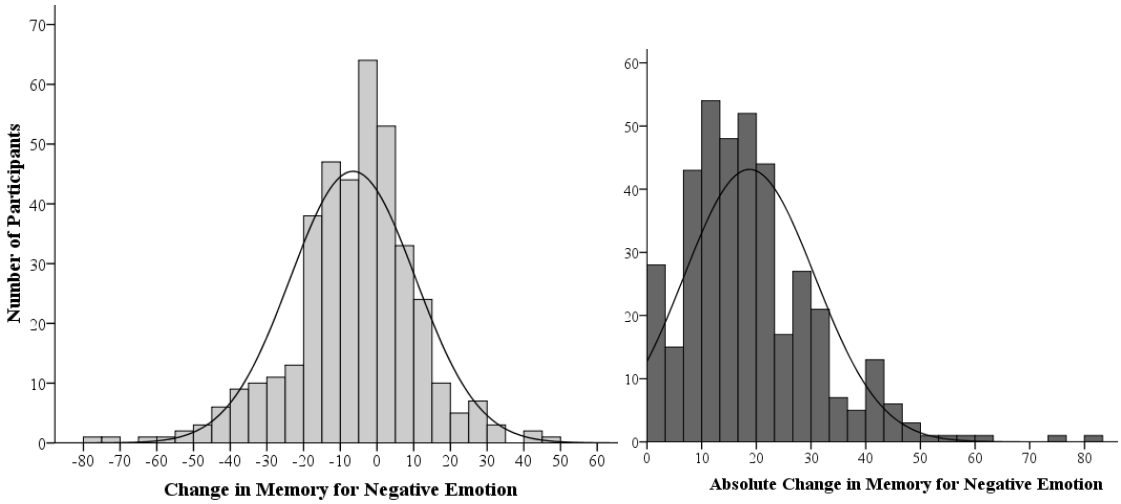

Figure 3.3. Distribution of memory for emotion change scores, indicating how inconsistent participants were from Session 1 to Session 2 on their memory of how often they felt negative emotions in the week after 9/11. Scores represent the composite of 14 negative emotions. Left histogram shows direction of change, whereas the right shows only the magnitude of the inconsistency.

Table 3.4

Mean Change Scores for Memory for Felt Emotion in the Week after September 11, 2001 (N = 389)

		M	*SD*
Change in Memory for Post-goal Negative Emotion (e.g. sadness)	Condition 1: United 93 - "There is Footage"	-.39	1.57
	Condition 2: United 93 - "There is No Footage"	-.42	1.40
	Condition 3: Control - Human Genome	-.65	1.41
Change in Memory for Pre-goal Goal Obstruction Negative Emotion (e.g. anger)	Condition 1: United 93 - "There is Footage"	-.34	1.48
	Condition 2: United 93 - "There is No Footage"	-.33	1.74
	Condition 3: Control - Human Genome	-.62	1.51
Change in Memory for Pre-goal Anticipation of Negative Outcome (e.g. anxiety)	Condition 1: United 93 - "There is Footage"	-.50	1.77
	Condition 2: United 93 - "There is No Footage"	-.41	1.58
	Condition 3: Control - Human Genome	-.84	1.43
Change in Memory for High Arousal Negative Emotion (e.g. tense)	Condition 1: United 93 - "There is Footage"	-.36	1.44
	Condition 2: United 93 - "There is No Footage"	-.41	1.44
	Condition 3: Control - Human Genome	-.78	1.58

Note. Values represent the mean and standard deviation of Time 2 minus Time 1 memory for emotion scores. Negative mean values represent a reduction in how often the participants remember feeling negative emotions in the week following September 11, 2001.

Pretest to posttest memory for emotion changes by crashing memory condition. As seen in Table 3.5, we found significant differences between conditions, and these differences can be explained by appraisal theory. Those randomly assigned to conditions that were asked to think about the United 93 crash, and remember details about it showed less reduction from Session 1 to 2 in memory for negative emotion when they were asked 5 minutes later. In other words, bringing the 9/11 plane crash to mind resulted in higher negative emotion recall than the group that did not go through the United 93 memory questionnaire (the control group instead went through Human Genome questionnaire). This finding is consistent with appraisal theory in that those who

were asked to remember the 9/11 attack appraised of the threat to the goal of survival as being more salient and self-relevant compared to those not reminded at all of 9/11.

Table 3.5

ANOVA Comparing Conditions on Change in Memory for Past Negative Emotion

			F (2, 389)	p	η_p^2
Omnibus ANOVA:			3.57	.03*	.02[a]
Tukey post hoc comparisons:					
United 93 Crash Footage	vs.	United 93 No Footage		.99	
United 93 Crash Footage	vs.	Control - Human Genome		.04*	
United 93 No Footage	vs.	Control - Human Genome		.06†	

Note. The dependent variable is change from Session 1 to Session 2 is the composite negative emotion scores. [a]Adjusted R^2 = .01. † p < .1, * p < .05.

Individual Differences Comparisons in Each Paradigm

We now compare how each of the four memory paradigms are related to the individual differences measures to see if similar types of people are susceptible to all or just some of the memory distortions.

Table 3.6 shows the Pearson correlations of demographics, politics, thinking skills, and sleep with the degree of memory distortion in each of our four paradigms. As can be seen in the demographics sections most correlations are non-significant, which indicates a general pattern that all genders, ages, ethnicities, and college majors are vulnerable to all four of our memory paradigms. One exception to this rule is family SES and the crashing memory paradigm, which has a significant correlation (r^2 = .02). As SES increases, the likelihood of saying they had seen the nonexistent footage of United 93 increases. Although significant, this is a relatively small effect that accounts for only 2% of the variance in the crashing memory paradigm.

Table 3.6

Pearson Correlations of Individual Differences with Memory Paradigms

	Misinformation Effect [a]	Classic Crashing Memory [b]	Imagination Inflation [c]	Memory for Emotion Inconsistency [d]
Demographics				
Gender [e]	-.01	-.01	.07	.08
Age	-.01	.01	-.04	.03
Ethnicity [f]	.01	.05	.02	-.04
Family SES	.05	**.14***	.05	-.03
Year in College	.02	.04	.01	.06
Major in College[g]	.04	-.008	-.03	-.01
Political Views (pretest)				
Political Orientation [h] - Social	.05	.06	-.11[†]	-.10
Political Orientation - Fiscal	.02	.08	-.01	**-.15****
Political Orientation - Foreign	.002	.01	-.03	-.08
Prison Years for Terrorist	-.08	-.02	.002	-.01
Mosque in New York? [j]	-.06	-.05	.08	-.07
Patriotism [k]	.04	.08	-.03	**.10***
Continue Afghan War? [j]	-.03	.07	-.12[†]	-.05
Agrees w Harsh Interrogation [l]	.002	.02	-.02	<.001
Cognitive Ability & Rationality				
College GPA	-.05	.04	-.02	-.05
SAT Reading/Verbal	-.001	.06	-.03	**-.15***
SAT Math	-.11	.10	-.15[†]	-.07
SAT Total	-.03	.05	-.05	-.11
Critical Thinking Score	**-.13***	.01	.04	-.08
Flexible Thinking Scale				
Disposition Toward Reflectivity	-.006	-.01	-.09	-.06
Consider Contrary Evidence	**-.18****	.04	.08	<.001
Consider Contrary Opinions	-.06	.04	.05	-.04
Tolerance for Ambiguity	**-.12***	-.02	.05	-.03
Sleep				
Hours Sleep Night Before	**.10***	**-.12***	-.01	-.05
Felt Rested Morning of	.06	-.02	-.01	.02
No. Awakenings Night Before	<.001	-.04	-.01	-.06
Total Hours of Sleep Last Week	-.01	-.06	.02	.03
Total No. Naps in Last Week	.04	.11	.02	-.03
Total No. Awakenings in Week	-.01	.004	-.05	-.03
Other				
Handedness	-.03	-.01	-.04	.09
Alcohol Use	-.02	.07	.02	.01
Number of Fluent Languages	.08	.02	.01	**.11***

Note. Statistically significant correlations are in boldface ($\alpha = .05$). [†] $p < .1$, * $p < .05$, ** $p < .01$, [a] Robust False Memory z-score adjusted (RFM_z). $N = 378$. [b] False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). $N = 297$. [c] Increase in certainty of seeing United 93 crash footage following the imagination inflation exercise in the interview. $N = 241$. [d] Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. $N = 389$. [e] Males coded 1, females 2. [f] Point by serial correlation: Caucasian (coded 1) vs. non-Caucasian (coded 0). [g] Psychology/eyewitness testimony related subjects coded 1, others coded 0. [h] Likert scale 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).

The political orientation and attitudes shown in Table 3.6 reveal mostly non-significant correlation which tells us that liberal and conservatives show comparable susceptibility to memory distortions. Those high on patriotism were less consistent in their memory for their emotions following 9/11 (r^2 = .01). However, in contrast to this, those more conservative of fiscal policy were more consistent in their memory for their emotions following 9/11 (r^2 = .02). These effects, though significant, are small and only account for 1-2% of the variance.

The cognitive ability and critical/flexible thinking measures in Table 3.6 reveal only small effects with the memory paradigms. Those who scored high on critical thinking, and the flexible thinking scale subscales measuring ability to consider contrary evidence and ability to tolerate ambiguity tended to have less false memories in the misinformation-effect experiment (r^2 = .02, .03, .01 respectively; accounting for 3% or less of the variance). Our proxy measure of cognitive ability/general intelligence, the SAT scores, were not related to any on the paradigms, although those who scored higher on the SAT Verbal tended to be more consistent with their memory for emotion following 9/11.

