

EMOTION AND MEMORY RESEARCH: A GRUMPY OVERVIEW

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A great deal of research on emotion and memory has focused on the question of whether emotion enhances memory. Based on this research, investigators have variously claimed that emotional memories are indelible; that emotion has no special effects on memory at all; and that emotion leads to enhanced memory for either congruent or central information. In this overview, we review the current status of these claims. Although considerable progress has been made toward understanding whether and how emotion enhances memory, much of this research has been limited by its treatment of emotion as merely "arousal." Evidence is presented that people process, encode, and retrieve information differently depending upon whether they are feeling happy, fearful, angry, or sad. We argue that a more complete understanding of the effects of emotion on memory will depend upon taking into account the differing motivations and problemsolving strategies associated with discrete emotions.

How do emotions influence memory for autobiographical events? How well do we remember a joyful family gathering, a terrifying near-miss on the freeway, or an angry falling out with a friend? Just as importantly, what aspects of these emotional events do we remember? Much of the scientific research on these questions has focused on evaluating four broad claims: the claim that emotional memories are indelible; the opposing claim that emotion has no special effects on memory at all; the claim that emotion enhances memory for information similar in tone; and the claim that emotion enhances memory for central information at

An earlier version of this article was presented as an invited plenary address at the Cognitive Aging Conference, Atlanta, GA, April, 2002.

We are grateful to Martin Conway and Ineke Wessel for their helpful comments on an earlier version of this article.

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the expense of peripheral details. Over the last couple of decades, research on emotion and memory has increased dramatically and considerable progress has been made toward evaluating the validity of these claims. This article provides an overview of some recent strides toward understanding whether and how emotion affects memory.

Why is this a grumpy overview? Fifteen years ago, Rob Neiss (1988) made a powerful argument against the use of the excessively broad construct of “emotional arousal” (also see Feldman & Waller, 1962; Lacey, 1967). Although researchers have long known that discrete emotions are associated with different motivations and problem solving strategies, few studies have assessed the implications of these differences for memory. We will argue that neglecting these differences leaves us with, at best, an incomplete picture of the relationship between emotion and memory, and at worst, an inaccurate one. Our aim is not to offer a comprehensive review of the literature on each claim discussed, as this has been done recently and well (Eich & Forgas, 2003; McGaugh & Cahill, 2003; Ochsner & Schacter, 2003; Reisberg & Heuer, 2004; Schooler & Eich, 2000). Rather, our goal is to illustrate how a focus on emotional arousal constrains our understanding of the effects of emotions on memory, and to offer a possible solution and research direction—for memory researchers to take discrete emotions seriously. To this end, the first section of this article is devoted to a discussion of the status of the four broad claims concerning whether and how emotion improves memory. We review what is currently known and point out limitations in our knowledge that stem from conceptualizing emotion as arousal. We then draw on appraisal theories of emotion to show the importance of shifting the level of analysis toward discrete emotions. We conclude by reviewing evidence in support of the claim that discrete emotions differ in their effects on memory.

ARE EMOTIONAL MEMORIES INDELIBLE?

It has long been acknowledged that memory for *nonemotional* information is partially reconstructed based on post-event information and appraisals (Bartlett, 1932; Conway & Pleydell-Pearce, 2000; Loftus, 1992; Ross, 1989). Highly emotional events, however, were once thought to leave indelible impressions on memory. William James wrote, “An experience may be so exciting as to almost leave a scar on the cerebral tissue” (1890, p. 670). In their now classic article on flashbulb memories, Brown and Kulik (1977) argued that, because of the obvious survival value, there may be some mechanism in the brain that leads to remembering biologically crucial but unexpected events with close to photographic accuracy. They demonstrated that, when people were asked to

describe how they first learned about highly emotional events, they could typically provide a detailed report of where they were, what was happening at the time, who told them the news, and how they felt. In contrast to memories for mundane events, emotional memories often contained vivid, highly idiosyncratic details that seemed to endure for a long time. LeDoux (1992) also argued that emotional memories are indelible. He was referring not to memory for the details of what happened, but to memory for the emotions evoked by events. This claim was based in part on the finding that, after they have been extinguished, classically conditioned avoidance responses can be reinstated by exposure to a stressful stimulus. Thus although extinction suppresses an animal's behavioral response, it does not seem to erase the emotional memory (also see Fanselow & Gale, 2003; van der Kolk, 1994).

