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Emotion and False Memory: The Context–Content Paradox

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False memories are influenced by a variety of factors, but emotion is a variable of special significance, for theoretical and practical reasons. Interestingly, emotion's effects on false memory depend on whether it is embedded in the content of to-be-remembered events or in our moods, where mood is an aspect of the context in which events are encoded. We sketch the theoretical basis for this content-context dissociation and then review accumulated evidence that content and context effects are indeed different. Paradoxically, we find that in experiments on spontaneous and implanted false memories, negatively valenced content foments distortion, but negatively valenced moods protect against it. In addition, correlational data show that enduring negative natural moods (e.g., depression) foment false memory. Current opponent-process models of false memory, such as fuzzy-trace theory, are able to explain the content-context dissociation: Variations in emotional content primarily affect memory for the gist of events, whereas variations in emotional context primarily affect memory for events' exact verbatim form. Important questions remain about how these effects are modulated by variations in memory tests and in arousal. Promising methods of tackling those questions are outlined, especially designs that separate the gist and verbatim influences of emotion.

Keywords: emotion, false memory, fuzzy-trace theory, mood, opponent processes

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Over the past quarter-century, false memory has been one of the most extensively studied topics in psychology. Practical motivations, in particular, have abounded as there are some high-stakes situations in which the consequences of false memories are quite serious (e.g., courtroom testimony, eyewitness identifications of suspects, histories taken during psychotherapy, recountings of battlefield events, histories taken during emergency room treatment, terrorism interrogations). The memories that are retrieved in those circumstances are affect-laden, and hence, one of the most enduring questions about false memory is how it is influenced by emotional states that accompany past experience (e.g., Howe, 2007; Loftus, 1993; Loftus & Bernstein, 2004; Stein, Ornstein, Tversky, & Brainerd, 1997).

Emotion can figure in past experience in two broad ways. It can be part of the content of events, in the sense that some events are emotional in themselves, or it can be present in our moods as events are experienced, which can be thought of as part of the context of experience. Importantly, our moods may or may not match events' emotional content. For instance, consider witnesses to violent crimes who subsequently attempt to remember those events during police interviews. On the one hand, many of the events (e.g., seeing someone threatened with a weapon, seeing property destroyed) are infused with emotional content; they are negative and arousing in the terminology of the circumplex model of emotion (Russell, 1980, 1991). On the other hand, the moods of individual witnesses at the time may have been different. Some may have been happy just prior to the crime, then became fearful and eventually angry. The moods of witnesses may be different still at the time of police interviews, although the emotional content of the events remains relatively unchanged. The point is that the emotional content of events and the emotional context that is supplied by moods are not the same thing. A key motivation for this review is to consider whether, according to extant data, they affect false memory in the same manner.

As Laney and Loftus (2010) discussed in their review of jurors' perceptions of testimony, the law provides a commonsense answer to the emotion-false memory question—namely, that emotional content inoculates memory against distortion, to the point that it is virtually impossible to have false memories of events whose content is strongly emotional. This view is so prevalent that it figures routinely in expert testimony in certain types of cases, such as when it is a core element in the defense of people who are accused of implanting false memories of traumatic experiences in plaintiffs (for a review, see Brainerd & Reyna, 2005). However, this view is known to be wrong empirically, it being well established that people can remember a range of traumatic and near-traumatic events that they did not experience, such as being sexually abused in a previous life (e.g., Spanos, 1996), being abducted by space aliens (e.g., Spanos, Cross, Dickson, & DuBreuil, 1993), committing embarrassing acts at public events (e.g., Hyman & Pentland, 1996), suffering injuries requiring hospitalization (e.g., Garry, Manning, Loftus, & Sherman, 1996), and committing major crimes (e.g., Shaw & Porter, 2015). Consequently, the view that that false memories of strongly emotional events are commonplace has also figured in expert testimony—for instance, in defense of

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people who have been accused of bizarre or improbable forms of sexual abuse (see Appelbaum, Uyehara, & Elin, 1997; Kassin, Ellsworth, & Smith, 1989; Loftus & Ketcham, 1996).

Although the data show that even highly emotional events are prone to memory distortion, some basic uncertainties remain about the emotion-false memory relation that must be resolved before theory and research can proceed to more subtle questions. Three elementary ones are these. First, does false memory vary in a uniform way as a function of the emotional concomitants of experience; that is, is there a simple *directional* relation such that distortion consistently increases or decreases as emotion varies? Second, does the manner in which false memory reacts to emotional variation depend upon the *quality* of that variation—in particular, whether its valence is positive or negative or how arousing it is? Third, does the manner in which false memory reacts to emotional variation depend upon *where* that variation is localized—in particular, whether it is inherent in the content of events or whether it is a feature of the context in which they are experienced? We consider findings on these questions in this review, and as an advance organizer, it will turn out that the answer to the last two questions is yes while the answer to the first is no. Paradoxically, we shall see that whether emotion distorts memory or inoculates memory against distortion depends upon whether it is localized in the content or the context of experience. This content-context paradox is one of the main themes of the present review.

Structure of the Review and Method of Literature Search

The article begins with a brief overview of method and theory in false memory research—of current accounts of factors that influence false memory, including manipulations and measures that are used to test those accounts. We then review findings from false memory experiments in which emotional content and mood were manipulated, with attention to methodological differences that may explain why a single, clear pattern for emotional influences has not yet emerged. We conclude with a working explanation that answers the direction, quality, and location questions and proposes near-term targets for research on emotion and false memory.

Our search method began with Web of Science, searching for entries containing the terms "emotion" and "false memory." We then followed up using "affect," "mood," "valence," or "arousal," as the first term and "false memory" or "misinformation" as the second. We then performed the same searches with the Google Scholar and PSYCinfo databases. Using the resulting articles, we conducted two snowball searches: First, we consulted the reference lists of the articles and searched for citations of referenced articles in Web of Science, and second, we did likewise with the reference lists of recent unpublished and in press articles. The latter articles were secured by searching conference proceedings and by contacting colleagues. Ultimately, we located 46 peer-reviewed articles reporting research that met three inclusion criteria: (a) The dependent variable was a form of false memory, and emotion was either (b) *manipulated* in the form of content variations (e.g., valence/arousal of words, pictures) and/or context variations (e.g., valence/arousal of music, videos), or (c) *measured* (e.g., scores on depression scales) and correlated with false memory. Of these 46 articles, 19 did not report sufficient data to compute effect sizes, which means that they do not appear in the table of effect sizes (see Table 1). The fact that effect sizes could not be computed for 40% of the literature militated against conducting a meta-analysis, and hence, the present article is a narrative review.

False Memory: Theory and Measurement

To make progress on how emotion influences false memory and to generate theoretical hypotheses, it is first necessary to be clear about what false memory is, operationally speaking, and to consider the processes that are thought to be responsible for it. Those two topics are examined in the present section. Then, in the next section, we consider how emotion has been manipulated in false memory experiments.

What Is False Memory?

False memory merely refers to situations in which subjects recollect events that, in fact, they did not experience. For instance, if a friend asks what you ate at a baseball game a week ago and what you drank at lunch yesterday, you may say hot dog and milk, although you consumed neither. This illustrates three features of false memories as they are normally measured. First, misremembered events are not ones that subjects have *never* experienced, such as being abducted by space aliens or winning the lottery, so that they are false in the narrow sense of not being part of a *particular context* that is specified in the experimental design (baseball game, lunch). Second, misremembered events are usually familiar: Hot dogs, unlike baklava, are a common food, and milk, unlike suanmeitang, is a common drink. Third, misremembered events fit the gist of the target context (hot dogs are baseball food, milk is a luncheon beverage). Thus, the false memories that are measured in the modal experiment are *semantic* errors that are rooted in strong meaning resemblance to actual events.

Although these are modal features that hold for most published experiments, none is universal. Researchers occasionally study false memories of events that subjects have never experienced (e.g., being in a traffic accident, being lost in a mall), that are unfamiliar or even bizarre, or that do not share semantic content with the experimental context (e.g., Santa Claus in a baseball game video, a gorilla in a ballet video; for a review, see Brainerd & Reyna, 2005). Nevertheless, the bulk of what we know about how emotion affects false memory is for familiar, previously experienced events that preserve the meaning of the events to which subjects are exposed. That still leaves very wide latitude with respect to how false memories are induced and what types of events subjects are exposed to.

Spontaneous false memory. In our example of eating hot dogs and drinking milk, suppose that your memory errors were pursuant to recall and recognition probes such as: What did you eat at the game? Did you eat a hot dog at the game? What did you drink at lunch? Did you drink a glass of milk at lunch? Apparently, such errors must be attributable to spontaneous, endogenous distortion processes that are a normal part of how episodic memory operates; that is, they are natural concomitants of trying to remember familiar events that fit with the gist of events that were actually experienced.

Over the decades, these spontaneous false memories have been measured with materials as varied as narratives (Bartlett, 1932),

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Table 1
Overview of Studies With Effect Sizes

Study	*n*	Paradigm	Population	Type of test	Groups	Mean	Comparison	Cohen's *d*
Budson et al. (2006)	58	DRM	Younger adults	Recognition	Negative	.37		.08
					Neutral	.39		
			Older adults	Recognition	Negative	.49		.11
					Neutral	.46		
			Adults with AD	Recognition	Negative	.63		.18
					Neutral	.68		
Howe, Toth, and Cicchetti (2011)	284	DRM	Maltx 6–9 yos	Recall	Negative	.17		4.34
					Neutral	.11		
			Maltx 10–12 yos	Recall	Negative	.15		10.38
					Neutral	.10		
			Non-maltx 6–9 yos	Recall	Negative	.16		4.06
					Neutral	.11		
			Non-maltx 10–12 yos	Recall	Negative	.14		10.60
					Neutral	.10		
El Sharkawy et al. (2008)	32	DRM	Young adults	Recognition	Negative	7.88		.67
					Neutral	6.56		
Howe et al. (2010; Exp. 1)	40	DRM	Young adults	Recognition	Negative	.67		1.28
					Neutral	.51		
				Recall	Negative	.27		1.44
					Neutral	.40		
Howe et al. (2010; Exp. 2)	60	DRM	Children	Recognition	Negative	.67		.45
					Neutral	.59		
				Recall	Negative	.23		.73
					Neutral	.34		
Howe et al. (2010; Exp. 3)	60	DRM	Young adults	Delayed recall	Negative	.20		.95
					Neutral	.30		
Howe et al. (2010; Exp. 4)	30	DRM	5 & 8 yos	Delayed recall	Negative	.10		1.82
					Neutral	.25		
Howe et al. (2010; Exp. 5)	80	DRM	7 & 11 yos	Delayed recall	Negative	.20		.77
					Neutral	.31		
Dehon et al. (2010; Exp 1)	36	DRM	Young adults	Recognition	Negative	.42	Neg vs. neu	.71
					Positive	.60	Pos vs. neu	.77
					Neutral	.59		
Dehon et al. (2010; Exp 2)	54	DRM	Young adults	Recall	Negative	.37	Neg vs. neu	.70
					Positive	.39	Pos vs. neu	.81
					Neutral	.19		
Gallo, Foster, and Johnson, (2009)	24	Pictures with labels	Younger and older adults	Recognition	Negative	.14	Pos vs. neu	.82
					Positive	.18	Neg vs. neu	.70
					Neutral	.09	Pos vs. neg	.65
Choi et al. (2013; Exp. 2)	48	Pictures with thematic labels	Young adults	Recognition	Negative	.25	Neg = pos vs. neu	1.41
					Positive	.30		
					Neutral	.25		
Bookbinder & Brainerd (2016)	68	Categorized pictures	Young adults	Recognition	Immediate		Immediate test	
					Negative	.67	Neg vs. pos	2.35
					Positive	.61	Pos vs. neu	3.14
					Neutral	.53	Delay test	
							Neg vs. pos	4.00
					Delay		Neu vs. pos	3.00

(*table continues*)

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Table 1 (*continued*)

Study	*n*	Paradigm	Population	Type of test	Groups	Mean	Comparison	Cohen's *d*
					Negative	.53		
					Positive	.45		
					Neutral	.51		
Mirandola et al. (2014)	53	Scripted material in pictures	Young adults (who did not elaborate	Recognition	Negative	.25	Gap-filling errors	.15
				Gap-filling errors	Neutral	.28	Causal errors	.45
				Causal errors	Negative	.32		
					Neutral	.44		
Porter et al. (2010)	40	Misinformation with pictures	Young adults	Recognition of major misinformation	Negative	.82		.38
					Positive	.92		
Porter et al. (2014)	44	Misinformation with ambiguous pictures	Young adults	Recognition of major misinformation			Descript. at encoding	.42
							Descript. at recall	.32
				Description of picture at encoding	Negative	.51		
					None	.35		
				Description of picture at recall	Negative	.33		
					None	.45		
Van Damme and Smets (2014)	53	Misinformation with pictures	Young adults	Recognition of peripheral details	Positive/low	.20	Positive/low vs. negative/low	6.75
					Positive/high	.21	Positive/high vs. negative/high	7.50
					Negative/low	.47	Ambiguous/low vs. ambiguous/high	5.52
					Negative/high	.59		
					Ambiguous/low	.33		
					Ambiguous/high	.58		
Storbeck and Clore (2005; Exp 1)	100	Music induction; DRM	Young adults	Recall	Negative	5.40	Pos vs. neg	.17
					Positive	6.00	Neg vs. control	.34
					Control	7.00		
Storbeck and Clore (2005; Exp 2)	119	Music induction; DRM	Young adults	Recall	Negative	8.00	Pos vs. neg	.15
					Positive	9.60	Neg vs. control	.13
					Control	9.20		
Corson and Verrier (2007)	222	Music induction; DRM	Young adults	Recall	Happy	.34	Recall	
					Angry	.36	Happy vs. serene	.60
					Serene	.24	Angry vs. sad	.96
					Sad	.20	Recognition	
					Control	.25	Happy vs. serene	.40
				Recognition	Happy	.66	Angry vs. sad	.38
					Angry	.64		
					Serene	.57		
					Sad	.55		
					Control	.54		
Storbeck (2013; Exp. 2)	86	Music induction; DRM	Young adults	Recognition	Negative	.60	Neg vs. pos	.79
					Positive	.73	Neg vs. neu	.44
					Control	.68		
Storbeck (2013; Exp. 3)	70	Music induction; DRM	Young adults	Word Recognition	Negative	.44	Word	
					Positive	.60	Neg vs. pos	.74
					Control	.59	Neg vs. neu	.65
				Word + picture recognition	Negative	.43	Word + picture	
					Positive	.48	Neg vs. pos	.21
					Control	.46	Neg vs. neu	.13

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Table 1 (*continued*)

Study	*n*	Paradigm	Population	Type of test	Groups	Mean	Comparison	Cohen's *d*
Van Damme (2013; Exp. 1)	301	Music induction, DRM	Young adults	Recognition at end of all lists	Serene	.81	Serene vs. happy	2.33
					Happy	.74	Sad vs. angry	3.00
					Sad	.82	Neutral vs. control	1.33
					Angry	.76		
					Control1	.81		
					Control2	.77		
Van Damme (2013; Exp. 3)	297	Music induction, DRM	Young adults	Recognition after each list	Serene	.71	Serene vs. happy	.57
					Happy	.68	Sad vs. angry	2.25
					Sad	.71		
					Angry	.62		
					Control1	.70		
					Control2	.71		
Knott, Threadgold, and Howe (2014)	72	Video induction, DRM	Young adults	Recall	Negative	.19	Neg vs. pos	.80
					Positive	.33	Neg vs. control	1.00
					Control	.40		
Yang et al. (2015)	78	Real-life mood induction, DRM	Young adults	Recognition	Positive	42.5		.72
					Neutral	56.5		
Ruci, Tomes, and Zelenski (2009)	93	Narrative induction, emotional DRM	Young adults	Recall	Positive mood-positive CL	.49	Recall	
					Positive mood-negative CL	.18	Positive mood-positive CL vs. positive mood-negative CL	1.26
					Positive mood-neutral CL	.27	Positive mood-positive CL vs. positive mood-neutral CL	.80
					Negative mood-negative CL	.55	Negative mood-negative CL vs. negative mood-positive CL	1.47
					Negative mood-positive CL	.13	Negative mood-negative CL vs. negative mood-neutral CL	1.04
					Negative mood-neutral CL	.22	Recognition	
							Positive mood-positive CL vs. positive mood-negative CL	.89
				Recognition	Positive mood-positive CL	.86	Positive mood-positive CL vs. positive mood-neutral CL	1.17
					Positive mood-negative CL	.60	Negative mood-negative CL vs. negative mood-positive CL	.96
					Positive mood-neutral CL	.51	Negative mood-negative CL vs. negative mood-neutral CL	1.12
					Negative mood-negative CL	.86		
					Negative mood-positive CL	.58		
					Negative mood-neutral CL	.50		
Knott and Thorley (2014)	48	Video induction; emotional DRM	Young adults	Delayed recognition	Negative mood-negative CL	.89	Negative mood-negative CL vs. negative mood-neutral CL	5.63
					Negative mood-neutral CL	.55		

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Table 1 (*continued*)

Study	*n*	Paradigm	Population	Type of test	Groups	Mean	Comparison	Cohen's *d*
Bland et al. (2016)	83	Video induction; emotional DRM	Young adults (18 year olds)	Recognition	Fearful mood-fearful CL	.93	Fear-fear vs. fear mood-anger list	5.69
					Fearful mood-angry CL	.57	Fear-fear vs. fear mood-neutral list	5.74
					Fearful mood-neutral CL	.53	Angry-angry vs. angry mood-fear list	2.14
					Angry mood-angry CL	.78	Angry-angry vs. angry mood-neutral list	3.99
					Angry mood-fearful CL	.63		
					Angry mood-neutral CL	.48		
Van Damme and Seynaeve (2013)	300	Video induction; misinformation	Young adults	Recognition	Serene	.11	Serene vs. sad	4.96
					Happy	.11	Happy vs. angry	.97
					Sad	.15		
					Angry	.09		
					Control1	.13		
					Control2	.12		
Howe and Malone (2011)	48	Emotional DRM	Depressed subjects and controls	Recognition	Depression-related lists		Depression-related lists: depressed vs. controls	1.10
					Depressed	.75		
					Controls	.47		
Toffalini et al. (2014)	60	Scripted material in pictures	Depressed subjects and controls	Recognition	Depressed	.52	Negative causal errors: depressed vs. controls	1.65
					Controls	.15		
Bremner, Shobe, and Kihlstrom (2000)	63	DRM	PTSD diagnosis, history of abuse but no PTSD diagnosis, controls	Recognition	PTSD	.95	PTSD vs. abuse	.51
					Abuse	.78	PTSD vs. female controls	.50
					Female control	.79	PTSD vs. male controls	.31
					Male control	.86		
Brennen, Dybdahl, and Kapidzic (2007)	100	DRM	PTSD and control	Recall	PTSD	.34	War-related: PTSD vs. control	.65
					Control	.19		
Hauschildt et al. (2012)	62	Videos	PTSD, trauma-non-PTSD, control	Sensitivity	PTSD	53.94		.70
					Control	60.61		
Goodman et al. (2011)	93	DRM	Adults and adolescents with and without histories of CSA and PTSD	Recall	CSA-related	.15	CSA CLs vs. positive CLs	.46
					Negative	.16	Negative CLs vs. positive CLs	.50
					Positive	.06		
					Neutral	.11		

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sentences (Bransford & Franks, 1971; Kintsch, Welsch, Schmalhofer, & Zimny, 1990), lists of semantically related words or pictures (Brainerd & Reyna, 2007; Howe, 2005), live staged events (e.g., Holliday & Hayes, 2000; Lampinen, Copeland, & Neuschatz, 2001), and videos of real-life events (e.g., Bjorklund, Bjorklund, Brown, & Cassel, 1998; Bjorklund et al., 2000). When recall tests are administered, the raw intrusion rate for unpresented events is the false memory index, and when recognition tests are administered, the false memory index is the false alarm rate for such events, which normally incorporates a correction for response bias, such as the signal detection statistics a' and d' (see Snodgrass & Corwin, 1988). Subjects respond to three types of probes when recognition tests are administered: targets (presented items; true memory measures), related distractors (unpresented meaning-sharing items; false memory measures), and unrelated distractors (unpresented items that do not share meaning with presented material; bias controls). Bias correction is essential because response bias can differ dramatically for different subject populations and conditions (e.g., Brainerd, Reyna, & Forrest, 2002).