Table 3.6 also shows that the number of hours slept the night before the experiment (Session 2) predicted false memories in both the misinformation-effect and crashing memories, but surprisingly *in opposite directions.* The more hours of sleep a participant got the night before, the higher the likelihood they would have a false memory in the misinformation-effect (r = .10), but the less likely they were to report a false memory of having seen the crash footage for United 93 (r = -.12). This could be explained by the fact that a lack of sleep may interfere with the encoding of the

misleading narratives in the misinformation-effect experiment, leading to less Robust False Memories. In contrast, lack of sleep in the crashing memory experiment may make them more suggestible or compliant - more likely to say "yes" in the interview.

How personality predicts the four memory distortions is shown in Table 3.7.

Table 3.7

Pearson Correlations of Personality with Memory Paradigms

	Misinformation Effect [a]	Classic Crashing Memory [b]	Imagination Inflation [c]	Memory for Emotion Inconsistency [d]
Creative Experiences (CEQ)	.05	**.12***	**.15***	.09[†]
Dissociative Experiences (DES)	-.03	.07	**.16***	.01
Mindfulness (MAAS)	.07	-.02	-.07	-.04
Absorption (TAS)	.08	.01	**.18****	.004
Basic Empathy Scale				
Cognitive Empathy	-.02	.05	.03	-.07
Affective Empathy	.03	.02	-.02	.03
Empathy Overall	.01	.03	-.004	-.01
SSP Personality Traits [e]				
Somatic Anxiety	.01	.04	.09	.06
Psychic Anxiety	.001	-.03	.10	.05
Stress Susceptibility	.006	.006	.004	.08
Lack of Assertiveness	-.07	-.07	**.15***	.005
Impulsiveness	-.01	.005	.01	-.003
Adventure Seeking	.04	-.07	.07	.02
Detachment	-.08	-.10[†]	-.03	.02
Social Desirability	.01	.09	.07	-.05
Embitterment	-.05	.009	.11	.006
Irritability	**-.11***	.008	.06	.04
Mistrust	.05	-.02	.04	.03
Verbal Aggression	-.06	.04	-.05	.03
Physical Aggression	-.04	-.01	-.01	.01

Note. Statistically significant correlations at $\alpha = .05$ are **bold**. [†] $p < .1$, * $p < .05$, ** $p < .01$.
[a] Robust False Memory z-score adjusted (RFM_z). $N = 378$. [b] False report of seeing United 93 crash footage in the interview, following initial suggestion (coded 1 = yes, .5 = maybe, 0 = no). $N = 297$. [c] Increase in certainty of seeing United 93 crash footage following the imagination inflation exercise in the interview. $N = 241$. [d] Absolute value of the change, from Session 1 to 2, of memory for felt negative emotion in the week following September 11, 2001. $N = 389$. [e] Swedish Universities Scale of Personality (SSP).

The Creative Experiences Questionnaire (CEQ) reliably correlated with false memory reports in both the crashing memory and the imagination inflation exercise. This indicates that those who scored high on this self-report measure of fantasy-proneness were more susceptible to falsely saying they had seen the footage than those scoring low on the CEQ scale.

Those who scored high on the Dissociative Experiences Scale (DES) and absorption (TAS) were more susceptible to a false memory in the imagination inflation paradigm (effect sizes are relatively small, accounting for about 3% of the variation). In contrast, the misinformation-effect paradigm did not correlate with fantasy-proneness, dissociative experiences and absorption. Measures that did not significantly correlate with any of the four memory distortion measures include empathy and mindfulness.

Looking at the SSP personality subscales, it is important to first point out that social desirability did not significantly correlate with any of the four memory measures. Social desirability has previously been used as an indicator or a variable to control for demand characteristics. Many of the other personality measures in the SSP subscales in Table 3.7 also did not correlate with the memory distortion measures. Two notable exceptions are that lack of assertiveness correlated positively with imagination inflation, which makes some intuitive sense, and irritability correlated negatively with the misinformation-effect. The latter means that those who are more irritable are less susceptible to misinformation. These effects account for about 2% of the variation in the memory measures. The combination of null effects and small effects indicates that people of all types are susceptible to memory distortions.

Hierarchical regression analyses. Tables 3.8, 3.9, 3.10, and 3.11 look at how individual differences predict susceptibility in the four paradigms, controlling for possible confounds.

Table 3.8 demonstrates that controlling for other variables in the model, lower scores on the critical thinking scale and the flexible thinking subscale "willingness to consider contrary evidence" reliably predict more Robust False Memories. Lack of assertiveness and trait irritability are negatively related to the number of Robust False Memories. Notice that although lack of assertiveness is negatively related to the misinformation (RFMz; Table 3.8; when controlling for other variables), it is positively related to imagination inflation (Table 3.7; bivariate). Being assertive may boost Robust False Memories in the misinformation effect because the source test requires participants to *assert* the source of their memory. In contrast, having the trait of assertiveness in the interview seems to lead to less imagination inflation. Mistrust is positively associated with Robust False Memories in the misinformation experiment. Individual differences explain about 6% of the variance in Robust False Memories (Models 2 and 3).

Controlling for other variables in the model, Table 3.9 shows that socioeconomic status is a positive predictor of crashing false memories in Model 1, but not when other variables are controlled for. The number of minutes of sleep the night before the interview negatively predicted crashing false memory in Models 1 and 2, and that effect became marginal in Model 3. Individual differences only explain less than 3% of the variance in false memories of seeing United 93 crash footage (see Model 3).

Table 3.10 shows that, when controlling for the variables shown in the model, no variables are reliable predictors of imagination inflation, and individual difference only account for about 1% of the variance in imagination inflation.

Table 3.8

Predictors of Robust False Memory (RFM_z) from the Misinformation Experiment (N = 377)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Demographics									
Gender	-.16	.12	-.07	-.23	.13	-.10	-.23	.13	-.10
Age	<-.01	.02	-.01	-.01	.02	-.02	<-.01	.02	-.02
Family SES	.04	.03	.06	.05	.03	.08	.05	.03	.08
Major in College[1]	.03	.11	.02	.01	.11	<.01	<.01	.11	<.01
Critical Thinking	**-.06***	**.03**	**-.11**	**-.07***	**.03**	**-.12**	**-.07***	**.03**	**-.12**
Flexible Thinking									
Contrary Evidence	**-.15****	**.05**	**-.15**	**-.14****	**.05**	**-.15**	**-.14****	**.05**	**-.15**
Toler. Ambiguity	-.09	.07	-.07	-.09	.07	-.07	-.09	.07	-.07
Sleep Night Before	<.01	<.01	.07	<.01	<.01	.07	<.01	<.01	.07
Personality Traits									
Somatic Anxiety				.22	.15	.10	.21	.15	.10
Psychic Anxiety				.11	.16	.05	.10	.16	.05
Stress Suscept.				.16	.16	.07	.16	.16	.07
Lack Assertive				**-.29***	**.15**	**-.13**	**-.30***	**.15**	**-.14**
Impulsiveness				.03	.16	.01	<.01	.16	<.01
Adventure Seek				.16	.14	.08	.17	.14	.08
Detachment				-.25	.15	-.10	-.25	.16	-.10
Soc. Desirability				-.12	.17	-.04	-.11	.17	-.04
Embitterment				-.23	.18	-.09	-.22	.18	-.09
Irritability				**-.36****	**.13**	**-.19**	**-.36****	**.13**	**-.19**
Mistrust				**.33***	**.15**	**.16**	**.33***	**.15**	**.16**
Verbal Aggress.				-.10	.15	-.05	-.10	.16	-.05
Phys Aggression				-.10	.12	-.06	-.10	.12	-.06
Possible Confounds									
Reason to Exclude[2]							.14	.12	.06
Crash Condition[3]							.02	.12	.01
Misinfo Condition[4]							.05	.10	.03
Constant	1.15	.59		2.31	1.08		2.31	1.09	
F (df)	**2.79**** **(8, 368)**			**2.23**** **(21, 355)**			**2.01**** **(24, 352)**		
ΔR^2	.06			.06			.004		
$R^2_{adjusted}$	.04			.06			.06		

† p < .1. * *p* < .05. ** *p* < .01. *** *p* < .001. Relationships statistically significant at .05 are **bold**.
Note. [1] Psychology/eyewitness testimony related subjects coded 1, others coded 0. [2] Participants who finished sessions quickly or who failed an attention check were coded 1 (*n* = 97), those with no reason to exclude were coded 0. [3] United 93 conditions coded 1, Human Genome condition coded 0. [4] Misinformation experiment Group A coded 0, Group B coded 1. Predictors in the model were chosen either due to theoretical relevance or a bivariate relationship with the dependent variable. Tolerance collinearity statistics ranged from .388 to .990. Dependent variable is Robust False Memory, z-score adjusted.