Claims about the indelibility of emotional memory stimulated a great deal of research on how accurate such memories really are. Contrary to the indelibility hypothesis, researchers have demonstrated that the vividness and detail that often characterize memories for emotional events do not necessarily imply accuracy. In one study, Neisser and Harsch (1992) found that inaccuracies were common when college students recounted how they found out about the explosion of the "Challenger" space shuttle after a delay of 2½ years (also see Thompson & Cowan, 1986). More recently, Talarico and Rubin (2003) compared people's memories of first hearing about the September 11, 2001 terrorist attacks with their memories of recent everyday events. They found that greater emotional intensity was associated with greater memory confidence but not with consistency. The consistency of memories for the terrorist attacks, and for everyday events, declined over time at a similar rate. In contrast, other studies have shown that greater emotional intensity is associated with greater (though not perfect) memory consistency over time (e.g., Conway 1995; Pillemer, 1984; Pillemer, Rhinehart, & White, 1986). For example, Conway et al. (1994) assessed people's memories for learning of the resignation of British Prime Minister Margaret Thatcher. Citizens of the United Kingdom, who were more emotional about Thatcher's resignation than noncitizens, showed greater consistency over time in their memories, even after statistically controlling for group differences in knowledge, importance, and rehearsal.

Thus, although some studies have shown that greater emotional intensity at the time of encoding is associated with greater consistency of memories over time, all studies have shown that memories for emotional events are far from error-free. Departing somewhat from Brown and Kulik's initial formulation of the flashbulb memory construct, the biologically significant features of emotional events may not be details concerning the reception context (i.e., "When did you first hear the

news?" "Who first told you the information?"). Rather, what matters most may be *that* the event occurred, the gist of what occurred, and the implications it had for the individual. We would expect these features to be remembered better for emotional than for nonemotional events, a point to which we will return later.

What about the indelibility of memory for emotions themselves? Are people always accurate when they recall how they felt in the past? Recent findings suggest not. Levine (1997) studied memory for emotions in supporters of former U.S. presidential candidate Ross Perot following Perot's abrupt withdrawal from the presidential race. For his supporters, Perot's withdrawal from the race had all the elements typically associated with the creation of vivid and lasting memories. The event was surprising, associated with intense emotion, and viewed by these individuals as being of tremendous personal and social importance. Levine had supporters describe their initial emotional reactions after Perot's withdrawal in July 1992 and again after the presidential election that November. Between the two assessment periods, the views of many supporters changed dramatically as Perot re-entered the race in October and received nearly a fifth of the popular vote. The results showed that supporters recalled their past emotions as having been more consistent with their current appraisals of Perot than they actually were. For example, those who favored Perot after his re-entry into the race underestimated how sad and angry they had felt when Perot first withdrew, but overestimated their initial feelings of hope that Perot could still make a difference. In contrast, those who had turned against Perot demonstrated stable recall of their previous feelings of anger, but underestimated how hopeful they had felt.

Similarly, Breckler (1994) found that people's current attitudes toward blood donation influenced their memories for how they felt when donating blood. Holmberg and Holmes (1994, study 2) found that husbands whose marriages had become less happy over time recalled early marital interactions as more negative than initially reported. People's memories for how distressed they felt when they learned of the September 11, 2001 terrorist attacks also changed over time; the changes were predicted by their current appraisals of the impact of the attacks (Levine et al., 2004). Taken together, these findings support the conclusion that people's memories for their past emotional responses can be partially reconstructed based on their current appraisals of events.

Because these data are correlational, however, one cannot be certain that changes in appraisals actually cause changes in memory for emotions. It may be, for instance, that distortions in memory affect current appraisals. So Safer, Levine, and Drapalski (2002) conducted an experiment that assessed college students' memories for how anxious they felt

before a midterm exam. Students were randomly assigned to one of two groups. One group learned their exam grades before recalling their pre-exam emotions. The other group did not yet know their grades when they recalled their emotions. In contrast to those who had not yet learned their grades, students who learned that they had done well on the exam underestimated how anxious they had felt before the exam. Students who learned that they had done poorly overestimated how anxious they had felt. Thus, post-event information about their grades led to distortions in students' memories for their past feelings of anxiety.

Bias in memory for emotion is not limited to declarative memory. Hendersen (1985) found that, in the absence of intervening events, rats retain conditioned fear responses extremely well. But real life does not occur in the absence of intervening events. In real life, after a frightening event occurs, other experiences follow that may be better or worse than the initial frightening one. What happens to conditioned fear in cases like that? Hendersen created a laboratory situation analogous to such real-life experiences. He conditioned rats to expect shock when they heard a tone. The intensity of the conditioned fear response was assessed by measuring how much the water-deprived rats' drinking was disrupted when they heard the tone. This memory test took place either one day or 60 days after conditioning. On that day, the rats first received gratuitous shocks (i.e., shocks unaccompanied by the tone) that were either milder or more intense than those used during conditioning. When re-exposed to the tone (the memory test), those rats that had received mild gratuitous shocks showed less disruption of drinking than those that had received more intense shock. Importantly, this difference increased over time. Hendersen concluded that, over time, memories for the intensity of fear had become increasingly malleable—increasingly subject to bias in the direction of more recent experience.