Currently, the dominant procedure for studying spontaneous false memories is a word list paradigm, the Deese/Roediger/McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) illusion. Subjects study short lists of related words (e.g., *town, state, capital, streets, subway, village, . . .*) from which a critical word (*city*) is missing, followed by recognition or recall tests. Recall or recognition of this missing word (usually called a critical distractor or critical lure) is the false memory measure. The key feature of the DRM illusion for this review is that it is easily adapted to study the effects of emotion. With respect to emotional content, Budson et al. (2006; see also Pesta, Murphy, & Sanders, 2001) pointed out that the DRM illusion can be compared for negatively valenced lists (e.g., *mad, fear, hate, rage, temper, . . .*; critical distractor = *anger*), positively valenced lists (e.g., *child, cute, infant, mother, doll, . . .*; critical distractor = *baby*), and neutral lists (e.g., *blouse, sleeves, pants, tie, button, . . .*; critical distractor = *shirt*). With respect to emotional context, Storbeck and Clore (2005) pointed out that the DRM illusion can be compared for subjects who were in different mood states when lists were studied or tested.

Implanted false memory. Returning to our example of eating hot dogs and drinking milk, suppose that your false memories were pursuant to probes such as: You ate a hot dog at the game, didn't you? You drank a glass of milk at lunch, didn't you? Now, you are confronted with clear suggestions about what you ate and drank, which are hallmarks of lawyerly questioning and police interviews. Presumably, you will be more likely to misremember than you were before. If so, it can no longer be assumed that endogenous distortion processes are responsible because external distortion is present.

The basic procedure for studying implanted false memories, the misinformation paradigm, was pioneered by Loftus (1975; Loftus & Palmer, 1974) and was designed to emulate the suggestive questioning that is integral to police interviews and interrogations (see Inbau, Reid, Buckley, & Jayne, 2001). This procedure involves the same two steps as spontaneous false memory designs, plus another step that is interpolated between them. During the interpolated step, the misinformation phase, erroneous suggestions are presented about the target material that subjects have encoded. To emulate police investigations, it traditionally consists of an interview about that material, with suggestions being delivered as leading questions. For instance, suppose that the target material is a video of a convenience store robbery. During the misinformation phase, the leading questions might include: How long was the knife he was holding? (The robber's hands were empty.) What color was his baseball cap? (The robber was wearing a ski cap.) What type of candy did he grab from the counter? (The robber grabbed cigarettes.) On subsequent memory tests, recall/recognition of such suggested details supply the false memory measure, and recall/recognition of actual details from the video supply the true memory measure.

Beyond interpolated suggestions, a key feature of the typical misinformation experiment is that the target materials are (a) realistic depictions of real-life events that (b) revolve around a theme that is either obviously forensic or is at least forensically related. By virtue of the latter property, negative emotion is a routine feature of misinformation experiments. In Loftus' (1975) original work, for instance, the target materials consisted of a slide show of a traffic accident that resulted in a pedestrian injury, and misinformation focused on details (traffic signs) that determined driver responsibility. On memory tests, subjects could no longer distinguish between critical details in the slide show and details that were only suggested to them.

The misinformation literature is vast, and several reviews of portions of that literature have been published (e.g., Brainerd & Reyna, 2005; Ceci & Bruck, 1993; Goodman, 2006; Reyna & Titcomb, 1997; see various chapters in Bjorklund, 2000). Although there have been occasional controversies as to how best to measure the distortive effects of memory suggestion (e.g., McCloskey & Zaragoza, 1985; see various chapters in Doris, 1991), those effects are routinely observed experimentally, and when coupled with reports of false memories in legal cases in which witnesses were subjected to suggestive interviewing (for reviews, see Kassin et al., 2010; Wells et al., 1998), there is little doubt that suggestion reshapes memory for the events of our lives.

In the present review, the crucial point about misinformation research is that owing to its forensic slant, it provides another existence proof that events that are accompanied by negative emotion, at least, can be systematically misremembered. Modifications to the basic misinformation procedure are then required to answer more subtle questions about whether suggestion also distorts memory when positive emotion is present, about the relative susceptibility to distortion of events that are accompanied by positive versus negative versus neutral emotion, and about whether emotion effects are different when emotion is embedded in content versus context (see below).

Theories of False Memory

If emotional content or context influence false memory, the basic memory processes that control such errors must be affected. There have been two historical stages in the evolution of theoretical hypotheses about the nature of those processes—namely, early one-process accounts, followed by contemporary opponent-process theories (Brainerd & Reyna, 2002). One-process theories, which emerged in the 1970s and 1980s, and their associated literatures, were reviewed by Reyna and Brainerd (1995). The most influential examples are constructivism (Bransford & Franks, 1971), schema theory (Alba & Hasher, 1983), and the source-

monitoring framework (Johnson, Hashtroudi, & Lindsay, 1993). The hallmark of these theories is the assumption that true and false memories are products of a single process, although the specific process was different for different theories: Constructivism assumed that true and false memory are products of meaning-driven interpretation and elaboration of target events; schema theory assumed that target events are encoded into preexisting interpretive structures (schemata), with episodic memory relying on retrieval from those structures; and the source-monitoring framework assumed that episodic memory relies on source attributions, which are attributions about the contexts in which events were experienced.

In connection with these theories, the common thread that true and false memory are attributable to a common process lead to the straightforward predictions that for a given type of false memory task, (a) variability in true and false memory over subjects and conditions should be positively correlated, and (b) manipulations that increase true memory should also increase false memory and conversely (see Brainerd, Reyna, & Ceci, 2008). However, data from early studies persistently failed to support either prediction. Several investigators examined the correlation between target hit rates and related distractor false alarm rates, finding that the two are usually uncorrelated (e.g., Brainerd, Reyna, & Kneer, 1995; Reyna & Kiernan, 1994, 1995; Tussing & Greene, 1999). Also, various manipulations were identified that dissociate true from false memory, in the sense that they affect one but not the other (single dissociation) or they drive them in opposite directions (double dissociation; e.g., Israel & Schacter, 1997; Lampinen et al., 2001; Payne, Elie, Blackwell, & Neuschatz, 1996; Schacter, Israel, & Racine, 1999).

Opponent-process accounts grew out of such findings, and they have two major characteristics (see Table 2 for a summary). First, they echo the dominant contemporary perspective on episodic memory, the dual-process approach, which is exemplified by many theories in the mainstream memory literature (e.g., Jacoby, Begg, & Toth, 1997; Parks & Yonelinas, 2007; Rotello, Macmillan, & Reeder, 2004). Their common feature is the principle that remembering an item, such as the word *bagpipe* from a study list, can be attributable to either of two retrieval operations. One, which is most often called recollection, brings realistic details of the item's presentation to conscious awareness, which may include psychological details (a visual image of a bagpipe or kilt) as well as physical ones (the visual appearance of *bagpipe* on a computer screen). The other, which is most often called familiarity, produces strong feelings that the item was presented but without awareness of accompanying details.

Dual-process approaches to false memory posit that the two processes operate in opposition when it comes to distortion. Familiarity supports false memories because the salient properties that related distractors (e.g., *chair, robin*) share with targets (e.g., *couch, sparrow*) produce strong feelings that they were presented, but recollection suppresses false memories because it consciously reinstates verbatim content, eliminating a variety of similar-but-not-verbatim possibilities. Fuzzy-trace theory (FTT; Reyna & Brainerd, 1995) is the original example of such a theory and the one that has most often figured in emotion-false memory research. In FTT, subjects are assumed to store two distinct traces of target items in parallel: (a) verbatim traces of targets' surface form (e.g., the word "couch" and the word "sparrow"), along with (b) gist

Table 2
Central Ideas and Predictions of Theories of Emotion and False Memory

Theory	Domain	Central idea	True memory predictions	False memory predictions
One-process	False memory	A single process controls true and false memory	Increases when false memory increases	Increases when true memory increases
Opponent-process	False memory	Recollection and familiarity work together for true memory but in opposition for false memory	Supported by recollection and familiarity	Supported by familiarity but not recollection
Easterbrook; central/peripheral tradeoff	Emotional content	Emotion reduces attention to peripheral or non-emotional details	Increased for central emotional details; reduced for peripheral or neutral details	Increased for peripheral or neutral details
Emotional enhancement of memory	Emotional content	Emotion enhances memory accuracy	Negative valence and arousal increase TM for details	Reduced for central details of emotional event
Fuzzy-trace theory	Emotional content	Emotional valence strengthens gist and negative valence strengthens it more than positive valence	Increased for positive compared to negative valence	Increased for negative compared to positive valence
Network theory of affect	Emotional mood	Memory is enhanced by mood congruence between study and test	Increases when mood is same at encoding and retrieval	
Affect as information	Emotional mood	Mood affects item versus relational processing	Increases for negative moods via item processing	Increases for positive moods via relational processing

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traces of their meanings (e.g., "household furniture," "bird"). Retrieval of verbatim traces is the basis for what is usually called recollection, supporting true memories ("yes, I clearly remember studying *couch*") and suppressing false ones ("no, I didn't study *chair* because I clearly remember studying *couch* instead"). Retrieval of gist traces is the basis for what is commonly called familiarity, supporting true memories ("yes, I studied *couch* because I know there was furniture on this list") and false memories for items that share that gist (*chair*).

Summing up, if false memory is affected by emotional content or context, opponent-process theories say that this would happen in either or both of two ways: (a) by influencing recollection-based suppression of false memories or (b) influencing familiarity-based acceptance of false memories. We shall see that the literature contains examples of both of these hypotheses. Here, experimentation on how the DRM illusion is affected by negative emotion is illustrative. Storbeck and Clore (2005) hypothesized that during the study phase, the presence of negative emotion in subjects' moods enhances the processing of targets' surface forms, producing stronger verbatim traces and enhanced suppression of false memories. In contrast, Brainerd, Stein, Silveira, Rohenkohl, and Reyna (2008) hypothesized that the presence of negative emotion in targets themselves enhances the processing of semantic relations among them, producing stronger gist traces and higher levels of false memory.

Emotion-False Memory: Method and Theory

We now sketch methodologies that have been used to measure and manipulate levels of emotion, and we consider the theoretical hypotheses that have most often guided research on how emotion might influence false memory. Then, in the next two sections, we review findings from extant studies of how false memory is influenced by the emotional content of target events and by subjects' moods.

Manipulating and Measuring Emotion

Most emotion-false memory research has relied on procedures that implement the circumplex model of emotion (Russell, 1991), according to which emotional states vary continuously along independent dimensions of valence and physical arousal. Russell defined valence as varying from pleasant to unpleasant and arousal as varying from calm to excited. Other conceptualizations have defined valence as varying from approach to withdrawal (Lang, Bradley, & Cuthbert, 1998) or from positivity to negativity (Tellegen, Watson, & Clark, 1999). The literature contains a number of standardized tools—such as the Affective Norms for English Words (ANEW; Bradley & Lang, 1999), the International Affective Pictures System (IAPS; Lang, Bradley, & Cuthbert, 2008), and the Geneva Affective Picture Database (GAPED; Dan-Glauser & Scherer, 2011)—that supply investigators with pools of familiar words or photographs that have been normed for valence and arousal (also for a third dimension, dominance.)

In the circumplex approach, any specific emotion can be conceived of as a pair of values on continuous scales of valence and arousal. The separability of those dimensions is assumed to be attributable to the activation of distinct neurological systems (Feldman Barrett & Russell, 1998). Here, different brain regions have been tied to variability in valence versus arousal (Colibazzi et al., 2010). Arousal has been most consistently linked to amygdala activation (e.g., Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003), especially when information is negatively valenced (Anderson & Phelps, 2001). Valence, on the other hand, has most often been linked to activation in the prefrontal and cingulate cortices (Beauregard, Levesque, & Bourgouin, 2001; Colibazzi et al., 2010).

Of course, there are influential theoretical conceptions other than the circumplex model, such as the theory of discrete emotions (e.g., Ekman, 1992) and psychoevolutionary theory (e.g., Plutchik, 2001). According to the former, there is a small number of discrete emotions, which have evolved for distinct universal purposes, each of which is grounded in a specific neurological system with a specific physiological expression. Facial expression research focuses on the universality and physiological distinctiveness of discrete emotions (e.g., Ekman & Friesen, 1971; Ekman, Levenson, & Friesen, 1983). Psychoevolutionary theory (Plutchik, 2001) combines the discrete and continuous views of emotion and has stimulated multiple models. According to one, there are eight basic emotions, with each being treated as a dimension that combines with the others to produce emotional states that are mixtures of these dimensions. Studies of computer recognition of facial expressions of emotion have been used to investigate this particular model (e.g., Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007).

Despite the existence of these other models, the circumplex approach has dominated research on emotion-false memory. No doubt, that is largely attributable to the availability of multiple pools of normed materials that allow the dimensions of valence and arousal to be manipulated under controlled conditions, a matter to which we now turn.

Manipulating emotional content. Emotional word lists are the most common method of manipulating the affective content of target events. We noted earlier that Budson et al. (2006; cf. Table 3) originated this technique by modifying DRM lists so that some consisted of emotional words and emotional critical distractors (e.g., *cough, fever, ill, flu,* and *vomit*; with the critical distractor *sick*) and others did not (e.g., *shoe, hand, toe, kick,* and *sock*; with the critical distractor *foot*). Budson et al.'s emotional lists are actually mixtures of emotional words (e.g., *violate, isolated, sad*) and neutral ones (e.g., *man, quiet, tissue*). Other than the emotional content manipulation, the Budson et al. procedure is a standard DRM design in which subjects study the lists in Table 3 followed by recognition or recall tests to measure true and false memory (e.g., Howe, 2007; Howe, Candel, Otgaar, Malone, & Wimmer, 2010).