Table 3.9

Predictors of False Memory of Seeing United 93 Footage in the Crashing Memory Interview (N = 294)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Demographics									
Gender	-.01	.05	-.01	-.02	.06	-.03	-.03	.06	-.04
Age	<.01	.01	.02	<.01	.01	<-.01	<-.01	.01	-.02
Family SES	**.03***	**.01**	**.13**	.02	.02	.09	.02	.02	.08
Major in College[1]	.01	.05	.01	.02	.05	.03	.02	.05	.03
Sleep Night Before	**<.01***	**< .01**	**-.12**	**<.01***	**<.01**	**-.12**	<.01†	<.01	-.12
Creative Exp.				.01†	.01	.14	**.01***	**.01**	**.15**
Dissociative Exp.				<.01	<.01	.10	<.01	<.01	.09
Mindfulness				<.01	<.01	<.01	<-.01	<.01	<-.01
Absorption				<-.01	<.01	-.12	<.01	<.01	-.12
Personality Traits									
Somatic Anxiety				.04	.07	.06	.03	.07	.05
Psychic Anxiety				-.05	.07	-.06	-.05	.07	-.07
Stress Suscept.				.02	.07	.02	.01	.07	.02
Lack Assertive				-.06	.06	-.08	-.06	.06	-.07
Impulsiveness				-.01	.07	-.01	<-.01	.07	<-.01
Adventure Seek				-.10	.06	-.13	-.09	.06	-.12
Detachment				-.11	.07	-.12	-.12†	.07	-.13
Soc. Desirability				.06	.08	.05	.06	.08	.06
Embitterment				.05	.08	.05	.03	.08	.04
Irritability				.01	.06	.01	.03	.06	.04
Mistrust				.02	.07	.03	.02	.07	.03
Verbal Aggress.				<.01	.07	<.01	<-.01	.07	<-.01
Phys Aggression				-.03	.06	-.05	-.03	.06	-.05
Possible Confounds									
Reason to Exclude[2]							-.04	.05	-.04
Crash Condition[3]							**.11***	**.05**	**.14**
Misinfo Condition[4]							.01	.04	.02
Constant	.14	.20		.66	.52		.63	.53	
F (df)	1.84 (5, 288)			1.18 (22, 271)			1.30 (25, 268)		
ΔR^2	.03			.06			.02		
$R^2_{adjusted}$	.01			.01			.03		

† p < .1. * *p* < .05. ** *p* < .01. *** *p* < .001. Relationships statistically significant at .05 are **bold**.
Note. [1] Psychology/eyewitness testimony related subjects coded 1, others coded 0. [2] Participants who finished sessions quickly or who failed an attention check were coded 1 (*n* = 97), those with no reason to exclude were coded 0. [3] United 93 conditions coded 1, Human Genome condition coded 0. [4] Misinformation experiment Group A coded 0, Group B coded 1. Predictors in the model were chosen either due to theoretical relevance or a bivariate relationship with the dependent variable. Tolerance collinearity statistics ranged from .342 to .990. Dependent variable is report of seeing the footage in the crashing memory interview (coded 1 = yes, .5 = maybe, no = 0).

Table 3.10

Predictors of Imagination Inflation (N = 240)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Demographics									
Gender	.06	.04	.10	.05	.05	.07	.05	.05	.07
Age	<-.01	.01	-.02	<.01	.01	<.01	<.01	.01	-.01
Family SES	.01	.01	.04	.01	.01	.05	.01	.01	.05
Major in College[1]	-.02	.04	-.03	<-.01	.04	-.01	<.01	.04	<.01
Flexible Thinking									
Reflectivity	-.06[†]	.03	-.12	-.04	.04	-.09	-.04	.04	-.08
Contrary Evidence	.03[†]	.02	.13	.03	.02	.10	.03	.02	.10
Creative Exp.				<.01	.01	.03	<.01	<.01	.04
Dissociative Exp.				<.01	<.01	.10	<.01	<.01	.10
Mindfulness				<.01	<.01	.03	<.01	<.01	.02
Absorption				<.01	<.01	.10	<.01	<.01	.10
Personality Traits									
Somatic Anxiety				-.01	.06	-.01	-.01	.06	-.01
Psychic Anxiety				.04	.06	.06	.03	.06	.06
Stress Suscept.				-.08	.06	-.12	-.07	.06	-.12
Lack Assertive				.07	.06	.11	.07	.06	.11
Impulsiveness				-.09	.06	-.13	-.08	.06	-.12
Adventure Seek				.03	.05	.05	.03	.05	.05
Detachment				.01	.06	.01	<.01	.06	<.01
Soc. Desirability				.02	.06	.03	.02	.06	.02
Embitterment				.06	.06	.09	.06	.06	.08
Irritability				.04	.05	.08	.04	.05	.09
Mistrust				-.02	.06	-.03	-.02	.06	-.03
Verbal Aggress.				-.10[†]	.06	-.16	-.10[†]	.06	-.16
Phys Aggression				.04	.05	.08	.04	.05	.08
Possible Confounds									
Reason to Exclude[2]							-.03	.04	-.04
Crash Condition[3]							.02	.04	.04
Misinfo Condition[4]							-.02	.04	-.03
Constant	.19	.20		-.13	.46		-.10	.48	
F (df)	1.27 (6, 233)			1.15 (23, 216)			1.04 (26, 213)		
ΔR^2	.03			.08			.003		
$R^2_{adjusted}$	.007			.01			.004		

[†] p < .1. [*] *p* < .05. [**] *p* < .01. [***] *p* < .001. Relationships statistically significant at .05 would be **bold**.

Note. [1] Psychology/eyewitness testimony related subjects coded 1, others coded 0. [2] Participants who finished sessions quickly or who failed an attention check were coded 1 (*n* = 97), those with no reason to exclude were coded 0. [3] United 93 conditions coded 1, Human Genome condition coded 0. [4] Misinformation Group A coded 0, Group B coded 1. Predictors in the model were chosen either due to theoretical relevance or a bivariate relationship with the dependent variable. Tolerance collinearity statistics ranged from .312 to .921. Dependent variable is the change in certainty of seeing the footage of the United 93 crash after the imagination inflation exercise in the interview (coded 1 = change from no to yes, .5 = change from no to maybe or maybe to yes, 0 = no change).

Table 3.11

Predictors of Inconsistency in Memory for Negative Emotion (N = 389)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Demographics									
Gender	2.02	1.39	.07	1.46	1.54	.05	1.54	1.54	.06
Age	.08	.20	.02	.11	.21	.03	.10	.21	.03
Family SES	.01	.39	.00	-.11	.40	-.01	-.12	.40	-.01
Fiscal Political Ori.	**-1.39****	**.47**	**-.13**	**-1.45****	**.48**	**-.16**	**-1.40****	**.48**	**-.15**
Patriotism	**.85****	**.32**	**.13**	**.90****	**.34**	**.14**	**.94****	**.34**	**.15**
# Fluent Languages	1.83†	.99	.10	2.02†	1.05	.11	2.01†	1.05	.10
Creative Exp.				**.39***	**.19**	**.14**	**.42***	**.19**	**.15**
Dissociative Exp.				-.01	.06	-.01	-.01	.06	-.01
Mindfulness				-.05	.07	-.05	-.05	.07	-.04
Absorption				-.08	.05	-.10	-.08	.05	-.10
Personality Traits									
Somatic Anxiety				1.05	1.84	.04	1.13	1.85	.04
Psychic Anxiety				-.17	1.91	-.01	-.16	1.91	-.01
Stress Suscept.				2.36	1.95	.09	2.22	1.95	.08
Lack Assertive				-.90	1.76	-.04	-1.11	1.76	-.04
Impulsiveness				-.90	1.99	-.03	-.88	1.99	-.03
Adventure Seek				1.51	1.71	.06	1.35	1.71	.05
Detachment				.18	1.89	.01	.09	1.90	.00
Soc. Desirability				-2.53	2.05	-.07	-2.78	2.06	-.08
Embitterment				-1.27	2.13	-.04	-1.20	2.14	-.04
Irritability				-.16	1.57	-.01	-.26	1.58	-.01
Mistrust				-.74	1.76	-.03	-.44	1.77	-.02
Verbal Aggression				.84	1.87	.03	.56	1.88	.02
Phys Aggression				-.23	1.52	-.01	-.19	1.52	-.01
Possible Confounds									
Reason to Exclude[2]							-.64	1.39	-.02
Crash Condition[3]							-.89	1.44	-.03
Misinfo Condition[4]							1.92	1.24	.08
Constant	10.57	5.98		18.60	14.76		19.89	14.87	
F (df)	**3.55**** **(6, 382)**			1.39 (23, 365)			1.35 (26, 362)		
ΔR^2	.05			.03			.008		
$R^2_{adjusted}$	.04			.02			.02		

† p < .1. $^{*}p < .05$. $^{**}p < .01$. Relationships statistically significant at .05 are **bold**.

Note. [1] Psychology/eyewitness testimony related subjects coded 1, others coded 0. [2] Participants who finished sessions quickly or who failed an attention check were coded 1 (n = 97), those with no reason to exclude were coded 0. [3] United 93 conditions coded 1, Human Genome condition coded 0. [4] Misinformation Group A coded 0, Group B coded 1. Predictors in the model were chosen either due to theoretical relevance or a bivariate relationship with the dependent variable. Tolerance collinearity statistics ranged from .378 to .982. Dependent variable is the absolute value of the change score (from Session 1 to Session 2, one week later), in composite memory for negative emotions in the week after 9/11.

Table 3.11 shows that when controlling for the other variables in the model, those who are prone to fantasy (high on the creative experiences questionnaire) and those who have a more liberal fiscal political orientation, but who are also patriotic, are more likely to be inconsistent in their memory for past negative emotion after 9/11. Individual differences explain about 5% of the variance in inconsistency in memory for emotion (Model 1).

In summary, individual differences only account for at most 6% of the variance in the memory paradigms we studied. This reinforces the idea that all people seem vulnerable to memory distortions.

Paradigm Comparisons

Now that we have compared the individual differences relationships with performance in the four memory paradigms, we move on to the final task of comparing the paradigms directly to each other. Since each subject participated in most or all of the memory distortion paradigms, we can see if susceptibility in one paradigm predicts susceptibility in some of the others. Figure 3.4 shows that most of these correlations are not statistically significant. This means that those who did say they had seen the United 93 footage were not any more susceptible to the misinformation-effect, nor to be any more or less inconsistent with their memory for emotion. However, those who had more Robust False Memories in the misinformation-effect paradigm tended to be *less* inconsistent in their memory for emotion (small effect size accounts for just 1% of variance).

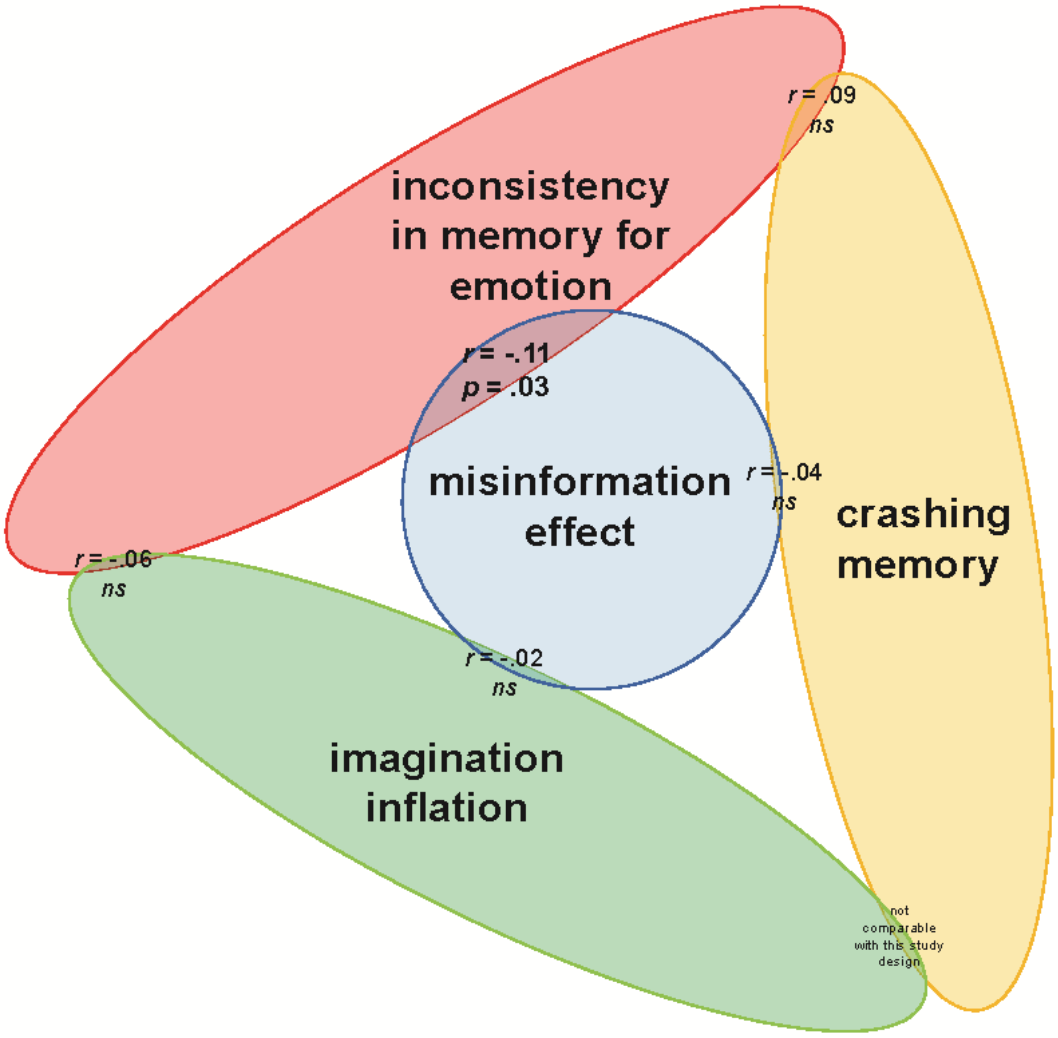

Figure 3.4. Correlations between paradigms. Illustration of the small amount of variance, 1% or less, that is explained by one paradigm on another. *ns* indicates memory distortion/inconsistency in one paradigm does not predict the other. Inconsistency in memory for emotion predicts *less* susceptibility to the misinformation effect, although the effect is small. Misinformation is $RFM_{z,}$ and crashing memory is the interview measure.

Table 3.12 investigates the inverse relationship between the number of Robust False Memories in the misinformation effect and inconsistency in emotion memory.

Even when controlling for demographics and several factors that had some relationship to either of the paradigms, we found that the small negative relationship held (see first row).

Table 3.12

Comparing Paradigms: Misinformation and Inconsistency in Memory for Emotion Paradigms: Predictors of Inconsistency in Memory for Negative Emotions in the Week After 9/11 (N = 374).

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Misinformation (RFM_z)[1]	**-1.42***	**.62**	**-.12**	**-1.35***	**.63**	**-.11**	**-1.33***	**.59**	**-.11**
Gender				2.36	1.43	.09	-.38	1.40	-.01
Age				.09	.20	.02	.04	.19	.01
Sleep Night Before[2]				-.01	.01	-.06	<-.01	.01	-.03
Crashing Memory Condition[3]				.10	1.25	<.01	.41	1.16	.02
Critical Thinking							-.14	.35	-.02
Flexible Thinking							-.16	.13	-.06
Trait Irritability (SSP)							-.28	1.12	-.01
Pretest Memory for Negative Emotion[4]							**.17*****	**.02**	**.38**
Constant	18.70	.62		15.45	5.19		18.41	8.28	
F (df)	**5.22* (1, 372)**			1.88 (5, 368)			**8.20***** (9, 364)**		
ΔR^2	.01			.01			.14		
$R^2_{adjusted}$	.01			.01			.15		

*$p < .05$. **$p < .01$. ***$p < .001$. Relationships statistically significant at $\alpha = .05$ are **bold**.

Note. [1] Robust False Memory, z-score adjusted. [2] Number of minutes slept the night before the misinformation experiment (Session 2). [3] United 93 conditions coded 1, Human Genome condition coded 0.[4] Reported memory of frequency of negative emotion in the week after 9/11. Individual differences not put in the model either reduced the degrees of freedom too much, correlated too highly with other predictors, or showed no relationship to the misinformation or emotion memory paradigms. Tolerance collinearity statistics ranged from .881 to .991. Dependent variable is the absolute value of the change score (from Session 1 to Session 2, one week later), in composite memory for negative emotions in the week after 9/11.

Tables 3.13, 3.14, 3.15, and 3.16 confirm that even when controlling for relevant individual differences, in hierarchical linear regression analyses, there is still no statistically significant relationship between the paradigms (notice how the first row in these tables remain non-significant in all three models). As you can see on the first row of each of these tables, these findings tell us the same thing as the bivariate correlations: higher memory distortion in one paradigm does not predict higher susceptibility in another paradigm.

Table 3.13

Comparing Paradigms: The Relationship Between Misinformation and Crashing Memory Paradigms: Predictors of Robust False Memory (RFM_z) in the Misinformation Experiment (N =283)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Crashing Memory[1]	-.12	.16	-.04	-.16	.17	-.06	-.19	.16	-.07
Gender				-.08	.14	-.03	-.15	.14	-.06
Age				-.02	.02	-.05	-.01	.02	-.03
Socioeconomic Status				.05	.04	.08	.07	.04	.11
Sleep Night Before[2]				<.01	<.01	.02	<.01	<.01	.01
Crashing Memory Condition[3]				.12	.13	.06	.08	.13	.04
Critical Thinking							-.08	.04	-.13
Flexible Thinking							-.02	.01	-.11
Trait Irritability (SSP)							-.24	.12	-.13
Creative Experiences[4]							.02	.02	.09
Constant	.05	.07		.04	.55		1.76	.86	
F (df)	.53 (1, 281)			.70 (6, 276)			**1.92** (10, 272)**		
ΔR^2	.002			.01			.05		
$R^2_{adjusted}$	-.002			-.01			.03		

$^{*}p < .05$. $^{**}p < .01$.

Note. [1] Interview response to the question "Do you remember seeing that footage?" coded 0 for no, .5 for maybe, and 1 for yes. [2] Number of minutes slept the night before the misinformation experiment (Session 2). [3] "There is Footage of Untied 93" condition coded 1, Human Genome condition coded 0. [4] The Creative Experiences Questionnaire (CEQ), also known as a measure of fantasy proneness. Individual differences not put in the model either reduced the degrees of freedom too much, correlated too highly with other predictors, or showed no relationship to the misinformation or crashing memory paradigms. Tolerance collinearity statistics ranged from .887 to .992. Dependent variable is the number of Robust False Memory, z-score adjusted.

Table 3.14

Comparing Paradigms: The Relationship between Misinformation and Imagination Inflation Paradigms: Predictors of Robust False Memory (RFM_z) in the Misinformation Experiment (N =231)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Imagination Inflation[1]	-.08	.24	-.02	-.08	.24	-.02	-.03	.24	-.01
Gender				-.08	.16	-.03	-.10	.16	-.04
Age				-.02	.02	-.06	-.02	.02	-.06
Sleep Night Before[2]				<.01	<.01	.05	<.01	<.01	.02
Crashing Memory Condition[3]				.10	.14	.05	.08	.14	.04
Critical Thinking							-.09*	.04	-.15
Flexible Thinking							-.01	.02	-.06
Lack of Assertiveness (SSP)							-.07	.15	-.03
Absorption (TAS)							-.23	.13	-.13
Creative Experiences[4]							.01	.02	.03
Constant	.06	.08		.32	.54		2.06	1.00	
F (df)	.11 (1, 229)			.45 (5, 225)			1.27 (10, 220)		
ΔR^2	<.01			.01			.05		
$R^2_{adjusted}$	<.01			<.01			.01		

*$p < .05$.

Note. [1] Change in certainty of having seen United 93 crash footage following the imagination inflation exercise, coded 0 for no change, .5 for a half way change (no to maybe, or maybe to yes), and 1 for a full change from no to yes. [2] Number of minutes slept the night before the misinformation experiment (Session 2). [3] "There is Footage of Untied 93" condition coded 1, Human Genome condition coded 0. [4] The Creative Experiences Questionnaire (CEQ), also known as a measure of fantasy proneness. Individual differences not put in the model either reduced the degrees of freedom too much, correlated too highly with other predictors, or showed no relationship to the misinformation or crashing memory paradigms. Tolerance collinearity statistics ranged from .888 to 1. Dependent variable is the number of Robust False Memory, z-score adjusted.