There are three complexities with these materials that have been topics of subsequent methodological refinement (Brainerd, Holliday, Reyna, Yang, & Toglia, 2010; Brainerd, Stein, et al., 2008). First, whereas the emotional lists are emotional, it is inaccurate to say that the others are nonemotional. Some of the nonemotional critical distractors (*sweet, fruit, soft,* and *sleep*) are clearly emotional words, as are some of the words on the corresponding lists (*candy, treat, apple, orange, nap, dream*). The key difference between emotional versus nonemotional lists is valence rather than emotion per se: Words such as *rape* and *alone* are negative, whereas words such as *sweet* and *soft* are positive. Second, there is an arousal difference between the two groups of lists. Many of the

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Table 3
Emotional Word Lists That Were Used in Various Studies of Emotional Content Effects on False Memory

Budson et al. (2006)

Neutral	*Chair*	*Foot*	*Fruit*	*Girl*	*Sleep*
	Table	Shoe	Apple	Boy	Bed
	Sit	Hand	Vegetable	Dolls	Nap
	Desk	Toe	Orange	Female	Dream
	Seat	Kick	Kiwi	Young	Snore
	Couch	Sock	Citrus	Dress	Awake
	Sofa	Arch	Ripe	Pretty	Doze
	Wood	Heel	Pear	Caring	Pillow
	Cushion	Ankle	Banana	Pink	Yawn
	Slow	*Soft*	*Sweet*	*Teacher*	*Window*
	Fast	Fur	Candy	School	Door
	Time	Touch	Sugar	Classroom	Glass
	Boring	Feather	Bitter	Student	Pane
	Stay	Satin	Sour	Learn	Shade
	Wait	Fleece	Treat	Quiz	Ledge
	Steady	Cotton	Pastry	Test	Sill
	Turtle	Smooth	Taste	Grade	House
	Stop	Gentle	Salty	Lecture	Open
Negative	*Alone*	*Anger*	*Cry*	*Danger*	*Hell*
	Single	Mad	Tears	Fear	Devil
	Isolated	Rage	Sad	Caution	Satan
	Solitary	Annoyed	Tissue	Trouble	Evil
	Apart	Furious	Sorrow	Warning	Damned
	Separate	Bothered	Eyes	Risk	Sin
	Quiet	Wrath	Weep	Hazard	Demon
	Detached	Hate	Sob	Alarm	Heaven
	Self	Mood	Unhappy	Help	Judgment
	Hungry	*Lie*	*Rape*	*Sick*	*Thief*
	Food	Fib	Sex	Cough	Steal
	Starve	Cheat	Man	Fever	Robber
	Famine	Truth	Violate	Ill	Crook
	Empty	False	Blame	Flu	Burglar
	Stomach	Mislead	Struggle	Vomit	Money
	Poor	Trick	Date	Doctor	Cop
	Eat	Fake	Force	Health	Purse
	Pangs	Betray	Shame	Dizzy	Mugger

Palmer & Dodson (2009)

Neutral	*Chair*	*Needle*	*Sleep*
	Table	Thread	Doze
	Rocking	Haystack	Bed
	Recliner	Injection	Snooze
	Stool	Sewing	Tired
	Desk	Knitting	Snore
	Sit	Prick	Pillow
	Sofa	Sharp	Dream
	Sitting	Thorn	Relax
	Bench	Point	Quiet
	Legs	Eye	Blanket
Negative	*Kill*	*Pain*	*Sad*
	Assassinate	Suffer	Depressed
	Slay	Hurt	Melancholy
	Slaughter	Ouch	Cheerless
	Murder	Anguish	Somber
	Execute	Pleasure	Miserable
	Massacre	Harm	Lonely
	Stab	Distress	Upset
	Behead	Back	Gloomy
	Homicide	Death	Hopeless
	Shoot	Blood	Desolate
Positive	*Beautiful*	*Happy*	*Love*
	Gorgeous	Glad	Adore

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Table 3 (*continued*)

		Stunning		Elated		Affection
		Picturesque		Content		Passion
		Breathtaking		Joyful		Heart
		Pretty		Pleased		Kiss
		Lovely		Ecstatic		Like
		Exquisite		Laugh		Attraction
		Striking		Enjoyment		Care
		Attractive		Satisfied		Devoted
		Elegant		Enjoyable		Admire
			Pesta et al. (2001)			
Neutral	*Peach*	*Rink*	*Shave*	*Digit*	*Hook*	*Park*
	Beach	Link	Slave	Widget	Book	Bark
	Leach	Mink	Stave	Midget	Look	Dark
	Teach	Sink	Shove	Bridget	Cook	Hark
	Reach	Wink	Share	Fidget	Nook	Lark
	Poach	Pink	Have	Dibot	Rook	Mark
	Peak	Rank	Shade	Divvy	Took	Nark
	Perch	Risk	Shake	Dimwit	Hock	Pack
	Peace	Ring	Shale	Digest	Honk	Perk
	Preach	Rick	Shame	Gadget	Hood	Pork
	Peal	Fink	Shape	Dig	Hoof	Spark
Negative	*Bitch*	*Hell*	*Penis*	*Rape*	*Slut*	*Whore*
	Ditch	Bell	Venus	Cape	Slug	Chore
	Hitch	Dell	Genus	Nape	Slum	Bore
	Batch	Fell	Penal	Tape	Slur	Wore
	Pitch	Jell	Peevish	Ripe	Slot	More
	Itch	Sell	Penance	Rope	Slue	Tore
	Botch	Tell	Venice	Race	Shut	Pore
	Mitch	Hall	Zenith	Rapt	Slit	Sore
	Butch	Hill	Pennies	Rake	Smut	Horn
	Birch	Hull	Punish	Rare	Glut	Shore
	Witch	Shell	Pianist	Raze	Scut	Core

	Moritz et al. (2005)	
Neutral	*Window*	
	Light	
	View	
	Air	
	Glass pane	
	Clean	
	Open	
	Curtain	
	Cover	
	Door	
	Flowers	
	Bird	
	Transparent	
Negative	*Betrayal* (Delusion-relevant)	*Loneliness*(Depression-relevant)
	Disappointment	Sad
	Deceit	Alone
	Backstabbing	Silence
	Trust	Sorrow
	Mistrust	Isolation
	Loyalty	Emptiness
	Intrigue	Longing
	Enemy	Boring
	Secret	Depression
	State	Dull
	Dishonest	Cold
	Spy	Hermit
Positive	*Holidays*	
	Sun	
	Beach	
	Sea	

(*table continues*)

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Table 3 (*continued*)

	Relaxation
	Recovery
	Leisure
	Fly
	Vacation
	Palms
	Travel
	Read
	Adventure

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critical distractors in the emotional group (e.g., *rape, anger, danger, hell, cry, lie, thief*) refer to states of excitement, as do several of the list words (e.g., *violate, rage, fear, damned, sob, cheat, steal*). In contrast, none of the critical distractors in the nonemotional group seem arousing, nor do most of the list words. Therefore, third, the actual differences between the two groups of lists are that (a) one consists of negatively valenced materials while the other consists of a mixture of positively valenced and neutral materials, and (b) one is more arousing than the other. Consequently, if the two groups of lists produce different false memory rates, this difference cannot simply be attributed to emotional versus nonemotional content, and it is unclear whether it is attributable to the valence difference or the arousal difference.

These complexities can be removed by revised lists for which valence and arousal values are known, which can be done by relying on word pools such as the ANEW (Bradley & Lang, 1999). Using such word pools, DRM lists can be constructed for which valence and arousal levels of both critical distractors and targets are precisely counterbalanced. A pool of 32 counterbalanced lists that have been administered in some recent experiments appears in Table 4. Lists of this sort allow two types of experiments to be conducted. First, whether false memory is affected by valence per se can be studied by comparing performance on positive, negative, and neutral lists whose arousal levels have been equated (Brainerd, Stein, et al., 2008). Second, by manipulating valence and arousal factorially, it is possible to study whether false memory is affected by both valence and arousal and whether the two interact (Brainerd et al., 2010).

Another technique for manipulating the emotional content of target materials is via pictures that have been normed for valence and arousal, such as the IAPS (Lang et al., 2008), which contains color photographs of people, animals, objects, and scenes, rated on valence and arousal using the same scales as the ANEW. Another example is the GAPED (Dan-Glauser & Scherer, 2011), which is a similar picture database. An important feature of the GAPED is that it contains *thematic* groups of pictures (e.g., several babies, several dangerous animals) that differ in valence and arousal. Similar to the DRM lists in Table 4, these picture norms can be used to construct lists in which valence and arousal are counterbalanced.

A final, rarely used, technique involves pictures of human faces that express various emotions. There are many databases of such pictures, but most have not been normed. A few have been normed for valence (e.g., Langner et al., 2010), but none has been normed for arousal.

Manipulating and measuring mood. Both experimental and correlational designs have been used to investigate how false memory is influenced by mood. In experimental work, *mood-induction* tasks are administered to distinct groups of subjects, whereas in correlational work, subjects' natural moods are measured. We sketch the basic characteristics of each type of design.

Mood-induction. Here, subjects participate in conditions that place them in different emotional states either before or after presentation of target material. The former can affect encoding processes—and, potentially, retrieval and consolidation processes—whereas the latter can affect retrieval and consolidation processes. The subjects in all mood conditions are exposed to the same target materials, and occasionally, the materials' emotional content is also manipulated. During the test phase, subjects respond to the usual recognition or recall tests. In addition, a mood manipulation check is administered at some point, to verify that induction was successful.

This brings us to how moods are induced and checked. With respect to induction, one of the most widely used techniques (e.g., Storbeck & Clore, 2005, 2011) is a music and guided imagery procedure that was introduced by Mayer, Allen, and Beauregard (1995). Subjects are asked to adopt a specific mood, and then they listen to music that matches that mood, and finally, they read some mood-matching vignettes. The Mayer et al. materials have been normed for their ability to induce happy, angry, fearful, and sad moods. A second method consists of viewing emotional pictures, especially from the IAPS, which has the key feature that pictures' valence and arousal levels can be varied systematically. A third method (Gross & Levenson, 1995) uses videos that represent eight discrete emotions (amusement, anger, contentment, disgust, fear, neutral, sadness, and surprise).

Subjects' moods are measured to check the effectiveness and durability of induction. The modal method is to administer the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), which asks subjects to indicate the degree to which they have felt emotions that are described by a series of words (e.g., excited, scared, irritable, inspired) during a specified period of time (e.g., right now, today, in the past week). The PANAS was developed for nonclinical populations (Crawford & Henry, 2004), and disorder-specific instruments are available for clinical populations (e.g., the Hamilton Depression Scale; Hamilton, 1960). Other mood measures have occasionally been administered in false memory experiments—such the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985; Koo & Oishi, 2009), the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988), and the Self-Assessment Manikin (Bradley & Lang, 1994)—but the PANAS predominates.

Correlational studies. Here, measures of naturally occurring moods are added to otherwise standard designs, and the scores are

Table 4
Emotional DRM Lists (Arousal Controlled) From Brainerd et al., 2010

Negative/High arousal		Negative/Low arousal		Positive/High arousal		Positive/Low arousal	
Anger	*Cold*	*Board*	*Dirt*	*Baby*	*Beach*	*Bird*	*Fish*
Mad	Hot	Wood	Mud	Child	Sand	Nest	Water
Fear	Snow	Chalk	San	Cry	Sun	Parrot	Swim
Hate	Warm	Surf	Clean	Small	Ocean	Eagle	Sea
Rage	Winter	Room	Soil	Bottle	Water	Feather	Scales
Temper	Ice	Game	Dirty	Cute	Towel	Animal	Smell
Fury	Wet	Nail	Filth	Infant	Ball	Wings	Cod
Ire	Frigid	Plane	Ground	Mother	Summer	Canary	Food
Wrath	Chilly	School	Bath	Crib	Girls	Cage	Trout
Happiness	Heat	Ship	Black	Doll	Swim	Sing	Gold
Fight	Weather	Walk	Grime	Little	Fun	Dog	Ocean
Hatred	Freeze	Two-by-four	Bike	Boy	Wave	Flight	Fry
Hostile	Air	Black	Brown	Adult	Blanket	Song	Shark
Calm	Shiver	Boat	Grease	Diaper	Bum	Blue Jay	Tank
Emotion	Arctic	Build	Mess	Girl	Coast	Tree	Bass
Enrage	Frost		Unclean	Young	Short	Robin	Bowl
Dead	*Hurt*	*Fall*	*Fat*	*City*	*God*	*Grass*	*Green*
Alive	Pain	Spring	Skinny	Town	Jesus	Green	Grass
Gone	Cut	Leaves	Thin	Crowded	Heaven	Cut	Yellow
Cold	Ouch	Winter	Cat	State	Love	Lawn	Blue
Funeral	Cry	Down	Ugly	Capital	Almighty	Mow	Color
Asleep	Injury	Autumn	Lady	Streets	Church	Hopper	Red
Bury	Life	Hurt	Big	Subway	Lord	Pot	Leaf
End	Sick	Frosty	Cow	Country	Religion	Mower	Arrow
Grave	Fall	Summer	Slim	New York	Creator	Weed	Clover
Sad	Harm	Catch	Albert	Village	All-knowing	Grow	Frog
Still	Hit	Cool	Slob	Metropolis	Bible	High	Vegetables
Animal	Sore	Trip	Boy	Big	Damn	Roots	Apple
Cemetery	Stop	Drop	Man	Chicago	Devil	Smoke	Bean
Deceased	Wound	Rise	Pig	Suburb	Faith	Turf	Elf
Die	Upset	Stand	Diet	County	Good	Yard	Go
Duck	Ache	Trees	Large	Urban			Money
Needle	*Rough*	*Glass*	*Sick*	*Hug*	*Love*	*Nice*	*River*
Thread	Smooth	Window	Ill	Kiss	Hate	Mean	Water
Pin	Bumpy	Cup	Well	Love	Kiss	Sweet	Stream
Eye	Road	Drink	Cold	Squeeze	Like	Good	Lake
Sewing	Tough	Break	Hospital	Embrace	Happy	Bad	Mississippi
Sharp	Sandpaper	Clear	Vomit	Affection	Heart	Kind	Boat
Point	Jagged	Jar	Doctor	Hold	Care	Pleasant	Tide
Prick	Ready	Crystal	Bed	Cuddle	Admire	People	Canoe
Thimble	Coarse	Cut	Flu	Arms	Adore	Friendly	Flow
Haystack	Uneven	Bottle	Illness	Bear	Close	Smile	Run
Thorn	Riders	Fragile	Fever	Caress	Friendship	Happy	Barge
Harm	Rugged	Plastic	Nurse	Tight	Girl	Friend	Creek
Injection	Sand	Sharp	Medicine	Touch	Happiness	Pretty	Brook
Syringe	Beard	Eye	Nausea	Warmth	Hug	Nasty	Bend
Cloth	Ground	House	Virus	Clinch	Kindness	Delightful	Bridge
Knitting	Gravel	Juice	Pills	Clutch	Life	Polite	Wind
Spider	*Thief*	*Shy*	*Trash*	*Music*	*Pretty*	*Sleep*	*Soft*
Web	Steal	Quiet	Garbage	Note	Ugly	Bed	Hard
Insect	Robber	Outgoing	Waste	Sound	Girl	Rest	Light
Bug	Crook	Timid	Can	Piano	Beautiful	Awake	Pillow
Fright	Burglar	Bashful	Refuse	Sing	Cute	Tired	Plush
Fly	Money	Scared	Sewage	Radio	Adorable	Dream	Loud
Arachnid	Cop	Bold	Bag	Band	Attractive	Wake	Cotton
Crawl	Police	Person	Junk	Melody	Flower	Snooze	Fur
Tarantula	Rob	Introvert	Rubbish	Horn	Gorgeous	Blanket	Touch
Poison	Jail	People	Sweep	Concert	Hot	Doze	Fluffy
Bite	Gun	Me	Scraps	Instrument	Model	Slumber	Warm
Creepy	Villain	Loud	Pile	Symphony	Pink	Snore	Furry
Black widow	Crime	Afraid	Dump	Jazz	Appealing	Nap	Downy
Monkey	Bank	Boring	Landfill	Orchestra	Sweet	Peace	Kitten
Feelers	Bandit	Coy	Debris	Art	Charming	Yawn	Skin
	Criminal	Extrovert	Litter	Rhythm	Lovely	Drowsy	Tender

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then correlated with measured levels of false memory. This has been done for two broad types of populations: the usual subjects in memory research (undergraduates) and special populations that are characterized by particular moods [for example, depressed individuals, individuals with Posttraumatic Stress Disorder (PTSD)]. As in mood-induction experiments, the PANAS has been the most common instrument for measuring naturally occurring moods.

Target materials may be neutral, or their emotional content can be varied. An advantage of the latter procedure is that a basic memory law, the encoding-specificity principle (Tulving & Thomson, 1971), should operate, according to which episodic traces of targets include contextual details from the study phase. Mood is a salient contextual detail, and by varying targets' emotional content, it can match or mismatch emotional content. According to encoding specificity, that should produce mood congruency effects (better memory when mood and content match; Bower, 1981). Such effects have been investigated in correlational studies of both nonclinical and clinical samples, typically by administering emotional DRM lists. Mood congruency effects could just as easily be investigated in mood-induction experiments, by varying the emotional content of targets, and we shall see that the literature contains a few experiments of that ilk.

Theoretical Conceptions of Emotion-False Memory

Extant proposals about real-world instances of emotional false memory suggest that the relation between emotion and false memory may not be straightforward. A prime example is complementary hypotheses about two circumstances that are laced with highly arousing negative emotion: flashbulb memories of major disasters, such as the Challenger explosion and the 9/11 attack, and memories of crimes during police interrogations. In the former, people often report detailed memories of these events many years afterward, and it has been claimed that the events' emotional qualities make it very unlikely that those memories are distorted (e.g., Brown & Kulik, 1977). In police interrogations, on the other hand, it has been claimed that the same qualities produce high levels of distortion in memory for details of crimes (e.g., Brainerd & Reyna, 2005) and the physical appearance of perpetrators (e.g., Kassin, 2001).

There are also complementary hypotheses about memories of emotionally arousing medical symptoms. Some have proposed that emotion makes patients' memories for such things as past pregnancies, children's health care, and AIDS treatment highly resistant to distortion (D'souza-Vazirani, Minkovitz, & Strobino, 2005; Githens, Glass, Sloan, & Entman, 1993; Weissman et al., 1996), but others have proposed that emotion makes memories for care received during counseling, number of doctor visits, and hospital stays quite error prone (Raina, Torrance-Rynard, Wong, & Woodward, 2002; Tisnado et al., 2006; Wolinsky et al., 2007). The denouement is that complementary hypotheses are a feature of current theoretical ideas about emotion-false memory. Beyond this, extant hypotheses are somewhat different for emotional content versus mood, and hence, we sketch them separately.

Content hypotheses. Early proposals were made by Easterbrook (1959), who argued that increased levels of emotion in events reduce the amount of information that subjects can attend to, which impairs later memory. This hypothesis has been studied by varying the emotional content of central and peripheral details of target events (Christianson & Hubinette, 1993; Christianson & Loftus, 1990), with the general result that only memory for peripheral events supports the hypothesis. This may mean that attention is optional for peripheral events but obligatory for central ones. Loftus (1979) introduced a well-known forensic example of this point, weapon focus: When a dangerous weapon is present in a crime, attention to the weapon is obligatory but is optional to other details (e.g., the appearance of the perpetrator).