Table 3.15

Comparing Paradigms: The Relationship between Inconsistency in Memory for Emotion and Imagination Inflation Paradigms: Predictors of Inconsistency in Memory for Emotion (N =238)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Imagination Inflation[1]	-2.71	2.74	-.06	-2.58	2.74	-.06	-2.91	2.83	-.07
Gender				1.41	1.77	.05	.76	1.83	.03
Age				.17	.24	.05	.21	.24	.06
Crashing Memory Condition[3]				-2.14	1.59	-.09	-2.26	1.60	-.09
Patriotism				.65	.42	.10	.65	.42	.10
Lack of Assertiveness (SSP)							2.60	1.79	.10
Creative Experiences[4]							.06	.28	.02
Dissociative Experiences (DES)							-.07	.07	-.08
Absorption (TAS)							.02	.06	.02
Constant	18.91	.93		10.32	5.997		4.68	8.15	
F (df)	.98 (1, 236)			1.33 (5, 232)			1.03 (10, 227)		
ΔR^2	.004			.02			.01		
$R^2_{adjusted}$	<.01			.001			.002		

Note. [1] Change in certainty of having seen United 93 crash footage following the imagination inflation exercise, coded 0 for no change, .5 for a half way change (no to maybe, or maybe to yes), and 1 for a full change from no to yes. [2] Number of minutes slept the night before the misinformation experiment (Session 2). [3] "There is Footage of United 93" condition coded 1, Human Genome condition coded 0. [4] The Creative Experiences Questionnaire (CEQ), also known as a measure of fantasy proneness. Individual differences not put in the model either reduced the degrees of freedom too much, correlated too highly with other predictors, or showed no relationship to the misinformation or crashing memory paradigms. Tolerance collinearity statistics ranged from .572 to 1. Dependent variable is the absolute value of the change score (from Session 1 to Session 2), in composite memory for negative emotions in the week after 9/11.

Table 3.16

Comparing Paradigms: The Relationship between Inconsistency in Memory for Emotion and Crashing Memory Paradigms: Predictors of Inconsistency in Memory for Emotion (N =292)

	Model 1			Model 2			Model 3		
	b	*SE(b)*	*β*	*b*	*SE(b)*	*β*	*b*	*SE(b)*	*β*
Crashing Memory[1]	2.83	1.88	.09	2.47	1.93	.08	1.29	1.85	.04
Gender				1.72	1.61	.06	-.16	1.56	-.01
Age				.10	.23	.03	.03	.22	.01
Socio-economic status				-.18	.46	-.02	-.17	.43	-.02
Sleep Night Before				-.01	.01	-.05	-.004	.01	-.04
Crashing Memory Condition[2]				-1.06	1.53	-.04	-.54	1.45	-.02
Patriotism				**.78***	**.38**	**.12**	.41	.36	.06
Creative Experiences[3]							-.07	.17	-.02
Pretest Memory for Negative Emotion[4]							**.15*****	**.03**	**.35**
Constant	18.31	.80		12.91	6.53		10.92	6.44	
F (df)	2.28 (1, 290)			1.31 (7, 284)			**5.10***** **(9, 282)**		
ΔR^2	.008			.02			.11		
$R^2_{adjusted}$	.004			.007			.11		

*$p < .05$. **$p < .01$. ***$p < .001$.

Note. . [1] Interview response to the question "Do you remember seeing that footage?" coded 0 for no, .5 for maybe, and 1 for yes. [2] "There is Footage of Untied 93" condition coded 1, Human Genome condition coded 0. [3] The Creative Experiences Questionnaire (CEQ), also known as a measure of fantasy proneness. [4]Reported memory of frequency of negative emotion in the week after 9/11. Individual differences not put in the model either reduced the degrees of freedom too much, correlated too highly with other predictors, or showed no relationship to the misinformation or crashing memory paradigms. Tolerance collinearity statistics ranged from .877 to 1. Dependent variable is the absolute value of the change score (from Session 1 to Session 2, one week later), in composite memory for negative emotions in the week after 9/11.

These results, taken together, show that susceptibility in one memory distortion paradigm did not predict higher susceptibility in other paradigms.

Chapter 4 - Discussion

We set out to investigate if the same participants who have false memory in one paradigm would also be more likely to succumb in other memory distortion paradigms. We first found that each paradigm produced observable memory distortions. Then, we not only found that susceptibility in one paradigm does not predict susceptibility to another, but we reinforced this finding by also finding no individual differences that predicted performance in all four paradigms. In this discussion, we briefly discuss the major findings from each paradigm, note some limitations, and finally discuss the paradigm comparisons in terms of possible implications for practice, theory, and future research.

Misinformation

To our knowledge, this is the first study to find that higher scores on a composite critical thinking scale and subscales of the Flexible Thinking Scales (FTS) both predict less false memory from misinformation. Both these measures are more related to rationality abilities rather than to intelligence, which is a distinction emphasized as important by Stanovich (2009). We found those who were willing to consider evidence that is contrary to their beliefs (an FTS subscale) were less susceptible to misinformation, even when controlling for many other factors in the model. This could be because those who have that flexible cognitive ability also have the ability to distinguish two differing perspectives, and hold them separately in the mind. This ability is useful when distinguishing misinformation from the original source memory.

The amount of sleep the participants got the night before the experiment positively correlated with Robust False Memories from misinformation. We could speculate that having more rest may make them more able to strongly encode and incorporate the misinformation given in the narratives. However, this relationship, though still in the right direction, became statistically non-significant when controlling for other variables in a regression analysis.

SAT scores did not predict Robust False Memory in this experiment, which is similar to what Powers, Andriks, and Loftus (1979) found. However, Zhu et al. (2010) did find a negative relationship between intelligence as measured on the WAIS, and false memory. Given that SAT scores correlate highly with general intelligence (r = .82; Frey & Detterman, 2004) we should be careful not to dismiss this lack of a relationship. Administering intelligence measures in the same battery of tests as a misinformation experiment could overestimate true relationships due to some participants being more motivated and attentive on both tasks, leading to both higher scores on intelligence tests and less false memories. If this were recreated in real world applications, it would be unusual to be able administer an intelligence test on the same day as the event they witnessed. Intelligence tests are likely to be done at a different time when they are in an altogether different state of motivation and attention. For that reason, past performance on the SATs in a different time and setting, may be a useful alternative measure for general intelligence. However, self reported SAT scores are not ideal in other respects, for example self report could inflate or deflate scores. We found no evidence of this, though, when we compared our SAT scores to average 2010 intake scores for the university.

Interestingly, the trait irritability predicted less false memories, and that relationship held when controlling for other variables. Those who had a stable tendency to be irritable had less Robust False Memories. Perhaps the irritability leads to more scrutiny (negative emotion sometimes leads to a narrowing of focus) of the materials that then leads to less false memory. When controlling for other variables, trait mistrust positively predicted Robust False Memory. This is a little counterintuitive, because we might expect those who are suspicious to resist misinformation and have less false memories, not more. Lack of assertiveness, when controlling for other variables, predicted less false memories, meaning that those who were more assertive had more false memories. This might be explained because to register a Robust False Memory, one must be assertive enough in the source test that you had seen it in the original photographic slideshow to choose. This latter finding fits well with Zhu et al.'s (2010a) finding that self directedness and persistence traits positively predicted Robust False Memory from misinformation.

Crashing Memory

The reduction in crashing false memory rates from the computer questionnaire (42% of those familiar with United 93) to the interview (23%) is interesting. One could argue that perhaps this discrepancy indicates that the questionnaire creates inflated figures, and that this may explain high false reports in previous studies (see Table 1.1). However, there are other possible explanations. It could be that participants become more suspicious that the experiment is about memory distortions by the time of the interview, leading to more careful answers. Also our higher crashing false memory rates on our computer questionnaire may be due to the fact that there was more than one crash

on 9/11. Whatever the reason, the more conservative measure of crashing false memories in this study still elicited a sizable minority (23% of those familiar with the event said "yes," they had seen the footage, and to give details).

Interestingly, we found that prior suggestion of there being crash footage added to the effect of suggestion used in the interview. This has particularly important implications in the real world where post-event misleading information is often repeated, presumably having an additive effect. The fact that two suggestions can produce more false memory of an upsetting scene from childhood (as would be seeing United 93 crash, if there was footage, because participants were on average 10 years old in 2001) than only one suggestion could have interesting real life implications. Applying this to the law or therapy, care should be taken to avoid suggesting to young adults something counterfactual happened earlier in their life, because repeated suggestion could plant the seeds of a false memory.

A consequence of being reminded of the United 93 news story, and trying to remember the event or footage in a series of questions, was that it changed their memory for how many flashbacks they had in the week after September 11, 2001. Compared to controls who did not answer questions on United 93, those who did indicated they had more flashbacks of planes crashing. So the mere task of thinking about plane crashing led to people overestimating how often they had experienced flashbacks a full 10 years ago. Since flashbacks are a psychiatric symptom, this could have applications how we assess symptoms from the past. For example, for the purposes of compensation in legal cases that claim damages for mental suffering, or in clinical psychology assessment and treatment.

Imagination Inflation

The imagination inflation exercise resulted in more than a third increasing their confidence that they had seen the United 93 footage. The fact that the personality measures of fantasy proneness (also known as Creative Experiences, CEQ), dissociativity (DES-C), and absorption (TAS) all predicted imagination fits well with past studies (Paddock et al., 1998), and with what one would expect. However, these associations become not statistically significant when demographics and other personality traits are controlled for. This may be due to some of the SSP personality traits co-varying with the CEQ, DES, and TAS scales in such a way as to reduce the predictive power of any one variable in the model.

Inconsistency in Memory for Emotion

Affective adaptation. The consistent reduction of memory for felt emotion shown in Table 3.4 is explained by the theory of affective adaptation (Wilson & Gilbert, 2008). When the question is asked in Session 1, it likely is the first time (in a long time) that the participants were asked how they felt after 9/11. For this reason the relative novelty and surprise of the question leads to high affective reactions in the participants, and this in turn leads them to recall relatively high ratings of how often they felt negative emotions following 9/11. When the questions are re-asked in Session 2, the novelty and surprise of the question is reduced, and the affective reaction of the participant is less, leading in turn to them remembering negative emotions less often following 9/11. An alternative explanation, still in keeping with the AREA model of affective adaptation, is that in Session 1 the participants spent at least a little time making sense of the event, or their reactions to it, and subsequently due to some explanation, by the time of Session 2

they have adapted a little to the stimuli, and thus a lower affective reaction leads them to recall less negative emotion following 9/11.