More recently, Kensinger, Garoff-Eaton, and Schacter (2007) proposed that memory for negative elements of negative events is enhanced but memory for neutral events is impaired. They also proposed a verbatim/gist tradeoff such that emotion enhances memory for the gist of experiences but impairs memory for verbatim details. The general pattern that is expected is that (negative) emotional content will reduce false memory for certain components of an event, which can be specified on theoretical grounds, but will increase it for other components of the same event. Mather (2007) extended this line of reasoning, proposing that the organization of an emotional event determines its effects on memory. Emotional content is assumed to attract processing attention, and any details that are "considered to be in the same object as the arousing item" (Mather, 2007, p. 36) will receive increased processing. This suppresses memory distortion for those details, but it increases false memory for other details because processing attention is drained away from them. Support for this hypothesis was obtained in some experiments reported by Doerksen and Shimamura (2001).

Emotional enhancement of memory (EEM; Heuer & Reisberg, 1990) is a broader proposal to the effect that emotional content enhances overall memory accuracy. For example, Heuer and Reisberg suggested that the presence of a weapon in a crime enhances memory for peripheral details as well as for the weapon. Other evidence in line with EEM was reported by Kensinger and Corkin (2003) and by Ochsner (2000). At present, EEM effects are thought to be attributable to a mix of factors that includes enhanced physiological responsiveness and enhanced semantic relatedness, as well as heightened distinctiveness and personal significance. Talmi and Moscovitch (2004), for instance, reported some influential experiments on the semantic properties of emotional content.

FTT's opponent process distinctions have been used to unpack the effects of different components of emotional content on false memory (e.g., Bookbinder & Brainerd, 2016; Brainerd, Stein, et al., 2008; Rivers, Reyna, & Mills, 2008). This analysis focuses on the valence and arousal dimensions, making predictions about how each affects retrieval processes that control false memory and providing a framework for explaining differences in the effects of discrete emotions (e.g., anger and fear). Recall that in the opponent process approach, strengthening gist traces foments false memories, whereas strengthening verbatim traces suppresses them. Emotional content is assumed to affect both, so that whether it increases or decreases false memory, relative to neutral content, depends on whether it has more pronounced effects on the gist or verbatim side. FTT makes three specific proposals about valence and two about arousal.

The first valence proposal is that content that is either positively valenced (words such as *baby*, *dream*, and *sweet*) or negatively valenced (words such as *death*, *mad*, and *spider*) strengthens gist traces, relative to neutral content, by increasing semantic connec-

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tions among target events. Second, semantic connections are more salient for negative than for positive valence, so that other things being equal, gist traces are strengthened more by negative than by positive valence. Together, these two ideas seem to predict that (a) false memories will be increased by both positively and negatively valenced content and (b) the increase will be greater for negative valence. However, that ignores how verbatim memory is affected by emotional content. Here, third, FTT assumes that positive valence strengthens verbatim traces, relative to neutral content, but negative valence weakens them. This proposal falls out of a substantial prior literature showing that subjects' ability to retrieve vivid, detailed memories of events is enhanced by positive valence but impaired by negative valence (for reviews, see Gomes, Brainerd, & Stein, 2013; Kensinger, 2004). Thus, the clear prediction about negative valence is that it will increase false memories because it strengthens gist traces while weakening verbatim traces, whereas in contrast, the prediction about positive valence is that its effect on false memory will depend on whether a particular manipulation strengthens verbatim or gist memory more.

Turning to arousal, FTT assumes that it chiefly affects verbatim memory (Brainerd et al., 2010; Rivers et al., 2008). Moderate levels of arousal, relative to baseline, can enhance attention to target events and strengthen verbatim traces, but high levels are a form of cognitive noise that blurs attentional focus and weakens verbatim traces (Yerkes & Dodson, 1908). Consequently, if valence is controlled, increases in arousal can suppress or increase false memory, depending on how high the levels of arousal are.

Last, in connection with specific emotions, emotions of the same qualitative valence may differ in just how strong that valence is and also in levels of arousal. For instance, on the ANEW norms (Bradley & Lang, 1999), anger is rated as both more negative and more arousing than fear (2.76 vs. 2.34 and 7.17 vs. 6.96). Hence, FTT simply uses its proposals about gist-verbatim effects to predict differences in false memory effects. However, specific emotions may be roughly comparable in valence and arousal, and when they are, their false memory effects may still differ. Here, FTT does not make differential predictions, but it uses opponent process distinctions to explain any observed differences.

Mood hypotheses. Other hypotheses about how emotion affects false memory have been formulated for mood. They are less extensive that those for emotional content and can be traced to Bower's (1981) landmark studies of how mood affects true memory. Bower proposed a network theory of emotion that featured a mood congruency principle: Memory for target events is enhanced when subjects' moods match during study and test.

In recent years, hypotheses have emerged that describe memory consequences of specific moods. The affect-as-information hypothesis (Schwarz & Clore, 1983; Schwarz, 1990) is the most influential example, according to which mood affects the nature of encoding during the study phase—in particular, subjects' reliance on what Hunt and Einstein (1981) termed item versus relational processing. Positive moods are assumed to promote relational processing, which focuses on connections among target events (e.g., their meanings), and negative moods are assumed to promote item processing, which focuses on targets' distinguishing features (e.g., their surface structures). In that vein, Bless et al. (1996) predicted that happy moods increase reliance on general knowledge structures (e.g., schemata), relative to sad moods. The distinction between item and relational processing resembles FTT's verbatim-gist distinction. The key difference is that one is concerned with subjects' processing and the other is concerned with the types of traces that they store, but obviously, verbatim traces should be favored by item processing and gist traces by relational processing.

The predictions of the affect-as-information hypothesis are straightforward because the item versus relational processing distinction is known to predict that false memory will increase as relational processing increases, but that it will decrease as item processing increases (e.g., Arndt, 2006). Therefore, positive moods should increase false memory because focusing on relations among targets ("tree" for *oak* and *pine*, "animal" for *cow* and *horse*, "color" for *blue* and *red*) supports false memory for related distractors (*maple*, *sheep*, *green*), but negative moods should decrease false memory because focusing on unique features of individual targets suppresses false memory for related distractors ("I could not have read *maple* because I clearly remember reading *oak* and *pine* instead.").

In addition to Bower's (1981) mood congruency principle and the affect-as-information hypothesis (see Table 2 for a comparison of the two theories), researchers have borrowed theoretical distinctions from the larger false memory literature and adapted them to mood differences in false memory. For example, Ruci, Tomes, and Zelenski (2009) explained increased false memory in mood-congruent conditions by combining Bower's theory of mood congruency with a spreading activation account that is often applied to the DRM illusion (McDermott & Watson, 2001). Others have attributed mood differences in false memory to increased arousal (e.g., Corson & Verrier, 2007) or to organizational differences (e.g., Schwartz, 1975). However, there are no dominant mood theories beyond the first two that we described, and hence, we rely primarily on those theories in interpreting current mood-false memory research.

Review of Data I. Emotional Content and False Memory

Now, we summarize the main patterns that have been reported in emotional content experiments. We separate these studies according to their focal form of false memory and emphasize convergent findings, beginning with studies of emotional DRM materials, continuing with studies of emotional pictures and scripted material, and concluding with misinformation studies. In the next section, we do likewise for research on the relation between false memory and subjects' moods.

DRM Experiments

Variants of this procedure, in which the valance and/or arousal of critical distractors (CDs) and list words were manipulated, have been used to measure the distortive effects of emotional content. In the first group of experiments below, false memory for negative, arousing CDs was compared with false memory for neutral CDs. In a second and smaller group of studies, false memory for positive, negative, and neutral CDs was compared with their respective arousal levels controlled.

False memory for negative, arousing content. Budson et al. (2006) developed the DRM lists at the top of Table 3, with emotional lists being both more negative *and* more arousing than

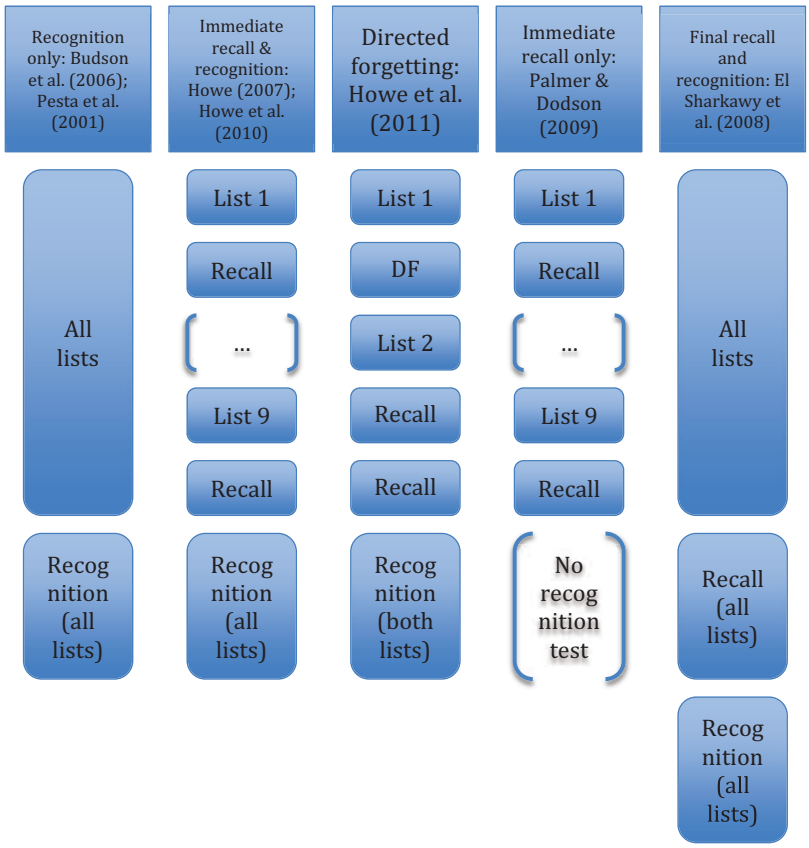


Figure 1. Variants of the DRM paradigm in studies of emotional content effects. See the online article for the color version of this figure.

neutral ones, which are a mixture of neutral and positive lists. The basic elements of their design are shown in the left column of Figure 1. Other experiments that are reviewed in this section implemented variations of Budson et al.'s design, with their key features being shown in the remaining columns of Figure 1.

Budson et al. (2006) administered their materials to healthy younger and older adults and to older adults with Alzheimer's Dementia (AD). They found that emotional content did not affect false memory in any of these groups, as shown in Panel A of Figure 2. Emotional content did affect true memory and response bias, but those effects were inconsistent across the three groups. It should be noted, however, that Budson et al.'s subject samples were small (19–20 per group), and the number of emotional CDs per subject was modest (10). The effect sizes for this study and all subsequent ones that reported means and standard deviations can be found in Table 1.

Howe (2007) soon reported more promising results with larger samples of children (ages 8 and 12). He obtained reliable differences in false memory for emotional versus neutral CDs, but the differences interacted with the type of memory test. On recognition tests, the false alarm rate was higher, whereas on recall tests, the intrusion rate was *lower* for emotional than for neutral CDs. Also, true recognition and true recall were both better for neutral lists. Obviously, these results do not square with any of the earlier hypotheses about content-false memory, but they may must be cautiously interpreted because the order of recall and recognition tests was not counterbalanced. Recall always preceded recognition, and other DRM research has shown that recognition performance is affected by whether or not subjects respond to prior recall tests (Brainerd, Yang, Reyna, Howe, & Mills, 2008; Gallo & Roediger, 2002). Although the lack of counterbalancing is a design flaw from one perspective, it was motivated by an important real-life situation in which recall precedes recognition—namely, best-practice forensic interviewing protocols (see Brainerd & Reyna, 2005).

Howe, Toth, and Cicchetti (2011) repeated this procedure with samples of children (ages 6–12) and added a directed forgetting condition, to measure subjects' ability to inhibit false memories. False recall and true recall were again higher for neutral than for emotional lists (Panel C of Figure 2 displays Howe's and Howe et al.'s results), but Howe et al. did not report their recognition data. In addition, they found that although children were less likely to report emotional false memories than neutral ones, children were less likely to forget emotional false memories once they had been reported. It might appear that Howe and colleagues' (2007) and (2011) detection of emotional false memory in children, compared with Budson et al.'s (2006) lack of effects in adults, confirms the commonsense idea that false memories are more common in children than adults. This not the case, for two reasons. First, the small sample size and modest number of replications in Budson et

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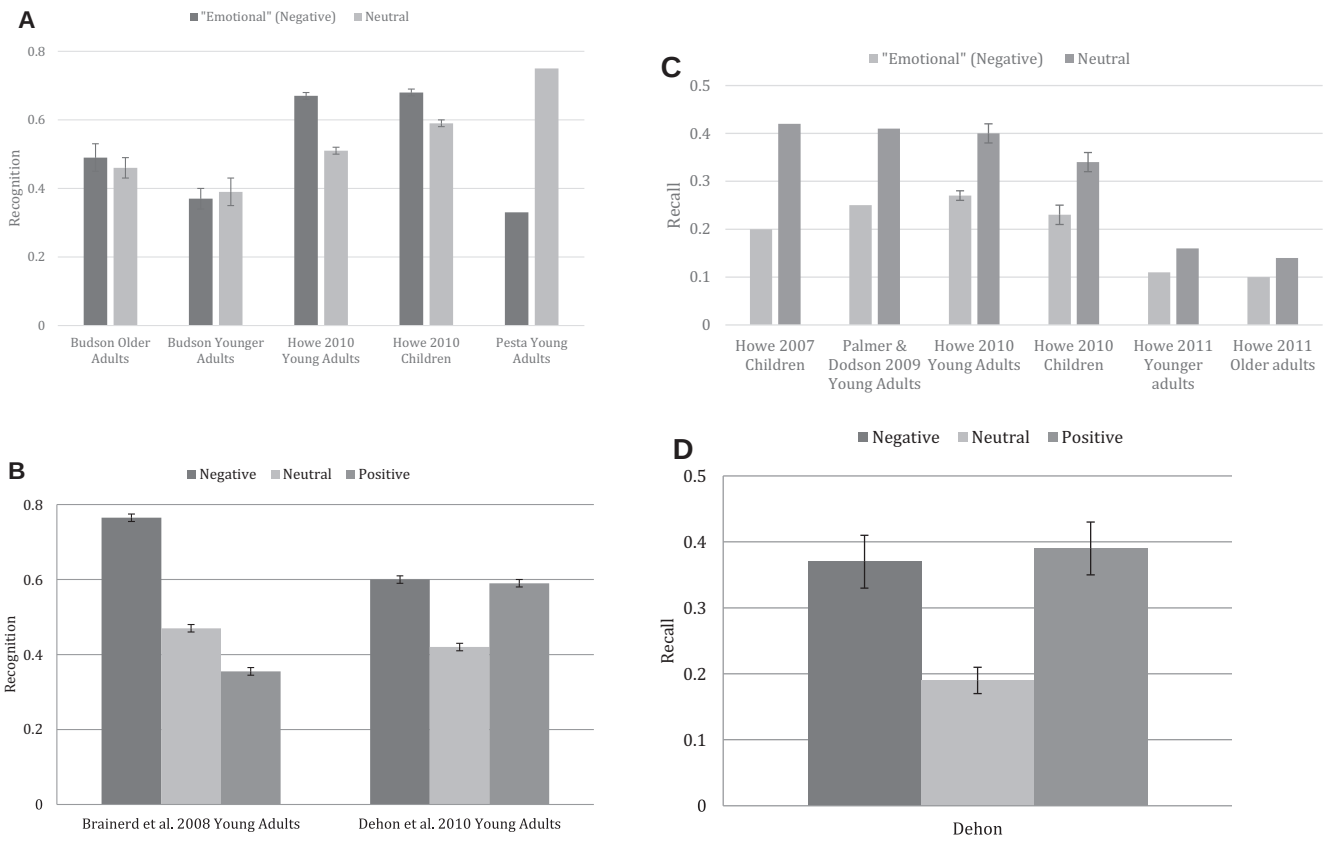


Figure 2. False recall and recognition rates in the DRM paradigm. Panel A = False recognition, arousal not controlled. Panel B = False recognition, arousal controlled. Panel C = False recall, arousal not controlled. Panel D = False recall, arousal controlled.

al.'s study may be responsible for the lack of effects, and second, we are about to see that patterns similar to those of Howe and colleagues have been obtained with adults.

In the latter connection, Palmer and Dodson (2009) found such patterns when they administered negative, neutral, and positive DRM lists to young adults (18–22 years; see the middle of Table 3). However, valence and arousal values were not reported for these lists. Palmer and Dodson also found that both true and false recall were higher for neutral than for negative or positive lists (Panel C of Figure 2), and they explained their false memory data with a variant of the item versus relational processing hypothesis—that emotional words, regardless of their valence, promote item-specific processing and draw processing attention away from semantic relations among words. That, in turn, weakens the representational basis for false memory (gist traces). Notice that this does not explain why true recall was also lower for emotional lists because the expectation would be that item-specific processing strengthens verbatim traces and, hence, increases true memory.

El Sharkawy, Groth, Vetter, Beraldi, and Fast (2008) used Howe's (2007) basic methodology with a sample of young adults but obtained different results. For recall, neither true nor false memory differed for emotional versus neutral lists. For recognition, however, emotional lists increased the false alarm rate for CDs but decreased the hit rate for targets. This pattern, which is consistent with opponent-process theories, seems to hold across child and adult subject samples. However, as in Howe's research, recognition tests were always preceded by recall tests.

Next, Howe et al. (2010) used the same procedure with young adults and children (ages 5–11) in a series of experiments. They replicated their earlier recognition results with children and extended them to young adults, and they also replicated and extended their earlier recall results (i.e., lower true and false recall for negative lists; see Panels A and C of Figure 2). Qualitatively, then, emotion-false memory effects were similar in adults and children. However, effect sizes (see Table 1) reveal that adult effects are consistently large, but child effects are moderate and depend on the type and timing of memory tests.