Appraisal. The effect of affective adaptation was modified and partially reversed by exposing participants to questions about the United 93 crash several minutes before the Session 2 re-asking of the memory for felt emotion following 9/11. Bringing the plane crash to mind likely brought up the goals that were threatened by the terrorism (goals for survival, safety, etc). These goals became relatively more salient in the participants' minds, and this turn affected the way they reappraised September 11 as relatively more self and goal-relevant compared to those not reminded of United 93 (the Human Genome condition).

In general, one can also see how even with a short interval of one week between Session 1 and 2, a full ten years after the attack, participants' recall of felt emotion following the 9/11 attacks are inconsistent from one week to the next. That inconsistency is explained well by affective adaptation, combined with appraisal theory. This study is consistent with other studies that have found that memory for felt emotion is reconstructed in accordance to appraisal theory (Levine, 1997; Levine, Prohaska, Burgess, Rice, & Laulhere, 2001; Levine, Whalen, Henker, and Jamner, 2005), and it goes a step further to use affective adaptation theory to explain a general trend of reduced memory for emotion. Like those previous studies just mentioned, this shows that appraisal theories can be successfully used to predict and explain not only current and future emotion, but also memory for felt emotion following a consequential event.

Limitations

Our study had some limitations, some of which may be due to the number of paradigms and individual differences we chose to measure. At a certain point, you cannot demand more of a participant in a single study. For example, the imagination inflation manipulation only had a short one minute interval between exercise and test, as well as having no control group. Three of our paradigms, crashing, imagination and emotion memory, were related to 9/11 in some way. This interrelatedness could possibly have been cited as a possible confound if we had found significant relationships between the paradigms. However, the fact that these three paradigms were related to 9/11 makes it all the more amazing that we found one did not predict the other. For example, one might expect inconsistency in remembering post-9/11 emotion to be related to false memory about seeing an emotion-provoking plane crash on 9/11. But, we found no relationship, despite the similarities in target events, a fact that may be seen to strengthen our findings. Nevertheless, future research could try comparing these paradigms with unrelated target events.

In addition, our memory for emotion manipulation did not involve as strong a re-appraisal manipulation as did some previous studies, but still our manipulation did still work. For example, whereas Levine (1997) relied on the effects of the withdrawal of Perot from the presidential race, time, and an election to make a strong reason to change appraisals, our method of changing appraisals was more subtle. We changed appraisals related to 9/11 by exposing participants to a questionnaire on United 93 in which they were asked a series of questions about their memory for the event that likely raised the salience of the threat to their goals of avoiding harm and survival. The time frame between our pretest and posttest was just a week, and this is a shorter interval than some

previous studies. This may be the reason why affective adaptation had a slightly stronger effect than our re-appraisal manipulation, although both effects were detectable. Since the time points were just one week apart, the emotion memory questions asked in Session 1 were so much more novel and surprising than when they were re-asked in Session 2. This difference in novelty and surprise from Time 1 to 2 would be much less if the interval were months or years instead of one week. Despite these differences between our present study and past studies, our memory for emotion paradigm worked in a way consistent with theory.

Paradigm Comparisons and Implications

As noted earlier, memory distortion in one paradigm did not predict increased susceptibility in another. Since other studies have found predictive ability between different paradigms, in particular DRM and rich false memories (Otgaar, et al., 2012; Clancy et al., 2002), it may depend on which paradigms you compare. So far in this small areas of research, we can either say there is no false memory trait (as with our study), or if there is, it does not account for enough of the variance to be a useful tool in the law or clinical psychology. For example, only 14% of the variance in rich false memory in children was accounted for by DRM memory distortions in Otgaar et al.'s (2012) study.

Our results imply that we are not be able to strongly predict whether someone may have false memories of an upsetting scene in childhood (like our manipulation involving nonexistent footage of a plane crash) by measuring them on a different false memory test, like a classic misinformation experiment.

From a theoretical perspective, the lack of relation between paradigms, and between individual differences in each paradigm, could imply that there are different

mechanisms at work. For example, encoding of information on the day of experiment is a mechanism that is important in the misinformation experiment, but no such encoding of recent events is important in the crashing memory study. Similarly, the encoding and retrieval of upsetting events, such as 9/11 plane crashes, will likely involve amygdala activation, a different memory mechanism to the encoding and retrieval of nonviolent slideshows. Individual differences predictors often add nuance to a model by moderating the main memory distortion effect. If these predictors vary from paradigm to paradigm, this does not bode well for a simple unified theory.

To explain why a unified grand theory may be difficult, and to show why we may need to keep our multitude of mini-theories, let's take two of the paradigms that we studied that are most different, and then apply the same argument to paradigms that are less different. Let's think conceptually about one of our paradigms that did not use misinformation (memory for emotion) to one that did: the misinformation paradigm. Theoretically speaking, source monitoring does not do as good job of explaining distortions in memory for emotions as appraisal does, and appraisal theory does not do a good job of explaining the misinformation effect. Imagine trying to fuse the two theories into one grand theory. It would be difficult. Source monitoring confusion could explain emotion memory malleability if one considers recent emotion as post-event information, but strictly speaking there is no *misleading* post-event information. The resulting model would probably be impressive in the complexity of its conceptual diagrams (imagine the complexity of the individual differences moderating each paradigm in different ways), but perhaps incomprehensible and unusable in practice. Perhaps that extreme example illustrates why other, more similar paradigms, like the crashing memory and

misinformation paradigms, may also not have the same shared theory and set of mechanisms that best predicts susceptibility to memory distortions within the model.

Future research could expand this line of inquiry into comparing other paradigms. Experiments that involve control groups for each memory distortion paradigm may become too big or costly when more than three paradigms are attempted concurrently. They may also ask too much of participants' energy, motivation, and/or time. As mentioned earlier, different target events could be used, as could various time intervals between event, post-event misinformation, and/or test. Also, older populations may be looked at; because it may be that a wider age range is needed to find out whether age is a consistent factor that predicts memory distortion in multiple paradigms. In addition, it is possible that some predictors of false memory may be able to predict multiple paradigms - for example working memory ability could be examined as a predictor across multiple paradigms.

However, when three or more memory distortion manipulations are attempted concurrently, as done here, it provides a unique opportunity to see if there is a type of person who is false-memory prone. If there was such a false memory "trait" (or maybe even a "gene," although that may be a stretch) then we would have expected within-subject relationships between some or all of the paradigms. We did not find that, and conclude that there is probably no false memory trait, at least within the age range and the paradigms we looked at. Our data suggest that every type of person is vulnerable to memory distortions to some degree. This indicates what has been suggested before, that memory distortions often occur on a perceptual level, or at the very least an almost

automatic cognitive level. In other words, memory distortions are a normal process in most or all humans, and not an aberration limited to a certain type of person.

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Appendix A: Misinformation Materials

Photographic Slideshow 1

[Each of the following photographic slides were presented on screen for 3500ms]

We will now show you a slideshow of photographs depicting a story of a main character who we will call Jane. We will later ask you some questions about it.

This slideshow will last about 3 minutes.


Gordon Florist

Photographic Slideshow 2

We will now show you a slideshow of photographs depicting a story of a man.
We will later ask you some questions about it.
This slideshow will last about 3 minutes.

Narrative 1

[Presented approximately 40 minutes after the photographic slideshows. Both Group A and Group B received narratives that differed only on 6 items. *Italic type indicates misleading information***,** whereas regular type is not misleading**.** This key was not visible to participants]

Narrations

Now we will show you a description of the slideshow you saw earlier about the woman called Jane.
Please read each sentence carefully as it appears, you will have a few seconds on each sentence before the next one appears.
This description will last about 5 minutes.
Please stay focused on reading and following the story for the whole time.

[Each of the following sentences were presented on screen for 5500ms]

1. Jane was walking down Main Street in Baltimore.
2. She was window shopping and continued walking.
3. Jane stopped to look at a video store after passing a hair salon.
4. She went inside.
5. Jane bought something inside, and left the video store.
6. On her way up the stairs from the store, she saw a friend.
7. Jane waved hello, and he smiled.
8. The two friends hugged.
9. They chatted for a little while.
10. Jane indicated that she had bought something from the video store.
11. *Group A: She showed her friend the new Simpsons DVD.*
    Group B: She showed her friend the new DVD.
12. Her friend did not approve of her selection.
13. They continued to talk.
14. They then hugged goodbye.
15. They walked in opposite directions.
16. Jane continued down Main Street, passing by a woman on a cell phone.
17. A man was walking across the street towards Jane.
18. The man was headed directly towards the girl, who was oblivious to him.
19. The man bumped into Jane from behind.
20. This bump caused her bag to fall to the ground.
21. Her new DVD, sunglasses, mirror and other things fell out of the bag.
22. After he bumped into her, she felt sore and rubbed her arm.
23. The man apologized for running into her.
24. She was angry because all of her items were wet and on the ground.
25. Both of them stooped to the ground to pick up the items.