In some experiments, Howe et al. measured forgetting on recognition tests. The well-established pattern in the larger literature (Brainerd, Reyna, & Brandse, 1995; Payne et al., 1996) is that the hit rate drops sharply while the false alarm rate for related distractors remains relatively stable, over intervals of a few days to a week. Howe et al. observed both effects with emotional and neutral lists, and further, they observed that the emotional false memory effect increased as time passed. Of course, this sleeper effect is consistent with the opponent process notion that negative content produces stronger gist traces and weaker verbatim traces, and that the latter fade more rapidly.

In a remaining study, Pesta et al. (2001) created DRM-like lists on which the words resembled each other in sound rather than

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meaning (e.g., *fell, dwell, shell, will, cell*; CD = *well*). Some lists were neutral but others were negative and arousing (see Table 3). There were two key results. First, the false alarm rate was lower for negative than for neutral CDs (Panel A of Figure 2), but the hit rate was higher. This is not inconsistent with prior experiments showing higher false alarm rates and lower hit rates for negative lists because those experiments involved semantically related materials. Second, when the relative distinctiveness of negative and neutral lists was equated, the false alarm rate was *higher* for negative CDs. Remember, here, that opponent-process theories and the item-relational processing distinction both assume that distinctiveness amplifies processes that work against false memory (i.e., verbatim traces, item-specific processing).

Summing up the results thus far, the most consistent pattern is that negative, arousing DRM lists produce higher levels of false memory and lower levels of true memory than neutral ones on recognition tests. Also, recall tests mostly produced a different pattern in which true and false recall were both lower for negative, arousing lists. Two notable points of difference between recognition and recall may explain these different patterns: (a) Recognition tests are more sensitive to gist memory, whereas recall tests are more sensitive to verbatim memory (Seamon et al., 2003), and (b) recognition is more sensitive to memory for contextual details that accompanied target events, with emotional reactions being examples of such context details (Brainerd, Gomes, & Moran, 2014). In the larger false memory literature, these differences are known to produce variability in how false memory is affected by the same experimental variable on recognition versus recall tests (for a review, see Brainerd & Reyna, 2005), and for such variables, the exact reasons must be identified with surgical manipulations. Emotional content may simply be another example.

This is subject to the proviso that recognition tests were always confounded with prior recall tests in the above studies (see Figure 1), and recall tests can alter the contents of memory. Whether unconfounded recognition tests produce different emotional content effects than recall tests therefore is an open question, but it should be reiterated that the procedure of administering recall tests before recognition tests was a deliberate choice that was motivated by forensic interviewing practices.

Valence comparisons with arousal controlled. In the preceding studies, one cannot tell whether emotional content effects were attributable to valence, arousal, or both. Another complexity is that Budson et al.'s (2006) neutral lists are not entirely neutral; some are clearly positive. Hence, one also cannot tell whether emotional content effects were attributable to the negative-neutral difference or the negative-positive difference.

To remove those limitations, Brainerd, Stein, et al. (2008), developed pools of negative, positive, and neutral lists in such a way that the three groups of lists and their CDs varied in valence but were equated on arousal. The lists were administered to large samples of young adults, followed by recognition tests. Three results were consistent across their experiments. First, false alarms to CDs were higher for negative lists than for positive or neutral lists and were higher for neutral than for positive lists (Panel B of Figure 2). Second, the hit rate was lower for positive lists than for neutral or negative lists. Third, valence effects were much larger for false than for true memory. Obviously, the first finding suggests that the higher false recognition levels for negative, arousing CDs in Howe and associates' experiments is a real valence result that is not attributable to testing or arousal confounds. In contrast, the second finding suggests that data showing lower hit rates for negative, arousing lists may not be real valence results.

A useful feature of Brainerd, Stein, et al.'s (2008) research is that the data were analyzed with a mathematical model whose parameters separate the contributions of verbatim and gist retrieval (Brainerd, Reyna, & Mojardin, 1999; Brainerd, Stein, & Reyna, 1998) to true and false memory. This technique measures the effects of emotional content at the level of memory processes, rather than raw performance, which delivers direct tests of different theoretical hypotheses about emotional content. The results are shown in Figure 3 (panels A and B), where it can be seen that with CDs, negative valence increased gist retrieval and decreased verbatim retrieval, relative to positive and neutral valence. Also with CDs, positive valence increased verbatim retrieval and decreased gist retrieval, relative to neutral lists. It can be seen that emotional content effects were the same at the gist level but were different at the verbatim level: Negative valence increased *both* gist and verbatim retrieval, and positive valence decreased *both* verbatim and gist retrieval. This suggests the theoretically important possibility that the effects of emotional content may depend on whether verbatim traces are available for test cues because that is the key memory difference between targets and related distractors.

Dehon, Laroi, and Van der Linden (2010) also administered positive, negative, and neutral DRM lists with matched arousal levels, and they found higher false memory for negative than for neutral lists, on both recall and recognition tests, as displayed in panels B and D of Figure 2. Unlike Brainerd, Stein, et al. (2008), they also found higher false memory levels for positive than for neutral lists, on both recall and recognition tests. True memory was not affected by valence. This finding that negative valence elevates false memory for recall as well as false recognition raises the possibility that Howe and associates recall results may be arousal effects rather than valence effects.

Factorial manipulation of valence and arousal. At the time of this writing, there was a single published experiment in which the valence and arousal of DRM lists had been manipulated factorially. Brainerd et al. (2010) did that by administering the lists in Table 4 to samples of children (age 7–11) and young adults, followed by recognition tests. In adults, false memory exhibited both valence and arousal effects; it was higher for negative than for positive valence and for high-arousal than for low-arousal. Arousal also interacted with valence such that it only influenced false memory when valence was negative. There were also valence and arousal effects on the true memory side, with the hit rate being higher for positive lists and high-arousal lists. The most important new result is that false memory may be more strongly influenced by valence than by arousal.

As for children, their levels of false memory were lower overall, which is another example of the well-documented but counterintuitive developmental reversal effect in semantic false memory (for a review, see Brainerd, Reyna, et al., 2008). Between 7 and 11, age increases in false memory were greater for negative than positive valence, arousal effects became more marked, and like adults, arousal effects were confined to negative lists. In short, emotional content effects were qualitatively similar in children and adults but were larger in adults.

Summary of DRM findings. On the overriding question of how false memory reacts to emotional content, DRM studies have

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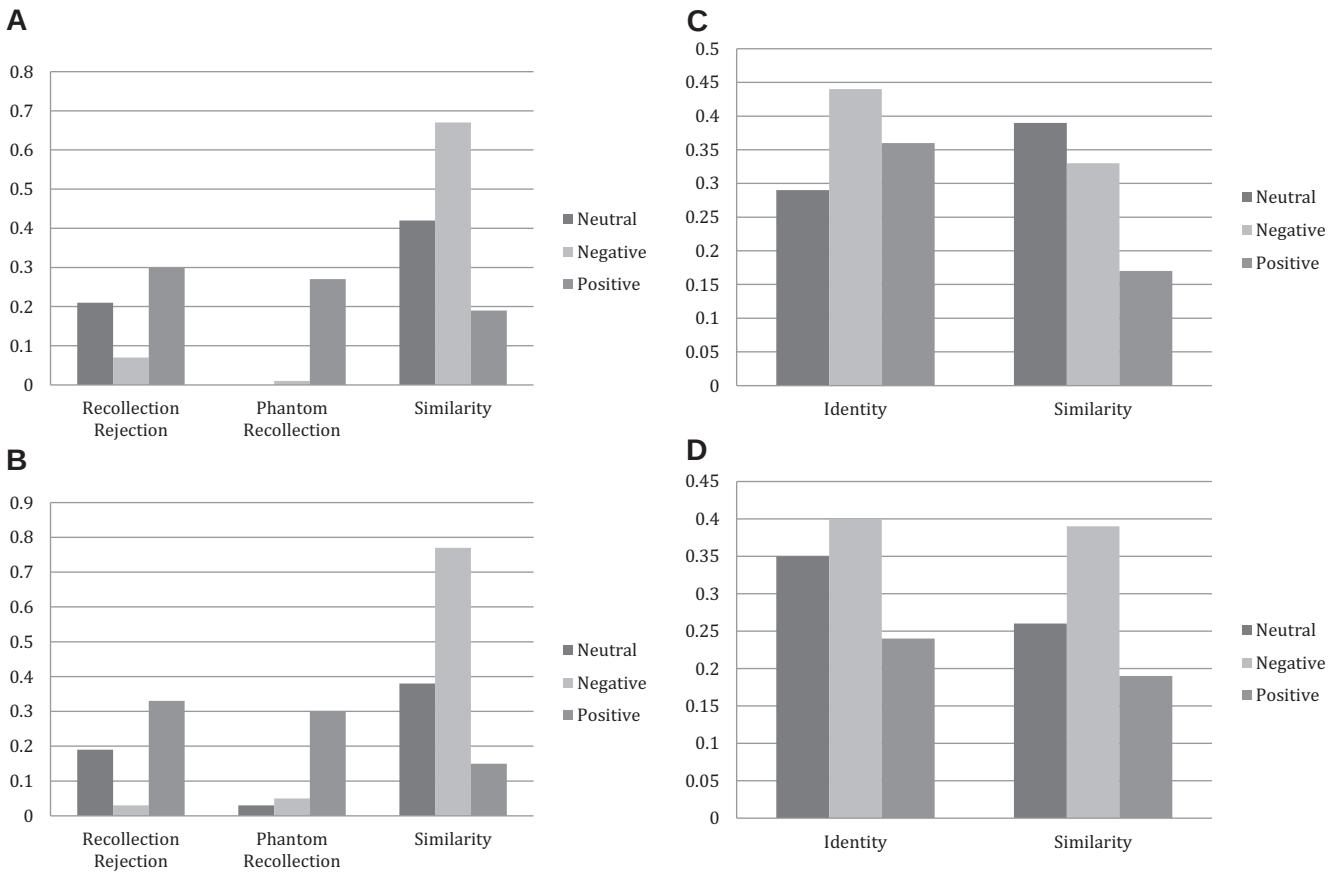


Figure 3. Parameter estimates of the conjoint recognition model by valence for the two experiments in Brainerd et al. (2008). Panel A = Experiment 1, false memory. Panel B = Experiment 2, false memory. Panel C = Experiment 1, true memory. Panel D = Experiment 2, true memory.

produced a consistent answer for recognition, at least: Negative valence increases false memory, relative to neutral and positive valence, regardless of lists' arousal level or whether recognition is confounded with prior recall. The data are nearly as consistent in showing that negative valence lowers true memory. The combined effect is that in recognition, negative emotional content substantially decreases overall accuracy. Notice that this has clear implications for the aforementioned forensic claims that witnesses' memories for negative-arousing events (crimes) are unusually accurate and resistant to distortion; the data suggest the opposite and also that memory distortion for negative events increases with arousal. Other results suggest that emotional content effects may be dependent on whether verbatim traces are available for test items because the effects were different for targets and distractors when verbatim and gist retrieval were directly measured.

Conclusions about recall are more uncertain. Negative-arousing content has been found to decrease intrusions and increase true recall in multiple studies, but because arousal was always confounded with valence, it is unclear whether this effect is attributable to valence, arousal, or some interaction between them. That concern is reinforced by the fact that results were different in the only study that eliminated this confound.

Picture Experiments

Here, study and test materials are vivid depictions of real-world events, but the basic feature of false memory being grounded in semantic relations between targets and distractors is preserved. Because it has long been known that subjects use different words to label the same picture (Paivio, 1971), pictures are often presented with accompanying verbal labels at study. From the perspective of opponent-process distinctions, an important difference between pictures and DRM lists is the finding that pictures enhance the processing of targets' verbatim content, relative to word lists (Brainerd & Reyna, 2005; Schacter et al., 1999).

In an early study, Gallo, Foster, and Johnson, (2009) presented older and younger adults with positive, negative, and neutral IAPS pictures, accompanied by verbal labels and followed by recognition tests (see Figures 4 and 5 for an explanation of their design). Arousal was equated for positive and negative pictures (both were highly arousing) but not for neutral ones (low-arousal). On the recognition test, the targets were presented words that had labeled the pictures, and the distractors were unpresented words that were labels of unpresented pictures. False recognition of related distractors was higher for both positive and negative pictures than for

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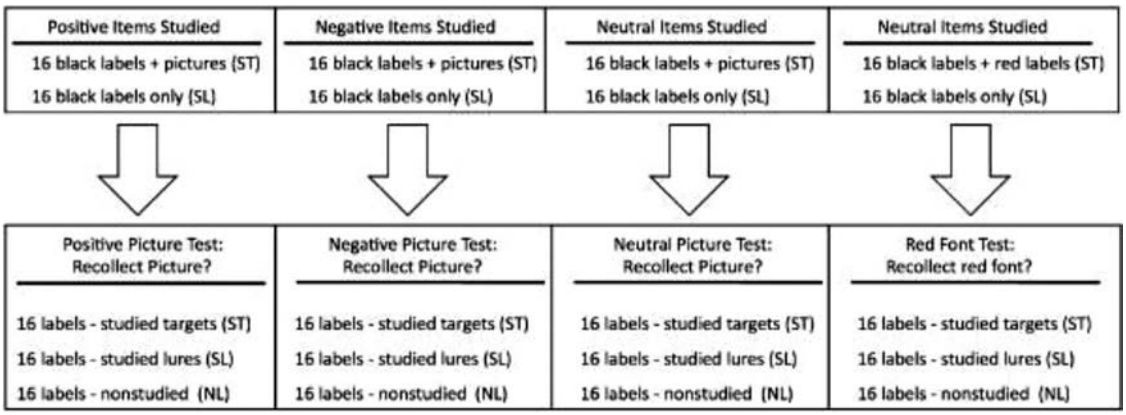


Figure 4. Experimental design in Gallo, Foster, & Johnson (2009).

neutral ones but did not differ for positive versus negative pictures. Note that this could be an arousal effect, a valence effect, or both. For true memory, however, there was an unambiguous valence effect: The hit rate was higher for negative than for positive or neutral pictures, which contrasts with the true memory valence effect in DRM studies. Consistent with the larger false memory literature, pictures seemed to enhance verbatim processing of targets: With neutral pictures, when performance was compared with a condition in which only neutral words were studied and tested, false alarm rates were lower and hit rates were higher for pictures.

In a follow up study, Choi, Kensinger, and Rajaram (2013) used thematically related groups of emotional words and pictures to determine whether valence helps subjects connect shared meaning across members of a thematic group. Arousal was equated for positive and negative pictures (high arousal) but not neutral ones (low arousal). They tested recognition of words that had been studied with pictures, varying the retention interval and whether thematic labels had accompanied the pictures. On an immediate test that included thematic labels, negative valence increased true memory but did not affect false memory. After 24 hours, negative valence still increased true memory, but now it decreased false memory. In a final experiment, Choi et al. eliminated thematic labels and administered immediate recognition tests, but emotional content effects did not change. Because negative valence consistently elevated true memory and sometimes lowered false memory, the indicated conclusion is that negative pictures enhanced verbatim processing, relative to gist processing.

In a slightly different paradigm, Bookbinder and Brainerd (2016) administered positive, negative, and neutral IAPS pictures with equivalent arousal levels. The pictures belonged to several categories, to promote gist processing, but they were not accompanied by verbal labels. On both immediate and 1-week delayed recognition tests, negative valence elevated true and false memory, but true memory declined markedly with time, particularly for negative valence. The data were analyzed with the same mathematical model that Brainerd, Stein, et al. (2008) used. As with DRM lists, negative valence decreased verbatim retrieval and increased gist retrieval for related distractors, compared with positive and neutral valence. For targets, negative valence increased gist retrieval and reduced a type of verbatim memory that causes incorrect rejection of targets. Thus, on the false memory side, these picture data are qualitatively similar to Brainerd, Stein, et al.'s DRM data when it comes to the process-level effects of valence.

An Experiment With Scripted Material

Mirandola, Toffalini, Grassano, Cornoldi, and Melinder (2014) investigated emotional false memories with a procedure developed by Hannigan and Reinitz (2003). Subjects viewed pictures of scripted events (e.g., grocery shopping, with someone taking an orange from the bottom of a pile), along with outcomes whose direct causes were not presented (picking up fallen oranges). In Mirandola et al.'s version of this procedure, the outcomes were either negative-arousing or neutral-nonarousing ones. False memory was tested with pictures of unpresented causes of outcomes and pictures of other unpresented script-consistent events (e.g., looking at milk in the dairy cooler). Mirandola et al. were also interested in the effects of elaboration, so they included a manipulation in which half of their subjects wrote descriptions of the scripted events before the recognition test and half did not.

Interestingly, emotional content effects varied as a function of elaboration such that the performance of subjects who wrote descriptions was dominated by gist retrieval. Those subjects (but not others) displayed more false memory for negative-arousing events than for neutral ones, and they displayed more true memory for script-consistent targets that for script-inconsistent targets. When the elaboration group completed a free-recall task for the scripted information, they recalled more negative-arousing themes than neutral ones.

Misinformation Experiments

Porter, Spencer, and Birt (2003) investigated whether misinformation effects were influenced by the emotional content of target events. Their subjects studied positive, negative, or neutral IAPS pictures (see Figure 6 for similar images), each of which contained both central and peripheral details. Similar to Gallo et al.'s (2009) study, arousal was equated for positive and negative pictures (both were highly arousing) but not neutral ones (nonarousing). During the misinformation phase, subjects were misled about both central and peripheral details. On subsequent recall tests, misinformation

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Positive: "Astronaut in space"



Negative: "Shark with teeth"



Neutral: "Clothes iron"

Figure 5. Sample images with verbal labels similar to Gallo, Foster, and Johnson (2009). From "Close-Up of Astronaut," "Shark," and "Electric Iron" by Arora (2011), O'Rockerz (2006), and Syed (2015), respectively (http://freeimages.com). In the public domain. See the online article for the color version of this figure.

effects were detected for both, and there were clear valence effects: Misinformation effects were more marked for negative central and peripheral details than for positive or neutral ones. For true memory, however, valence interacted with central-peripheral details, such that more central details were recalled for positive valence but more peripheral details were recalled for negative valence.