26. He placed her mirror back in the plastic bag, while she picked up her tape dispenser.
27. The girl stood up and turned around to make sure nothing else had fallen out.
28. Group A: While her back was turned, the man reached with his hand into her pocketbook.
    Group B: While her back was turned, the man reached with his right hand into her pocketbook.
29. *Group A: He took her wallet and hid it in his pants pocket.*
    Group B: He took her wallet and hid it in a pocket.
30. He helped her with her plastic bag that had a yellow smiley face on it.
31. They put the plastic bag back inside her other bag.
32. Jane shook his hand to thank him for helping her out.
33. The man headed back towards the street, first watching a man who was getting something out of his car trunk.
34. The man crossed the street.
35. As Jane continued down the street, the woman talking on her cell phone was finishing her conversation.
36. Group A: Jane took out her cell phone.
    Group B: Jane took out her blue cell phone.
37. Suddenly Jane realized that her wallet was missing.
38. She searched frantically in her bag for her wallet.
39. The woman who had been on the cell phone called out to Jane.
40. *Group A: The woman had a green backpack on.*
    Group B: The woman had a backpack on.
41. The woman explained what she had seen the man do and pointed towards the direction the man headed.
42. Jane looked across the street to see if he was there.
43. Unfortunately, the man had already disappeared.
44. Jane turned back to the woman with a disappointed look.
45. Jane shrugged her shoulders, realizing that she would not be able to catch up with him now.
46. Jane thanked the woman for trying to help her.
47. The two headed in opposite directions.
48. Jane turned a corner and disappeared.
49. The other side of the street still looked empty.
50. Group A: The man, who had been watching them, came out from his hiding place.
    Group B: The man, who had been watching them, came out from behind a tree.

Narrative 2

Narrations

Now you will see a series of sentences describing the slideshow you saw earlier about the man and the car.

Please read each sentence carefully as it appears, you will have a few seconds on each sentence before the next one appears.
This narrative will last about 5 minutes.
Please stay focused on reading and following the story for the whole time.

[Each of the following sentences were presented on screen for 5500ms]

1. On a cloudy afternoon, a young man walked down a residential street.
2. He noticed a light purple car across the street.
3. He crossed the street and walked towards the car.
4. He looked into the car, which had a Johns Hopkins University sticker on the rear window.
5. He tried to open the driver-side door.
6. He looked around suspiciously to see if anyone noticed him by the car.
7. *Group A: He used a clothes hanger to open the car door.*
   Group B: He used an object to open the car door.
8. The door opened.
9. The young man pulled the driver's seat back so he could get in.
10. He then opened the change compartment.
11. He saw several bills and a few pennies in the compartment.
12. Group A: He examined the bills.
    Group B: He examined the $10 bills.
13. He put the money into his pocket.
14. He then looked into the back seat of the car.
15. He saw a purse and picked it up.
16. He found a purse and rummaged through it with his right hand.
17. Finding nothing in it, he threw down the purse in frustration.
18. Angry, the young man wondered what to do next.
19. The young man pulled the trunk lever to open it.
20. He got out of the car.
21. He left the front door open as he headed towards the trunk.
22. He approached the trunk to see if the lever worked.
23. He saw that the trunk had opened.
24. He opened the trunk all the way.

25. The young man was pleased with what he saw in the trunk.
26. He suddenly heard a sound nearby.
27. He suspiciously looked across the street and saw nobody there.
28. He turned his attention back to the trunk.
29. He pulled out a bag of cocaine.
30. *Group A: He also found a few rings.*
    Group B: He also found a few pieces of jewelry
31. He put all of the items in his pocket.
32. He then closed the trunk door.
33. Group A: He accidentally slammed the trunk on his hand.
    Group B: He accidentally slammed the trunk on his right hand.
34. Furious and in pain, he hit the car.
35. With a pained look on his face and holding his hands together, he walked towards the passenger-side door.
36. He approached the door.
37. He opened the door and got in.
38. He opened the glove compartment.
39. He rummaged through the compartment.
40. He closed the glove box.
41. *Group A: He then pulled down the sunshade and found a white parking permit.*
    Group B: He then pulled down the sunshade and found a parking permit.
42. Not interested in it, he closed the sunshade.
43. The young man then got out of the car.
44. He closed the door.
45. Group A: He noticed that his shoe was untied and bent down to tie it.
    Group B: He noticed that his right shoe was untied and bent down to tie it.
46. He stood up and wondered if there was anywhere else to look in the car.
47. Suddenly, he heard police sirens in the distance
48. He looked around to see in which direction it was coming from.
49. He then began to run in the opposite direction.
50. As he ran away, his hat fell off.

Test

[Occurred about one hour after the original slideshows, i.e. 20 minutes after the narratives. Note the **correct answers are in bold,** *misleading information answers are in italic*, and the foil answers are in regular type. This key was not visible to participants]

Memory Test for Picture Slideshow

For each of the following questions, select the answer that you yourself remember seeing in the original slideshows of photographs.
First consider the first slideshow of photographs, which involved a woman named Jane interacting with several people.

1. What is the name of the video store that Jane entered?
   a. Video Internationale
   b. Video Starrz
   c. **Video Americain**
2. After Jane leaves the video store, how does she greet her friend?
   a. She hugs him
   b. They shake hands
   c. They give each other a high five
3. Which DVD does Jane show her friend?
   a. The X-Files
   b. South Park
   c. The Simpsons (Condition A received this misinformation)
4. How does her friend react to her DVD selection?
   a. He seems pleased
   b. He seems displeased
   c. He seems neutral
5. Which hand did the man use to take Jane's wallet out of her bag?
   a. **Left**
   b. *Right* (Condition B received this misinformation)
   c. He did not use any hand to take her wallet from her bag.
6. After he takes her wallet out of her purse, where does he hide it?
   a. In his pants pocket (Condition A received this misinformation)
   b. In his sleeve
   c. In his jacket pocket
7. What color is the cell phone Jane takes out of her purse?
   a. Blue (Condition B received this misinformation)
   b. White
   c. Red
8. What color backpack did the other woman have on?
   a. **Red**
   b. Green (Condition A received this misinformation)
   c. Blue
9. Where does the man come out from after the girl is gone?
   a. Inside a car

b. Behind a tree (Condition B received this misinformation)

c. **Behind a doorway**

Now consider the second slideshow of photographs of the man and the car.

10. What object did the young man use to break into the car?
    a. Screwdriver
    b. Clothes hanger (Condition A received this misinformation)
    c. Credit card
11. What type of bills did the man find in the car's change compartment?
    a. $1 bills
    b. $10 bills (Condition B received this misinformation)
    c. $20 bills
12. Where did the man put the money he found?
    a. Back pocket of his pants
    b. Front pocket of his pants
    c. Under his hat
13. While the man was looking in the trunk, what did he see across the street?
    a. A man walking a dog
    b. Nobody
    c. A couple holding hands
14. In addition to drugs, what did the man find in the trunk?
    a. A few rings (Condition A received this misinformation)
    b. Some diamond earrings
    c. A few necklaces
15. What happened when he closed the trunk?
    a. He slammed the trunk on his left hand
    b. He slammed the trunk on his right hand (Condition B received this misinformation)
    c. He was not hurt by the trunk
16. What did the man take out of the glove compartment?
    a. A cassette tape
    b. Sunglasses
    c. Nothing
17. When the man pulled down the sunshade, what did he find?
    a. A purple parking ticket
    b. *A white parking ticket (Condition A received this misinformation)*
    c. A key
18. After the man got out of the car, which shoe did he bend down to tie?
    a. He did not tie any shoe
    b. Left
    c. Right (Condition B received this misinformation)

Source Test

Memory Source Test

For each of the following questions (which are the same questions from the previous page), please choose the option that best describes how you arrived at the answer you gave.

First consider the first slideshow, which involved a woman named Jane interacting with several people.

1. What is the name of the video store that Jane entered?
    (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
    (e) I guessed

[Note that the same answer choices shown in Question 1 also followed every question listed here]

2. After Jane leaves the video store, how does she greet her friend?
3. Which DVD does Jane show her friend?
4. How does her friend react to her DVD selection?
5. Which hand did the man use to take Jane's wallet out of her bag?
6. After he takes her wallet out of her purse, where does he hide it?
7. What color is the cell phone Jane takes out of her purse?
8. What color backpack did the other woman have on?
9. Where does the man come out from after the girl is gone?

Now consider the second slideshow, which involved the man and the car.

10. What object did the young man use to break into the car?
11. What type of bills did the man find in the car's change compartment?
12. Where did the man put the money he found?
13. While the man was looking in the trunk, what did he see across the street?
14. In addition to drugs, what did the man find in the trunk?
15. What happened when he closed the trunk?
16. What did the man take out of the glove compartment?
17. When the man pulled down the sunshade, what did he find?
18. After the man got out of the car, which shoe did he bend down to tie?

Appendix B: Crashing Memory Computer Questionnaire Materials

United 93 Crash Footage Condition

Memories of News Events

Now we would like to gather some information about how well you remember news events. Please answer each of the following questions to the best of your ability.

1. As you may know, on September 11, 2001, United Airlines Flight 93 crashed in a field near Shanksville, Pennsylvania, killing all 44 people on board. Video footage of the plane crashing, taken by one of the witnesses on the ground, has been well publicized both by the news media and on the internet. Have you seen the video? (Check one)

Yes No

2. How well can you remember having seen the video?

1 2 3 4 5 6 7 8 9 10

(no memory at all) (very clear memory)

Please answer the following questions about your memory of the video footage of the United 93 crash.

3. The plane

(a) came down vertically, nose down and almost without forward speed
(b) slid into the ground almost horizontally and at considerable speed
(c) I can't remember

4. After the impact

(a) parts of the plane were visible in the wreckage
(b) the plane's body disintegrated
(c) the fire and smoke made it impossible to tell
(d) I can't remember

5. The video footage was

(a) very clear, you can see and hear exactly what is happening
(b) fuzzy, it is difficult to tell what is happening
(c) I can't remember

6. The footage was

(a) less than 60 seconds long
(b) between 1 and 2 minutes long
(c) longer than 2 minutes
(d) I can't remember.