As misinformation is an analogue of suggestive police questioning, Porter et al. examined whether valence affected what they



Positive



Negative



Neutral

Figure 6. Sample images with central and peripheral details similar to Porter, Spencer, and Birt (2003). From "Wedding Ceremony," "Ready to Shoot," and "Shopping" by Gomez (2005), Lucretious (2006), and Niewiadomski (2015), respectively (http://freeimages.com). In the public domain. See the online article for the color version of this figure.

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termed "major misinformation" effects—which meant falsely remembering major details that were not present in the studied pictures. Major misinformation effects proved to be more common for subjects with negative valence (80% of subjects falsely remembered such events) than with positive or neutral valence, underscoring the apparent tendency of negative valence to heighten susceptibility to suggestion.

In a follow-up, Porter, Bellhouse, McDougall, Ten Brinke, and Wilson (2010) again investigated whether valence influenced the magnitude of major and minor misinformation effects across different time periods. They administered arousal-matched positive and negative IAPS pictures but not neutral ones. As in the earlier study, major misinformation effects were more common with negative than with positive valence, but there were no valence effects for minor misinformation. Misinformation effects decreased over time, but they were still present after a month.

Porter and associates' key finding that negative valence heightens susceptibility to suggestion was also obtained by Otgaar, Candel, and Merckelbach (2008) in a study with children (age 7), using quite different materials. They provided children with narratives about events that had supposedly happened to them at school, some true and some misinformation. Some events were negative, others were neutral, and arousal was not controlled. On later recognition tests, misinformation effects were larger for negative than for neutral events. As in spontaneous false memory, then, emotion-false memory effects in adults appear to extend to children.

Porter, Ten Brinke, Riley, and Baker (2014) manipulated valence by presenting ambiguous pictures, which were then *described* to subjects using positively- or negatively-valenced terminology. For instance, a picture depicting passengers boarding an airplane was described as headed toward a sunny vacation spot or a dismal war zone. The valenced descriptions did not control arousal level. These descriptions were provided at study or at test or omitted altogether. When provided at study, negative descriptions increased misinformation effects, relative to no descriptions but not relative to positive descriptions. The opposite was true when descriptions were provided at test. Because there was no positive-negative difference, descriptions were collapsed across valence to reveal that emotional descriptions at study caused more major misinformation effects than no descriptions, whereas the opposite was true when descriptions occurred at test. A novel feature of these results is that the tendency of negative content to amplify misinformation effects was not restricted to events that subjects experienced, but instead, it extended to the emotional content of descriptions of events.

Van Damme and Smets (2014) modified Porter, Ten Brinke, et al.'s (2014) design by manipulating the arousal as well as the valence of study pictures. They administered both high- and low-arousal positive and negative pictures, and they also administered medium- and low-arousal neutral pictures. Once again, susceptibility to misinformation was higher for negative pictures than for other types, but only for peripheral details and the effect did not depend on arousal level. For central details, differences in valence and arousal did not affect susceptibility to misinformation. In a no-misinformation control condition, spontaneous false memories for central details were reduced by negative pictures and by positive arousing pictures. One way to think about the latter results is as baseline effects of emotional content that are overridden when misinformation is presented.

Taken together, misinformation experiments provide a picture of the effects of emotional content that is reminiscent of the earlier one for the DRM illusion—namely, that negative valence increases susceptibility to false memory, relative to positive and neutral valence, and less often, it impairs true memory. As before, such results bear on the aforementioned forensic claims that memory for negative events is unusually accurate and resistant to distortion. Contrary to such claims, the modal pattern is that negative valence reduces memory accuracy in two ways, by amplifying false memory and reducing true memory.

We noted earlier that misinformation effects are different than spontaneous false memories in the sense that the former can be attributable to either verbatim or gist retrieval, whereas gist retrieval predominates with the latter. All findings considered, the simplest theoretical interpretation of the tendency of negative content to amplify misinformation effects and reduce true memory relies on verbatim retrieval. This pattern would result if negative content makes verbatim traces of misinformation more accessible, increasing false memory and also interfering with retrieval of verbatim traces of original targets because original events conflict with the content of misinformation.

The Story So Far

Before moving on to emotional context effects, here is an interim summary of key results. In DRM experiments, negative valence consistently increased false memory on recognition tests and mostly decreased true memory. With recall, emotional content effects were less consistent, but at least it seems that they are different for recall as compared with recognition. That is consistent with the theoretical principle that recall and recognition differ in their relative verbatim versus gist reliance and their relative sensitivity to memory for contextual details. Emotional content may be one of a handful of variables that have contrasting effects on recognition versus recall. In experiments with pictures and scripted materials, there was further evidence that negative valence—and also positive valence—can increase false memory, but it was less extensive than DRM data. Finally, data from the misinformation paradigm showed that these basic patterns extend from spontaneous to implanted false memories because negative valence also heightened susceptibility to misinformation and impaired true memory.

Review of Data II. Emotional Context and False Memory

There are different types of mood-induction procedures, which are discussed separately in this section, and they have been implemented almost exclusively with the DRM illusion. We begin with mood experiments that used different induction methods in conjunction with standard DRM lists, coupled with recognition or recall tests. We conclude with a smaller group of experiments in which mood-induction was combined with emotional DRM lists to measure mood congruency effects.

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Induced Mood Experiments

Music. Music has proved to be an effective method of inducing positive and negative moods in a variety of studies (e.g., Niedenthal & Setterlund, 1994), and hence, it has been used in false memory studies to create group differences in subjects' moods before they are exposed to target materials and memory tests. In a pioneering example, Storbeck and Clore (2005) exposed subjects to either negatively valenced music (Mahler's *Adagietto*) or positively valenced music (Mozart's *Eine Kleine Nacht Musik*) or no music, followed by study and recall of DRM lists, and a mood manipulation check. According to the affect-as-information hypothesis, the former should enhance item-specific processing (stronger verbatim traces), relative to a neutral baseline, and the latter should enhance relational processing (stronger gist traces).

Consistent with that prediction, Storbeck and Clore (2005) found that the positive mood group exhibited more false recall than the negative mood group, who also exhibited lower false recall than the control group. These data are shown in Figure 7, which plots false memory levels by valence in several mood-induction studies. As there were no mood effects for true recall, it seems to have affected gist but not verbatim memory. That conclusion was supported in a follow-up experiment in which a gist-memory condition was added. In that condition, subjects are told to recall (or recognize) *both* targets *and* related distractors (see Brainerd et al., 1999), so that they can rely entirely on gist memory. Therefore, mood effects should be the same as before, if they were gist effects. They were.

Although these findings seem to show that negative moods interfere with gist processing, Corson and Verrier (2007) offered an alternative explanation. They noted that arousal was confounded with valence in Storbeck and Clore's (2005) mood manipulation (the negative musical segment was more arousing than the positive one), and they conducted a replication in which valence and arousal were manipulated factorially in a 2 × 2 design; that is, different groups were exposed to music that was positive/high-arousal (happy), positive/low-arousal (serene), negative/high-arousal (angry), or negative/low-arousal (sad). A neutral condition was also included. Following mood induction and a mood check, subjects studied and recalled DRM lists, and finally, responded to a recognition test, too. The core finding was simple: There were arousal effects but not valence effects. False recall and false recognition of CDs were higher in high-arousal groups than in the other groups (see Figure 8), and neither true recall nor true recognition was affected by mood group. Although the valence findings are just null results, these data do suggest that arousal may be a more important component of mood-false memory effects than valence. However, Corson and Verrier's results have not been consistently replicated, and some experiments have found mood valence effects with arousal controlled.

Storbeck (2013) reported some experiments that focused on whether negative moods promote item-specific processing (stronger verbatim traces) by adding tests of subjects' memory for

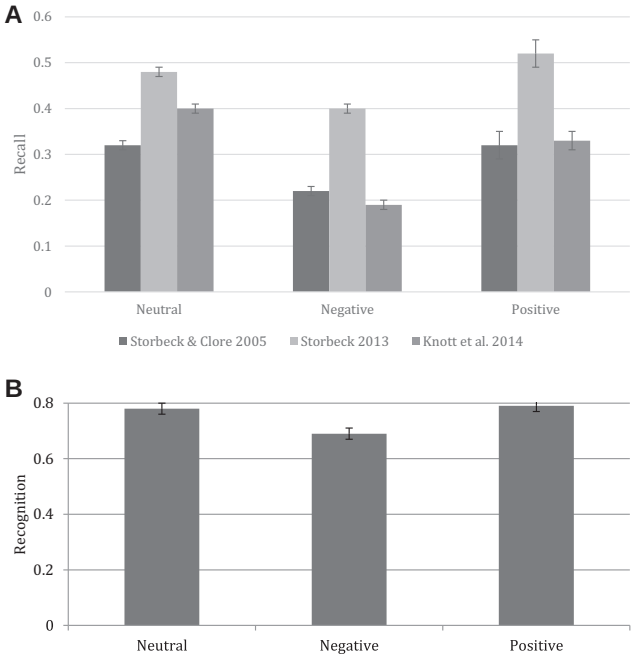


Figure 7. False recall and recognition rates in induced mood studies with arousal not controlled. Panel A = false recall in Storbeck and Clore (2005); Storbeck (2013), and Knott et al. (2014). Panel B = false recognition in Storbeck and Clore (2011) when mood was induced before study.

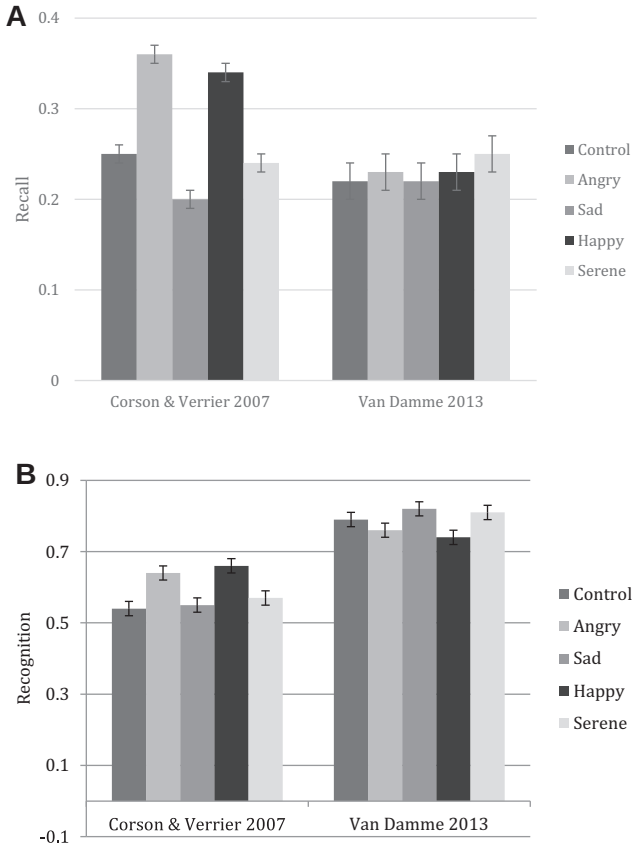


Figure 8. False recall and recognition rates in induced mood studies with arousal controlled. Panel A = recall. Panel B = recognition.

study-phase contextual details. Following mood induction, subjects studied DRM lists, but certain contextual cues (spatial positions) were varied as lists were presented. Subjects recalled each list after it was presented, which provided the usual measures of true and false memory, and finally, they received a source memory test, on which the quadrant of the computer screen in which each word had been presented was identified. As in Storbeck and Clore's (2005) study, false memory was lower in the negative group than in the positive or neutral groups (see Panel A, Figure 7). Simultaneously, the negative group was better at remembering contextual details, which favors the item-specific processing hypothesis. In a second experiment, other contextual details were manipulated at study (font), arousal levels were equated for positive and negative groups, and recognition tests were administered for true and false memory and for memory for contextual details. The mood induction used IAPS pictures rather than music, but the results were analogous: False recognition of CDs was lower in the negative mood group and recognition of contextual details was higher than in the other groups. More complex results were obtained in a final experiment in which half the subjects in each mood group studied DRM lists in the usual way, and half studied such lists with accompanying pictures that depicted the objects that the words named (cf. Schacter et al., 1999). Again, false memory for CDs was lowest in the negative group, but that effect was only present for subjects who studied words without pictures. This result, too, is consistent with the notion that negative mood produces stronger verbatim traces by encouraging item-specific processing. If that is true, pictures should reduce or eliminate negative mood effects because, as we saw earlier, pictures produce strong verbatim traces, leaving limited room for negative mood to strengthen verbatim traces.

Van Damme (2013) replicated Corson and Verrier's (2007) procedure in three experiments and added a second control condition in which neutral moods were induced prior to the study phase. In an initial experiment, similar to Corson and Verrier, false recognition of CDs was elevated for high-arousal groups on a delayed recognition test but did not vary as a function of valence, as shown in Panel A of Figure 8. However, when immediate recall tests were administered in a second experiment, neither valence nor arousal affected false memory. When immediate recognition tests were administered in a final experiment, the results resembled those of the first experiment in that false recognition of CDs was elevated in the high-arousal conditions, regardless of valence, as shown in Panel B of Figure 8.

Overall, the results in the three articles considered up to this point show that mood-false memory effects are localized within the arousal component rather than the valence component when they are manipulated factorially, but that there are valence effects, too, when arousal is equated for negative versus positive moods. Theoretically, all of these effects can be explained on the ground that mood chiefly affects the strength of verbatim traces.

Video. Video clips can also be used to induce mood states, and Storbeck and Clore (2011) reported an experiment that relied on that procedure. To determine whether mood effects are localized at encoding or retrieval, mood induction occurred before list presentation for half the subjects and after it for the other half. True and false memory were measured with recognition tests. As in earlier experiments, false memory was reduced in the negative mood group when induction occurred before list presentation (see Panel B of Figure 7), but there were no mood effects when it occurred later. Thus, mood seems to affect how targets are processed during encoding, rather than how traces are retrieved, which is consistent with the affect-as-information hypothesis. It is not possible to tell whether this effect is attributable to arousal or valence, however, as arousal was again higher in the negative condition than in the other two conditions.

Emery, Hess, and Elliot (2012) used a video mood induction prior to DRM list presentation, followed by recall tests, with younger and older adults. As in prior studies, false recall was lower in the negative group than in either the positive or neutral groups. In a related study, Knott, Threadgold, and Howe (2014) also found that false recall was lower in a negative mood group than in a positive mood group (see Panel A of Figure 7). Interestingly, the negative group also performed more poorly on word problems that required processing the semantic content of DRM lists. Although we noted earlier that reported mood effects on false memory, whether they are attributable to arousal or valence, can be explained if negative moods strengthen verbatim traces, Knott et al.'s results for word problems suggest that negative moods may also impair gist processing.

Other mood inductions. Yang, Yang, Ceci, and Isen (2015) used candy to induce positive moods, conjecturing that they would reduce false memory if subjects are explicitly warned that people falsely remember CDs in the DRM paradigm. Half of the subjects in the positive mood and control groups received such warnings and half did not. As in prior studies, positive mood affected neither true nor false recognition when subjects were not warned, but when they were, positive moods reduced false recognition, as predicted. Thus, despite the lack of positive mood effects up to this point, positive moods may affect false memory with specific types of retrieval cues.

Most recently, Mirandola and Toffalini (2016) used IAPS pictures to induce positive, negative, and neutral moods, with arousal in the positive and negative groups being higher than the neutral group. True and false memory were measured with a version of Mirandola et al.'s scripted-picture paradigm. Unlike most prior studies, mood induction occurred just before the recognition test, so that mood affected retrieval but not encoding, and subjects' rated their moods for valence and arousal following induction. False memory for unpresented causes was lower in the positive and negative groups, compared with the neutral group, and false memories were less often accompanied by erroneous remember judgments. Also, true memory was elevated in the positive and negative mood groups.

However, analysis of the mood rating data provides evidence that these differences were in fact attributable to arousal rather than valence: Subjects' valence ratings did not correlate with their levels of false memory in either the positive or negative group, but their arousal ratings correlated negatively with false memory in both conditions. Likewise, true memory correlated positively with arousal ratings in both groups, but it did not correlate with valence ratings in either group. Overall, subjects' ratings of their moods were better predictors of their levels of false memory than which mood group they were in, and importantly, this was the first study to provide evidence of pure-retrieval effects of mood on false memory.

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Mood Induction Experiments With Emotional DRM Lists: Mood Congruence

Thus far, apart from a few experiments, mood effects have been studied by administering standard DRM lists, followed by recognition or recall tests. As noted earlier, Bower's (1981) mood congruency hypothesis specifies that beyond that, the memory effects of mood states will depend on the level of match between mood states at encoding versus test. Bower's general prediction was that being in, say, a negative mood during the study phase leads to the storage of contextual details that are shared by negative events, making it easier to access studied material when those details are reinstated by negative moods during the test phase. This is analogous to predictions in classic work on study-test match/mismatch of contextual details, such as Godden and Baddeley's (1975) study of deep-sea divers' memory for word lists. In that research, divers studied lists underwater or on land and recalled the lists underwater or on land. Recall was better when the two environments matched than when they did not.

In an initial test by Ruci et al. (2009), a narrative mood induction (positive, negative, or no induction) was followed by positive, negative, and neutral DRM lists. Arousal was not controlled in either the mood induction or the DRM lists. Subjects recalled each list after it was presented, and a final recognition test with remember/know judgments was administered after all the lists were recalled. That is, when subjects recognized an item as old, they indicated whether they specifically remembered the item occurring earlier or whether they simply knew that it had been presented (Tulving, 1985). (Again, as in many other studies, recognition was confounded with prior recall.) For false memory, there was evidence of mood congruency with both recognition and recall: False memory was elevated for negative mood/negative content relative to negative mood/positive content and for positive mood/positive content relative to positive mood/negative content. Also, false remember judgments (conscious memory of the "presentation" of CDs) was elevated when mood and content matched, which is consistent with other research showing that manipulations that increase the retrieval of study-phase contextual details increase false remember judgments (Arndt, 2012; Brainerd et al., 2014). For true memory, the mood-congruency effect was limited to the positive mood group and the recall test.

Knott and Thorley (2014) investigated whether Ruci et al.'s (2009) results were stable over a forgetting interval. They administered negative and neutral DRM lists followed by recognition tests, with arousal being higher for negative lists, and again, mood induction preceded the study phase. Ruci et al.'s mood-congruency pattern was not replicated on immediate memory tests, but all components of that pattern were present on 1-week delayed tests, for true as well as false memory. A new finding was that across mood conditions, there was a consistent emotional content effect for recognition: As in the bulk of the content studies that were reviewed earlier, the false alarm rate for CDs was higher and the hit rate for targets was lower for negative lists, and unlike many studies, recognition was not confounded with prior recall tests.

Bland, Howe, and Knott (2016) extended this line of research to mood congruency for discrete negative emotions. They paired a mood induction (fearful, angry, or no induction) with angry, fearful, and neutral DRM lists. Moods were induced with videos, and the DRM lists were developed using the University of Florida word association database (Nelson, McEvoy, & Schreiber, 2004). Arousal was equated for the two types of negative lists, but was higher for those lists than the neutral lists. There were mood congruency effects because false recognition of CDs in the fearful group was higher for fear lists compared with anger and neutral lists, and false recognition of CDs in the angry group was higher for anger lists than neutral lists but not fear lists. As in prior studies, there was also a mood-congruency effect for false remember judgments. This study also produced the first reliable evidence of mood congruency for true memory: The hit rate in the fearful group was higher for fear lists than for neutral lists but not anger lists, and the hit rate in the angry group was higher for anger lists compared with fear lists but not neutral lists. Because arousal was equated across the two discrete emotions, it appears that at least some of these mood congruency effects are valence effects.

Summing up, mood-congruency effects were detected in all of the false memory studies in which they were investigated, and there was limited evidence that these effects are stable over time. Although the theoretical and practical significance of these results is considerable, they do not support the principles that Bower (1981) used to predict mood congruency. Mood congruency ought to be more pronounced for true than for false memory because episodic traces containing the contextual details that produce encoding specificity effects are stored *for targets*, not CDs. Although they can be retrieved by either, targets are far better retrieval cues for those traces and, hence, should yield stronger encoding specificity effects. However, the opposite was true in the above studies, and indeed, mood congruency was observed for targets in only one study. Mood congruency studies also do not resolve the question of whether such effects would occur if mood were only induced at test, which is a key question in applied contexts such as forensic interviewing and sworn testimony.

Interim Summary of Mood-Induction Experiments

Across extant studies, positive moods increased false memory and negative moods decreased it. This is the opposite of the valence effect for emotional content, where negative content elevates false memory. Forensically, these opposite trends suggest that although witnesses' memories for negative events can be distorted, negative moods may actually reduce such distortion. According to the theoretical ideas that first motivated mood-false memory research, the protective effect of negative moods may be attributable to the fact that they foment item-specific processing (enhanced verbatim memory), or to the fact that positive moods foment relational processing (enhanced gist processing), or both. All things considered, however, the most parsimonious interpretation of the accumulated data is that differences in the strength of verbatim memory are responsible for mood-group differences in false memory. Again, note the difference relative to content studies, which favor the conclusion that differences in the strength of gist memory are responsible for emotional content effects.

The respective contributions of valence and arousal to mood-group differences in false memory remain unclear. Valence did not have reliable effects when valence and arousal were manipulated factorially, but on the other hand, it did have reliable effects when arousal levels were equated for different valence groups. Finally, although published data on mood congruency in false memory are not extensive, those that are available are consistent in showing that false memory levels for positive and negative moods, includ-

ing discrete negative moods, are higher when the emotional content of target materials matches subjects' moods.

Mood and Misinformation

Fiedler and Bless (2001) predicted mood effects for misinformation, using a theoretical analysis that resembles the item-specific versus relational processing distinction. According to their analysis, negative moods focus processing on actual details of target events, whereas positive moods encourage more abstract, heuristic processing. Obviously, memories that are stored pursuant to the first type of processing ought to be more resistant to misinformation than memories that are stored pursuant to the second type.

Forgas, Laham, and Vargas (2005) tested that prediction in some experiments in which mood induction occurred after the study phase. Subjects were exposed to positive or negative pictures (a wedding or a car crash), followed by video mood induction (positive, negative, or neutral), followed by misinformation about the pictures, followed by memory tests. Arousal was not controlled in either the target materials or the mood induction. Mood influenced the misinformation effect in the predicted manner: False recognition of misinformation was lower in the negative mood condition than in either the positive or neutral mood conditions. There were no emotional content effects, however, as neither false nor true memory varied as a function of the valence of the studied pictures, and there was no evidence of mood congruency in misinformation. In a second experiment, the study phase, in which subjects viewed a live negative event, was a week before mood induction (positive, negative, neutral), misinformation, and memory testing. The results were the same as before.

Hess, Popham, Emery, and Elliott (2012) examined the contrasting notion that positive moods increase misinformation effects by studying younger versus older adults. There is a large literature pointing to the conclusion that the frequency of positive moods, relative to negative ones, increases during healthy aging (e.g., Carstensen, Isaacowitz, & Charles, 1999). Hess et al.'s subjects' moods were measured by the PANAS, after which they studied a sequence of positive and negative pictures, followed by misinformation, followed by a recognition test. As predicted, misinformation effects were larger in older than in younger adults. False recognition of misinformation was negatively correlated with negative moods, and interestingly, a regression analysis showed that age differences in misinformation effects were entirely attributable to age differences in mood. Consistent with the emotional content studies that we reviewed earlier, misinformation effects were larger for negative than for positive pictures.

Van Damme and Seynaeve (2013) expanded Forgas et al.'s (2005) design to include factorial manipulation of valence and arousal levels over mood groups. Video mood induction occurred before the study phase, which was followed by misinformation and a recognition test in which subjects also rated their confidence in each response. As in Van Damme's (2013) work on mood with the DRM paradigm, there were four mood conditions, in which valence and arousal were varied, and two control conditions (neutral mood induction and no mood induction). Neither valence nor arousal affected false recognition of misinformation, but there were confidence effects. False recognition of misinformation was accompanied by higher confidence in the negative mood groups than in the positive mood groups, and the same was true of correct recognition of targets. In other words, subjects in negative moods were more confident in all of their responses than subjects in positive moods.

Natural Moods

Cause-effect relations between mood and false memory can only be established if subjects' moods are manipulated experimentally, but such research is prone to the criticism that induced mood states are transitory and artificially created. In contrast, mood states that arise during personally significant events are more enduring and natural. Further, arousal and valence levels are more intense with natural mood states, and that, in turn, may yield a different picture of the relation between mood and false memory. An obvious way to investigate these possibilities is to measure moods that occur naturally in certain groups of subjects. Below, we summarize findings from research in that vein, dividing it into studies of nonclinical populations versus clinical populations.

Nonclinical populations. Here, the mood states of normal adults have been assessed, true and false memories have been measured with the DRM procedure, and relations between the two sets of measurements have been investigated. For instance, Emery et al. (2012) compared the effects of induced and natural moods in older and younger adults on a standard DRM task. They measured so-called state mood using the PANAS (Watson et al., 1988) and so-called trait mood using the NEO Five-Factor Inventory (NEO-PI; Costa & McRae, 1990), a measure of extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience. The authors paid particular attention to NEO scores for neuroticism and extraversion on the hypothesis that they are associated with negative and positive mood, respectively (Caspi, Roberts, & Shiner, 2005), and are indexes of long-term mood "traits." In contrast, PANAS scores were used as short-term measures of mood "states." Then, positive and negative moods were induced in different groups using video clips, and a control group was also included. Finally, a series of DRM lists was studied and recalled. Both natural and induced mood effects on false memory were observed in older adults: False recall was higher for subjects with more positive natural moods and for subjects in the positive induction condition. Thus, although subjects' natural moods correlated with false memory, the relation was qualitatively the same as that of induced mood.

Koo and Oishi (2009) investigated natural mood-congruency effects for subjects *who were in positive moods*, using positive, negative, and neutral DRM lists that were not equated on arousal. In their design, a natural mood-congruency effect would have involved higher levels of false and/or true memory for positive DRM lists than for negative or neutral ones. No overall patterns of that sort were observed, although false memory for one positive CD (*happy*) was higher than false memory for all neutral CDs.

Clinical populations. Considerably more research has been focused on populations that experience enduring negative moods, where mood-congruency effects have been investigated by varying the emotional content of target materials. Multiple studies are available with two populations: Subjects with depression diagnoses and subjects with posttraumatic stress disorder (PTSD) diagnoses. We selected those populations for two reasons: First, neg-

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ative affect is a concomitant of these disorders; depressed individuals experience depressed moods and feelings such as guilt and individuals with PTSD experience negative emotions pursuant to trauma and persistent negative beliefs. Second, there have been several studies of false memory with these two disorders, but not with others.

Depression. It has long been understood that depressed individuals display memory impairments (Burt, Zembar, & Niederehe, 1995), to the point that depression in older adults can be misdiagnosed as cognitive impairment or dementia (e.g., Brainerd, Reyna, & Howe, 2009). It is also well known that depressed individuals exhibit a mood-congruent processing bias in *true* memory (Bower, 1981); that is, it is easier for depressed individuals to remember negatively valenced information than positively valenced information. Consequently, recent research has examined whether that bias extends to false memory.

Watkins, Mathews, Williamson, and Fuller (1992) conducted a preliminary investigation of this possibility, albeit not with a standard false memory paradigm. They presented depressed and control subjects with depression-related, positive, and neutral words, followed by two memory tasks. They administered a cued-recall test that used stems of studied words (e.g., *hop___* for *hopeless*) to measure true recall, and they used a word completion test with stems of unstudied as well as studied words to measure implicit memory. The second test generated a false memory-like effect in which more stems were completed for *unstudied* words that were related to presented words than for other unstudied words (e.g., *___ault* for *assault* [related] or *vault* [unrelated]). A mood-congruency effect was observed on the first test: Depressed subjects recalled more depression-related words than positive words on the explicit task, but controls did not. However, there was no mood-congruency effect on the implicit test; both groups completed more depression-related word stems than stems of other types.

Although Watkins et al. (1992) did not detect mood-congruency effects in false memory, others have. Moritz, Glascher, and Brassen (2005) studied depressed subjects and matched controls. They administered depression-related, delusion-related, positive, and neutral DRM lists (see the lists at the bottom of Table 3), with arousal not equated, to determine whether the mood-congruent true memory effect holds for false memory as well. For true recognition, depressed subjects displayed better memory for all of the emotional lists than for the neutral lists, whereas controls' memory was best for the positive lists. Depressed subjects displayed a similar effect for false memory: False alarm rates were higher for the three types of emotional lists than for the neutral lists, and in addition, they were highest for the negative lists (mood congruency). In contrast, controls' false alarm rates were highest for the neutral lists.

Moritz, Voigt, Arzola, and Otte (2008) reported some follow-up research that increased the number of DRM lists. They also measured a variable that may be a mediator of mood congruency, personal salience, as indexed by the extremity of subjects' valence ratings, beyond valence averages. There were no group differences in memory as a function of valence (i.e., no mood-congruency effect) but salience predicted performance: Depressed subjects' hit and false alarm rates were both higher for personally salient words, and the same was true for controls. Joormann, Teachman, and Gotlib (2009) then extended Moritz et al.'s (2005) design from recognition to recall of positive, negative, and neutral DRM lists. There was a mood-congruency effect for false memory: Depressed subjects recalled more negative CDs than controls, but false recall of positive and neutral CDs did not differ for the two groups. Concerning true memory, depressed subjects' recall was poorer overall, and this was especially true for positive DRM lists. Yeh and Hua (2009) conducted a similar study using recognition of Chinese emotional DRM lists, and overall, false recognition of CDs was higher in depressed subjects than in controls. Also, false recognition was higher for positive and negative CDs than for neutral CDs in depressed subjects, whereas the opposite was true in controls. Thus, there were mood-congruency effects in both of these latter studies such that false memory was higher for negatively valenced versus neutral words.

Similar to Moritz et al. (2005), Howe and Malone (2011) administered depression-related lists—as well as other negative lists, positive lists, and neutral lists—followed by recognition tests. There was a highly specific mood-congruency effect in which false recognition was elevated in depressed subjects for depression-related CDs but not for other types of CDs. There was a broader mood-congruency effect for true memory in which hit rates were elevated in depressed patients for depression-related and other types of negative targets.

Toffalini, Mirandola, Drabik, Melinder, and Cornoldi's (2014) procedure differed from studies considered so far. They implemented Hannigan and Reinitz' (2003) method of administering scripted pictures and assessing false memory for unpresented causal events and other related events. Toffalini et al. included emotional scripted material (negative vs. neutral), which was administered to young adults with depressive-anxious symptoms and to controls. There was a mood-congruency effect for false memory: Negative causal errors (i.e., false memories of unpresented causes of negative outcomes) were more common in the depressive-anxious group than in the control group, but the incidence of neutral causal errors did not differ for the two groups.

To differentiate the effects of natural negative moods that are pursuant to depression from natural negative moods that are pursuant to other conditions, Toffalini, Mirandola, Coli, and Cornoldi (2015) repeated the above procedure with a different subject group that experiences predominantly negative moods, highly anxious individuals. The scripted target material included positive as well as negative and neutral scenarios. Once again, there was a mood-congruency effect in false memory because subjects in the anxious group made more negative causal errors than neutral causal errors and made more negative causal errors than controls. Subjects in the anxious group also made more negative than positive noncausal errors.

An important methodological point about all of the preceding studies that affects their theoretical interpretation is the absence of arousal controls. This feature of their design means that, currently, it is unclear whether mood-congruency effects in depressed subjects are valence effects, arousal effects, or both.

PTSD. Individuals with PTSD diagnoses report predominantly negative moods and increased negative memories—as well as increased arousal, evidenced by hypervigilance and/or increased startle responses (**American Psychiatric Association, 2013**). Such individuals experience a range of negative emotions, including fear, anger, shame, and alienation, and they may report intrusive memories of trauma, plus numbing and dissociation to miti-

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gate such memories. False memory in PTSD has been a topic of considerable interest for some time, owing to concerns about the accuracy of recovered memories of long-forgotten childhood trauma (e.g., Loftus, 1993). More generally, false memory research with PTSD populations was originally undertaken to determine whether they are at increased risk of erroneous memories of traumatic events, while at the same time displaying reduced memory for the actual details of traumatic events (e.g., Foa & Riggs, 1993). With respect to mood, because intrusive memories of trauma are usually accompanied by strong emotions, this aspect of PTSD persistently reinstates negative moods.

In an early article, Bremner, Shobe, and Kihlstrom (2000) measured false recall and false recognition of standard DRM lists in subjects with self-reported histories of childhood sexual abuse and current PTSD diagnoses (i.e., PTSD pursuant to abuse), subjects with histories of abuse but no PTSD diagnosis, and nonabused controls. False recognition of CDs but not false recall was elevated in the PTSD group, relative to the other two groups. True recall but not true recognition was lower in the PTSD group, relative to the other two groups. In short, there was a global suppression of accuracy in PTSD patients.

Zoellner, Foa, Brigidi, and Przeworski (2000) extended Bremner et al.'s (2000) design by studying the same subject groups but (a) adding remember/know judgments to recognition tests and (b) administering recall followed by recognition to half the subjects and arithmetic problems followed by recognition to the other half, so that recognition was no longer confounded with prior recall. The false memory data were not consistent with a simple mood-congruency hypothesis: False recall was higher in *both* abused groups than in the control group, false remember judgments were higher in the non-PTSD abused group than in the other two groups, and true recognition was also highest in the non-PTSD abused group.

Similar to Bremner et al. (2003), Brennen, Dybdahl, and Kapidzic (2007) found some evidence of mood congruency in false memory with PTSD patents. They measured true and false recall—using neutral DRM lists, negative lists, and negative trauma-related lists—in traumatized-PTSD subjects and nontraumatized-non-PTSD controls, with PTSD subjects having experienced war trauma. There was no difference in false memory for neutral lists or negative lists, but consistent with mood congruence, false memory for trauma-related lists was elevated in the PTSD group.

Jelinek, Hottenrott, Randjbar, Peters, and Moritz (2009) administered Moritz et al.'s (2008) picture memory task to subjects who had experienced trauma from traffic accidents and assault, some of whom had PTSD diagnoses and others of whom did not. Subjects viewed pictures of common positive, negative, and neutral scenes (e.g., beach, funeral) from which some typical details were removed (e.g., beach towels, coffin), followed by recognition tests. Contrary to mood congruency, there were no group differences in false recognition for any of the three valences, and PTSD subjects' hit rates were lower for all three valences.

Hauschildt, Peters, Jelinek, and Moritz (2012) reported a follow-up study that focused on false memory for videos. A PTSD group, a traumatized non-PTSD group, and a control group viewed negative trauma-related, negative-unrelated, positive, and neutral videos with central details removed, followed by recognition tests. Contrary to mood congruence, there were no group differences in false memory, and true memory was lowest in the PTSD group.

Childhood maltreatment. Goodman et al. (2011) reported a further investigation of trauma-related false memory in adults and adolescents with and without histories of child sexual abuse (CSA) and PTSD. As in some prior studies of depressed and PTSD patients, neutral, positive, negative, and negative trauma-related (CSA) DRM lists were administered, followed by recall and recognition tests. CSA is of special interest because it is associated with depression and PTSD (Roosa, Reinholtz, & Angelini, 1999; Widom, 1999), and even when its effects do not rise to the level of diagnosis, it is associated with memory impairment (Bremner et al., 2003). PTSD patients who are CSA victims may experience intrusive memories of abuse and recurrent negative moods, and thus, mood-congruent memory effects can be investigated with CSA-related lists. Overall, true recall was greatest for CSA-relevant lists and false recall was greatest for CSA-relevant and negative lists, but there was no evidence of mood congruency in false memory: Although the adolescent PTSD group displayed higher levels of false recognition than all other groups, that effect was not specific to CSA-related lists or even to negative lists.