7. My memory for the footage is

1 2 3 4 5 6 7 I can't remember

(dim) (sharp/clear)

8. My memory for the footage involves visual detail

1 2 3 4 5 6 7 I can't remember
(little or none) (a lot)

9. My memory for the footage involves sound

1 2 3 4 5 6 7 I can't remember
(little or none) (a lot)

10. Overall vividness of my memory of the footage is

1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

11. My memory for the location where the footage takes place is

1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

12. The video footage seems

1 2 3 4 5 6 7 I can't remember
(short) (long)

13. The overall tone of my memory for the video footage is

1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

14. I remember how I felt at the time I first saw the footage

1 2 3 4 5 6 7
(not at all) (definitely)

15. Feelings at the time that I first saw the video were

1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

16. Feelings at the time that I first saw the video were

1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

17. As I am remembering the footage now, my feelings are

1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

18. Since I saw the footage, I have thought about it

1 2 3 4 5 6 7
(not at all) (many times)

19. Since I saw the footage, I have talked about it

1 2 3 4 5 6 7
(not at all) (many times)

United 93 No Footage Condition

Memories of News Events

Now we would like to gather some information about how well you remember news events. Please answer each of the following questions to the best of your ability.

1. As you may know, on September 11, 2001, United Airlines Flight 93 crashed in a field near Shanksville, Pennsylvania, killing all 44 people on board. There is no video footage of the plane crashing, although the event has been well publicized both by the news media and on the internet. Do you remember this event? (Check one)

Yes No

Please imagine what may have happened and answer the following questions about the event to the best of your ability.

3. The plane
   (a) came down vertically, nose down and almost without forward speed
   (b) slid into the ground almost horizontally and at considerable speed
   (c) I can't remember

4. After the impact
   (a) parts of the plane were visible in the wreckage
   (b) the plane's body disintegrated
   (c) the fire and smoke made it impossible to tell
   (d) I can't remember

5. When I imagine the event, the images and sounds are
   (a) very clear, you can see and hear exactly what is happening
   (b) fuzzy, it is difficult to tell what is happening
   (c) I can't remember

6. The first news report about this event that I saw was
   (a) less than 60 seconds long
   (b) between 1 and 2 minutes long
   (c) longer than 2 minutes
   (d) I can't remember.

7. My memory for the event is

1	2	3	4	5	6	7	I can't remember
(dim)						(sharp/clear)	

8. My memory for the event involves visual detail

1	2	3	4	5	6	7	I can't remember
(little or none)						(a lot))	

9. My memory for the event involves sound

1 2 3 4 5 6 7 I can't remember
(little or none) (a lot)

10. Overall vividness of my memory of the event is

1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

11. My memory for the location where the event takes place is

1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

12. The event seems

1 2 3 4 5 6 7 I can't remember
(short) (long)

13. The overall tone of my memory for the event is

1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

14. I remember how I felt at the time I first saw the event

1 2 3 4 5 6 7
(not at all) (definitely)

15. Feelings at the time that I first learned about the event were

1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

16. Feelings at the time that I first learned about the event were

1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

17. As I am remembering the event now, my feelings are

1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

18. Since I learned about the event, I have thought about it

1 2 3 4 5 6 7
(not at all) (many times)

19. Since I learned about the event, I have talked about it

1 2 3 4 5 6 7
(not at all) (many times)

Human Genome Condition

Memories of News Events

Now we would like to gather some information about how well you remember news events. Please answer each of the following questions to the best of your ability.

1. On February 1, 2001, the Human Genome Project international consortium announced the publication of a draft sequence and initial analysis of the human genome the genetic blueprint for a human being. The pioneering paper appeared in the February 15 issue of the journal Nature. Did you hear or see this news event? (Check one)

Yes No

Please answer the following questions about your memory of news for the Human Genome Project.

3. The Human Genome Project
   (a) was complete in 2001
   (b) was fully completed in 2004
   (c) I can't remember

4. After the news of the Human Genome Project
   (a) It was widely reported in all media
   (b) It was reported only in newspapers
   (c) It was reported on TV news only
   (d) I can't remember

5. The news coverage of the event was
   (a) very clearly communicated
   (b) not clearly communicated
   (c) I can't remember

6. The first news report was
   (a) less than 60 seconds long
   (b) between 1 and 2 minutes long
   (c) longer than 2 minutes
   (d) I can't remember.

7. My memory for the initial news report is

1	2	3	4	5	6	7	I can't remember
(dim)						(sharp/clear)	

8. My memory for the initial news report involves visual detail

1	2	3	4	5	6	7	I can't remember
(little or none)						(a lot)	

9. My memory for the initial news report involves sound

1 2 3 4 5 6 7 I can't remember
(little or none) (a lot)

10. Overall vividness of my memory of the initial news report is

1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

11. My memory for the location where the initial news report takes place is

1 2 3 4 5 6 7 I can't remember
(vague) (very vivid)

12. The initial news report seemed

1 2 3 4 5 6 7 I can't remember
(short) (long)

13. The overall tone of my memory for the initial news report is

1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

14. I remember how I felt at the time I first saw the initial news report

1 2 3 4 5 6 7
(not at all) (definitely)

15. Feelings at the time that I first learned about the initial news report were

1 2 3 4 5 6 7 I can't remember
(extremely negative) (extremely positive)

16. Feelings at the time that I first learned about the initial news report were

1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

17. As I am remembering the initial news report now, my feelings are

1 2 3 4 5 6 7 I can't remember
(not intense) (very intense)

18. Since I saw the initial news report, I have thought about it

1 2 3 4 5 6 7
(not at all) (many times)

19. Since I saw the initial news report, I have talked about it

1 2 3 4 5 6 7
(not at all) (many times)

Appendix C: Crashing Memory Interview Script

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]**

Appendix D - Memory for Past Emotion Materials

[These questions were asked first in Session 1, and then one week later in Session 2.]

Questions on 9/11

Sometimes after tragic events like the terrorist attacks of September 11, 2001, people feel negative emotions.

1. In the week following the terrorist attacks of September 11, 2001, how often did you feel the following emotions?

Upset	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Distressed	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Scared	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Sad	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Confused	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Grief	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Angry	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Anxious	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Stressed	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Helpless	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Traumatized	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Frustrated	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Tense	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)
Jumpy	1 (never)	2	3	4	5	6	7	8	9	10 (all the time)

Appendix E - Critical and Flexible Thinking Scales

[Critical Thinking Questions; Several authors - see Method for citations]

Directions: Please read the following questions carefully and choose the best answer.

1. It is known that 1 dollar out of every 10,000 is counterfeit. Imagine a money-changing machine that rejects real dollar bills 5 out of every 100 times it changes money. However, it always rejects bills when they are counterfeit. If this machine rejects your dollar bill, what is the probability (expressed as a percentage ranging from 0% to 100%) that your bill is counterfeit? Choose the best answer.
(a) Less than 1%
(b) About 5%
(c) About 50%
(d) About 95%
(e) More than 95%

2. When playing slot machines, people win something about 1 in every 10 times. Lori, however, has just won on her first three plays. What are her chances of winning the next time she plays? Choose the best answer.
(a) She has better than 1 chance in 10 of winning on her next play
(b) She has less than 1 chance in 10 of winning on her next play
(c) She has a 1 chance in 10 that she will win on her next play.

3. A doctor had been working on a cure for a mysterious disease. Finally, he created a drug that he thought would cure people of the disease. Before he could begin to use it regularly, he had to test the drug. He selected 400 people at random who had the disease. Of the 400, he randomly assigned 300 to the treatment group and gave them the drug to see what happened. He randomly assigned 100 people to the no-treatment group and gave them a placebo (a sugar pill manufactured to look like the treatment drug) to see what happened. Table 1below indicates the outcome:

	Group	
Drug condition	Cured	Not cured
Received	200	100
Did not receive	75	25

Table 1.

Choose the statement that best summarized the results shown in the table from among the following statements:
(a) The evidence indicates that the drug was effective
(b) The evidence is inconclusive
(c) The evidence indicates that the drug was not effective

4. Assume that you are presented with two trays of black and white marbles: a large tray that contains 100 marbles and a small tray that contains 10 marbles. The marbles are spread in a single layer on each tray. You must draw out 1 marble (without peeking, of course) from either tray. If you draw a black marble, you win $2.
Consider a condition in which the small tray contains 1 black marble and 9 white marbles, and the large tray contains 8 black marbles and 92 white marbles.
From which tray would you prefer to select a marble in a real situation?
(a) small tray
(b) large tray

5. There are 3 blocks in a stack, where each of the blocks is either new or old. The top block is new, and the bottom one is old. The middle block is either new or old. Is there a new block directly on top of an old block?
(a) Yes,
(b) No
(c) Cannot be determined.

6. A certain town is served by two hospitals. In the larger hospital, about 45 babies are born each day, and in the smaller hospital, about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it is higher than 50 percent, sometimes lower. For a period of one year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?
(a) The larger hospital
(b) The smaller hospital
(c) About the same

16. Imagine an urn filled with balls, two-thirds of which are of one color and one-third of which are of another. Tom has drawn 5 balls from the urn and found that 4 are red and 1 is white. Ben has drawn 20 balls and found that 12 are red and 8 are white. Which of the two individuals should feel more confident that the urn contains two-thirds red balls and one-third white balls, rather than vice versa?
(a) Tom
(b) Ben

17. Jack is looking at Anne but Anne is looking at George. Jack is married but George is not. Is a married person looking at an unmarried person?
(a) Yes
(b) No
(c) Cannot be determined

18. A bat and ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost?

_____cents

[Flexible Thinking Scale; Stanovich & West, 1997]

Directions: For the next group of questions indicate by choosing the number that corresponds to the degree to which you disagree or agree with each statement:

1. If I think longer about a problem I will be more likely to solve it

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

2. Difficulties can usually be overcome by thinking about the problem, rather than through waiting for good fortune

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

3. Intuition is the best guide in making decisions

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

4. Coming to decisions quickly is a sign of wisdom

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

5. People should always take into consideration evidence that goes against their beliefs

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

6. A person should always consider new possibilities

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

7. Considering too many different opinions often leads to bad decisions

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

8. There is nothing wrong with being undecided about many issues

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

9. Changing your mind is a sign of weakness

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*

10. Basically, I know everything I need to know about the important things in life

1	2	3	4	5	6
(disagree strongly)	*(disagree moderately)*	*(disagree slightly)*	*(agree slightly)*	*(agree moderately)*	*(agree strongly)*