Expanding Goodman et al.'s design, Baugerud, Howe, Magnussen, and Melinder (2016) administered negative and neutral DRM lists, without controlling arousal, to maltreated and nonmaltreated children (7- to 12-year-olds). On subsequent recall tests, true memory was lower and false recall of negative CDs was higher for maltreated children, but false recall of neutral words did not differ between groups. This points to a mood-congruency effect in false memory, but one that fades with time: Whereas maltreated children exhibited lower true memory and higher false memory for negative lists, adolescents and adults who experienced maltreatment as children did not show these effects.

Conclusions about natural mood. Across nonclinical, depressed, and PTSD subjects, valenced natural moods have usually been associated with higher levels of false memory than neutral moods. However, the type of valence that elevates false memory appears to be different for nonclinical versus clinical populations; positive in the former, negative in the latter. Note that this difference has some rather striking implications for forensic analyses of witnesses' susceptibility to false memory because depression and PTSD diagnoses are rarely taken into account in forensic work (see Toglia, Ross, Pozzulo, & Pica, 2014). At the level of specific valence, the results for nonclinical natural moods resemble the earlier pattern for induced moods.

With respect to mood-congruency in false memory, some evidence that favors this hypothesis has been obtained with natural moods, but the results are different for nonclinical versus clinical populations. On the one hand, mood-congruency effects tend to be specific to negative moods in clinical populations, which is hardly surprising inasmuch as negative moods are hallmarks of the populations that have been studied. On the other hand, both positive and negative mood congruency have been observed in nonclinical populations and in mood induction studies.

Discussion and Conclusions

How emotion influences false memory has long been a topic of lively speculation in the forensic and clinical literatures. Now, for

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the first time, the literature that we have surveyed provides extensive evidence that under controlled conditions, emotion has substantial and varied influences on false memory, some of which are paradoxical. Below, we summarize the major patterns that have emerged, highlighting the content-context paradox. We then reconsider the three questions posed at the beginning of this review, about the *direction*, *quality*, and *locus* of emotion-false memory effects. Finally, we discuss practical implications and some obvious lines of research that should answer key open questions.

Major Patterns

In the first part of this survey, we focused on one of two implementations of emotion—namely, content. The dominant methodology was the DRM paradigm, owing to its efficiency in creating false memories and the ease with which valence and arousal can be manipulated. We saw that whether arousal is confounded with valence, controlled at fixed levels, or manipulated factorially with valence influences DRM false memory, as does whether memory is tested with recall or recognition. Despite such variability, a consistent result was that negative valence elevates false recognition of CDs.

Beyond the DRM illusion, we saw that encoding modality can influence results with other paradigms, such as pictures and scripted materials. There are fewer experiments with other procedures, but they also show that negative content increases false memory. Although there is a fundamental difference between false memories that occur spontaneously because they fit the gist of experience versus those that are implanted via misinformation, the general finding of false memory being elevated by negative content holds for both. In misinformation studies, subjects were usually more likely to falsely remember misinformation when it was negative.

In the second part of our survey, we focused on the other implementation of emotion—namely, context, as supplied by subjects' moods. We began with research in which moods were experimentally induced, chiefly by music, and then considered other methodologies. The dominant patterns were that positive moods elevated false memory relative to negative moods, and aroused moods elevated false memory compared with nonaroused moods. These patterns were fairly consistent across mood methodologies. Obviously, the valence effect is in stark contrast to the chief result of content-false memory studies. Further, when mood induction was paired with emotional DRM lists, false memory was only elevated for negative lists when moods were also negative. As in content studies, mood valence effects were similar for spontaneous and implanted false memories.

Turning to natural mood studies, when clinical populations were studied the results were different than when moods were induced. With depressed and PTSD populations (persistent negative moods), subjects were more prone to false memory than control subjects, whereas negative induced moods reduced false memory. Mood-congruency effects were detected for these populations as well because memory was elevated for negative DRM lists that were specific to their condition.

In the end, our survey identified three major ways in which emotion-false memory effects vary as a consequence of major design features. First, negative content increased false memories on recognition tests but not on recall tests. This is an intriguing datum theoretically because content manipulations that elevate false memory in recognition normally elevate it in recall (Brainerd, Reyna, et al., 2008). Second, negative content increased false memories but negative induced moods reduced false memories. Third, although negative induced moods reduced false memories, negative natural moods *elevated* false memories. Below, we sketch theoretical explanations of these patterns.

Direction of Effects

Our first question was whether false memory varies uniformly with changes in emotion. The answer is no, and instead, the direction of valence effects varies as a function of design details. The direction of arousal effects is somewhat more uniform, but that is subject to the proviso that it is has not been extensively studied by itself. With that qualification in mind, there is evidence from both content and context studies that increasing arousal elevates false memory.

Recall versus recognition tests was the first example of differences in the direction of valence effects that we encountered. In DRM studies, negative content has been found to reduce false memory on recall tests but to increase it on recognition tests. That difference could be attributable to known differences in the relative sensitivity of recognition and recall to gist and verbatim memory, respectively. If valence affects the strength of the gist traces that support false memories, those effects would be more pronounced on recognition than on recall tests. If valence also affects the strength of verbatim traces that suppress false memories, those effects would be more pronounced on recall tests. That hypothesis remains tentative because recognition has so often been confounded with prior recall in the studies that we reviewed.

A second example of variability in the direction of emotion-false memory effects was that the direction of mood effects can depend on whether moods are induced or natural: Negative induced moods suppress false memory, whereas recurrent negative natural moods, as in depression or PTSD, are positively correlated with false memory. It should be added, however, that these contrasting effects are for mood states that differ in extremity and duration. Induced moods are weaker and more transient than persistent natural moods, and further, natural moods are products of real-life events of personal significance.

How could these differences affect the direction of valence effects in false memory? On the natural mood side, research on true memory has shown that enduring negative moods promote a processing style that favors reliance on gist traces, resulting in elevated levels of false memory for subjects with depression or PTSD diagnoses. On the induced mood side, however, negative moods promote item-specific processing, which favors reliance on verbatim traces and suppresses false memories. Positive induced moods, as predicted by the affect-as-information hypothesis, promote relational processing, which favors reliance on gist traces and elevates false memory.

Differences between clinical and induced mood effects could also be a consequence of differences in levels of valence and arousal, which are much higher for the former. This may also explain why mood-congruency effects have more often been detected with natural moods. In that connection, subjects who are in strong negative natural moods may be more prone to connect the gist across different events that are congruent with their moods.

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Under the usual opponent-process account of false memory, that would result in more mood-congruent false memories, as compared with subjects who experience induced moods.

Another potential source of clinical versus induced mood differences is the many confounding factors that are present in clinical populations (e.g., individual differences in memory). Such factors are eliminated via random assignment in induced mood studies, but with the clinical populations that figure in the present review, memory impairment is itself a symptom of depression and PTSD. Thus, associations between depression, PTSD, and false memory could be consequences of uncontrolled, extramood variables in clinical populations.

Developmental variability provides a third example of principled differences in the direction of emotion-false memory effects. From what is known, which is confined to content studies, emotion-false memory effects are qualitatively similar in children and adults, but the magnitude of those effects is smaller in children. To many, this finding has seemed counterintuitive because it suggests that children are less susceptible to false memory than adults, when conventional wisdom says the opposite. However, this finding is quite consistent with the large literature on developmental reversals in semantic false memories. There is far less research on mood effects in children, far too little to hazard conclusions about developmental variability in those effects.

Quality of Emotion

The second question was whether emotion-false memory effects are attributable to valence, arousal, or both. In content studies, we saw that false memory varies for both positive versus negative valence and high- versus low-arousal. When arousal was equated, negative DRM lists produced more false memory than positive ones, and so did negative thematic pictures. Turning to arousal, increasing it seems to elevate false memory, at least for negative DRM lists. The first result is likely attributable to the increased salience of semantic connections among negative targets as compared with positive ones, which strengthens gist memory. The arousal effect is more difficult to interpret because in most cases, arousal was confounded with valence, but it follows from FTT's proposal that increasing arousal reduces the strength of verbatim traces by blurring attentional focus during encoding.

Valence and arousal also appear to affect false memory as components of mood, but there has been substantially less control of arousal in that literature. In mood research in which valence and arousal were manipulated factorially, there were arousal effects but not valence effects. Further, although negative moods reduced false memory relative to positive moods, it was only when arousal was *not* controlled. With respect to opponent-process distinctions, all of this suggests that mood chiefly affects verbatim memory, and consistent with affect-as-information, it does so primarily at encoding. Notwithstanding that the effects of mood valence are uncertain because it has so often been confounded with arousal, it does appear that those effects depend on arousal because they seem to decrease as arousal increases.

Most mood studies in which valence and arousal were factorially manipulated did so by varying specific emotions (e.g., positive valence/low arousal = serene; Van Damme, 2013). Those studies produced inconsistent results, but as discussed earlier, that may simply be because each Valence × Arousal combination can be represented by more than one specific emotion. In that connection, appraisal theories (Scherer, 1999) claim that specific emotions can be pre- or postgoal oriented, meaning that they focus on future goal attainment or failure (e.g., desire, fear) or they are reactions to past goal attainment or failure (e.g., happiness, sadness). That has straightforward implications for attention: Pregoal emotions narrow attention to information that is central to the goal itself, whereas postgoal emotions broaden attention to include the consequences of goals. This is important when it comes to false memory because it is known that memory distortion varies as a function of such differences in attentional focus (Van Damme, Kaplan, Levine, & Loftus, 2016). In addition, when specific emotions differ in valence or arousal, opponent-process theories such as FTT make predictions about differences in false memory as a function of differences in specific emotions (Bookbinder & Brainerd, 2016).

Arousal-driven differences in false memory may ultimately be attentional in origin, and more generally, attention has been mentioned as a likely factor in some influential theoretical proposals about emotional false memory. For instance, some have argued that the item versus relational processing distinction is about narrowing versus broadening attention, and that it is the broader attentional focus of positive moods that elevates false memory (e.g., Derryberry & Tucker, 1994). Similarly, others have interpreted the affect-as-information hypothesis as implicating differences in attentional focus via differences in approach versus avoidance (e.g., Förster, Friedman, Özelsel, & Denzler, 2006). The basic proposal is that positive moods motivate approach, which broadens attention, whereas negative moods motivate avoidance, which narrows attention. Beyond predicting that false memory will vary as a function of attentional breadth, this account also incorporates evolutionary ideas, such as the role of fear in avoiding danger: There is a survival advantage to focusing attention when experiencing fear, explaining why attention increases and false memory decreases with negative mood states.

Locus of Emotion

The third question asked whether emotion-false memory effects depend on whether content or context is the locus of emotion. The answer, if we have learned anything, is yes. The picture that is provided by the overall arc of data is that negative valence elevates and positive valence reduces false memory when the locus is content, but positive valence elevates and negative valence reduces false memory when the locus is mood. Just as recall versus recognition seems to switch the direction of emotional content effects, then, locus seems to switch the direction of effects. Fortunately, the principles of opponent-process theories, which are grounded in the larger false memory literature, are able to explain this dependency. At the level of memory representation, the most likely explanation is that negative content and positive moods both enhance semantic processing, strengthening gist traces relative to verbatim traces, but positive content and negative moods both enhance the processing of targets per se, strengthening verbatim traces relative to gist traces.

Beyond this basic account, a full explanation of the context-content paradox may need to include differences in the relative contributions of valence and arousal when they are manipulated in content versus context. There is some slim evidence from factorial

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manipulations of the two that valence effects are more pronounced than arousal effects in the content sphere, whereas the reverse is true in the context sphere. If that pattern continues to hold, then valence preferentially drives processing when it is embedded in the target material itself, but arousal preferentially drives processing when it figures in the context in which that material is presented. Theoretically, that difference could be explained by relying on the distinction between target recollection and context recollection in episodic memory (see Brainerd et al., 2014).

Practical Importance

Returning to the forensic situations in which emotion-false memory effects are of great concern, pragmatic recommendations derived from the literature we have reviewed are complex because emotional content and context are normally confounded in legal cases. That is because (a) the specific events during crimes that the law is concerned with are inherently emotional (negative, high-arousal); (b) the general context of a crime is apt to generate negative-arousing moods in witnesses; (c) witnesses may initially be in quite different moods (positive, low-arousal); (d) some events that occur during the postcrime investigation phase (e.g., police interviews and interrogations) and the trial phase (e.g., direct testimony and cross examination) are inherently emotional; (e) those postcrime events are apt to induce specific moods states; and (f) research suggests that memory distortion pursuant to a and d will be different than memory distortion pursuant to b, c, and e. However that may be, remember that the many design variations in the literature we have reviewed supply differential evidence on the influence of all of these factors, which is what is needed for forensic analysis of the reliability of witnesses' memories. For instance, studies in which mood was induced before versus after encoding target material show that b and c will usually be more important considerations than e. The main conclusion for the present is that because the literature shows that these factors have different effects, a forensic analysis that relies on just one is flawed and misleading.

It should be added that beyond memory distortion in the law, there are other high-stakes remembering situations to which the same considerations apply, point for point. Patients' reports of medical symptoms and histories are prime examples in which the parallels are so self-evident as to require no discussion. Interestingly, as mentioned earlier, this is another domain that features the same conflicting hypotheses about whether emotional variations are distortive or protective that are found in the law. What we have learned in this review is that conflicting hypotheses are tenable because emotional variations can have both effects, depending on design features.

Future Directions

The most obvious near-term goal for research, which we have mentioned at several points, is more consistent control of arousal to identify the nature of valence effects and arousal effects independently of each other. Notwithstanding the progress in that direction in DRM content studies, comparable studies with other false memory paradigms will be necessary to ensure that the effects that have been obtained are not DRM-specific. This is far from idle speculation, considering that the DRM illusion is a very special paradigm. In the same vein, there has been disappointingly little control of arousal in mood studies, in both experimental and correlational designs. Arousal is rarely measured in natural mood studies, and in most mood-induction procedures (e.g., music and guided imagery), it is not varied systematically. Better separation of arousal from valence in mood studies will be essential if there are to be systematic comparisons to emotion-false memory effects in content studies. Such comparisons are further hampered by the fact that much mood research conceptualizes emotion as discrete emotional states, whereas the content literature relies primarily on the notion of continuous valence and arousal dimensions. Obviously, the two literatures' theoretical conceptions will need to be aligned to effect direct comparisons of valence and arousal effects in content versus context.

Another obvious target for future research, one that is probably easier to accomplish, is to disentangle emotion-false memory effects for recall and recognition by testing theoretical hypotheses about the reasons why those effects are test-dependent. As we saw, extant data are inadequate because recognition tests have been routinely confounded with prior recall, so that extant recognition data are recall-dependent in unknown ways. Thus, it is not entirely clear whether the different emotion-false memory effects for recognition versus recall are real or are attributable to this confound. Fortunately, mathematical models exist for both recognition and recall that can pinpoint the precise retrieval processes that are responsible for a manipulation's effects with each type of test. Thus, experiments that combine those models with counterbalanced testing procedures would not only isolate different emotional effects for recognition versus recall, but they would deliver process explanations of those differences as a by-product.

A third direction for future research is to expand research with clinical populations, particularly as a way of studying the effects of more intense levels of emotion. With respect to PTSD especially, available data do not provide a consistent picture of false memory effects, especially for traumatic information (mood-congruent false memory). Obviously, it is important to determine whether PTSD individuals are at elevated risk for false memories and whether such elevation is mood-congruent. As part of such work, current explanations of established PTSD impairments in true memory should be put to the test, such as reduced autobiographical memory (Brewin, Kleiner, Vasterling, & Field, 2007). As for depression, the research goals, both empirical and theoretical, would be much the same.

Concluding Comment

Emotion-false memory has been widely studied, and that work has produced some instructive findings. One of them is that those effects vary as a function of whether emotion is manipulated in target material or in subjects' moods. Paradoxically, the two implementations produce largely opposite effects. Although this pattern is surprising, contemporary opponent-process theories can explain it. According to this explanation, the locus of emotional content effects lies primarily with gist memory, whereas the locus of emotional context effects, at least as they are exemplified in subjects' moods, lies primarily with verbatim memory.

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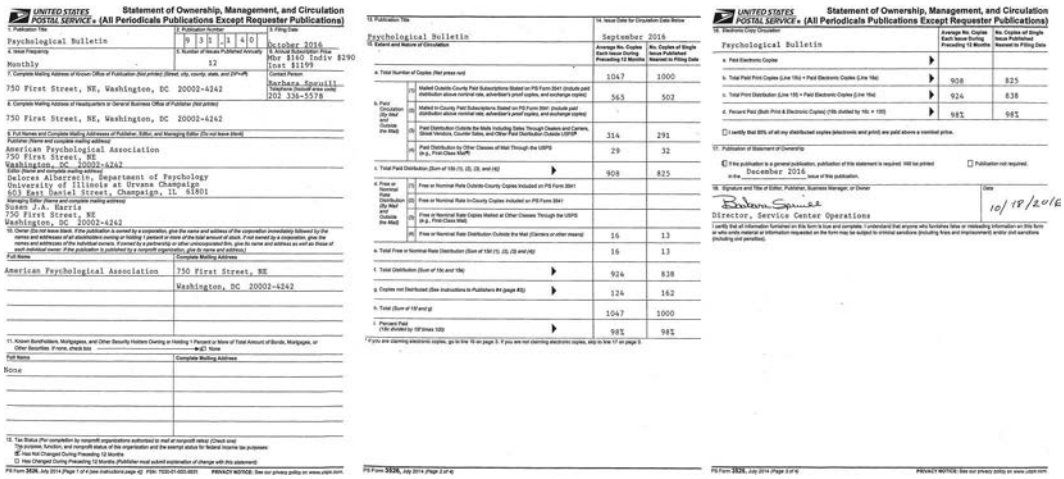
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