In short, current research demonstrates that neither memory for emotional events nor memory for emotional feelings is indelible. Like memories for more mundane events, emotional memories change over time and can be influenced by post-event experience and appraisals. The malleability of emotional memories should not be entirely unexpected. After all, the primary function of memory may be to guide future behavior rather than to keep an exact record of the past. For example, recalling past emotions of delight or annoyance lets people know whether to seek out similar situations in the future or avoid them (Damasio, 1994; Hendersen, 1985; Levine, 1997; Levine, Prohaska, Burgess, Rice, & Laulhere, 2001; Robinson, 1980). Because emotional memories are informed by current appraisals of the emotion-eliciting situation, rather than being perfectly faithful to the past, they may serve as a superior guide for future behavior (Levine & Safer, 2002).

EMOTION MAKES MEMORY BETTER

The inaccuracies found in memory for emotional information led some investigators to conclude that there are no emotion-specific effects on memory at all. They claimed that any memory advantage observed for emotional events could be accounted for by ordinary memory mechanisms. That is, to the extent that emotional events are remembered better, it is because they tend to be novel, distinctive, or interesting, and well-rehearsed (e.g., Brewer, 1992; Finkenauer et al., 1998; McCloskey, Wible, & Cohen, 1988; Talarico & Rubin, 2003; for reviews, see Schooler & Eich, 2000; Shobe & Kihlstrom, 1997). For example, Michael McCloskey (1992) wrote:

[P]roponents of the special-mechanism hypothesis face an uphill battle as they attempt to place the hypothesis on a more solid foundation. Given that flashbulb memories may not be all that good, and the performance expected from ordinary memory mechanisms may not be all that bad, motivation for postulating a special flashbulb memory mechanism may not be easy to come by. (p. 234)

Despite findings that emotional memories are not indelible, it seems to us that this “uphill battle” has been won. Converging evidence from autobiographical memory studies, animal and human laboratory studies, and brain imaging studies shows that emotional events are remembered better than nonemotional events and that mechanisms specific to emotion underlie these effects. In studies of autobiographical memory, when people are asked to recall events that they had previously recorded in diaries, greater emotional intensity is associated with greater memory vividness, even after controlling for event novelty, importance, and the amount of rehearsal (Conway, 1995; Thompson, Skowronski, Larsen, & Betz, 1996).

Laboratory studies with animals and humans show that stress hormones, such as epinephrine, are released when events evoke strong emotions. These peripheral stress hormones in turn activate noradrenergic systems in the amygdala, and amygdala activation mediates consolidation of long-term memory in other brain regions (Cahill, Prins, Weber, & McGaugh, 1994; for a review see McGaugh & Cahill, 2003). The critical role of the amygdala in strengthening emotional memories is well-documented. Infusing stress hormones directly into the amygdala enhances memory for emotional information. Inactivating this region, using lesions or drugs, attenuates the enhancing effects of stress hormones on memory (McGaugh, 2000).

Brain imaging studies also support the view that the amygdala plays an important role in the consolidation or strengthening of memory for emotional events (Ochsner & Schacter, 2003). Importantly, the enhancement of memory associated with amygdala activation is specific to emotional information. Consider for example, the following two studies. Canli, Zhao, Brewer, Gabrieli, and Cahill (2000) conducted an fMRI study in which participants saw negative and neutral pictures. A separate fMRI response was recorded in the amygdala as participants rated each picture for emotional intensity. Three weeks later, participants were given a surprise recognition test with previously seen and new pictures. They were asked to indicate whether they had seen each picture before, and if so, whether they remembered seeing it or it just seemed familiar. The results showed that the more emotionally intense participants found the pictures, the more bilateral activation was found in the amygdala. Three weeks later, pictures that had been rated as the most emotionally intense were remembered better, on average, than pictures rated as less intense. Moreover, for those pictures rated as the most emotionally intense, the greater the left amygdala activation, the more likely it was that the picture would be clearly remembered (also see Cahill et al., 1996).

Can these findings be explained in terms of “ordinary memory mechanisms” such as the distinctiveness or interestingness of the stimuli? Hamann, Ely, Grafton, and Kilts (1999) conducted a PET scan study in which participants viewed, and rated, four types of pictures: positive, negative, affectively neutral (e.g., a book, a towel), and affectively neutral but interesting (e.g., a scene from a surrealistic film, an exotic parade). During each PET scan, participants rated the pictures for emotional arousal, valence, and degree of interest. A month later, participants were given a surprise recognition test. The results showed that both emotional and interesting pictures were remembered better than neutral pictures. Greater bilateral amygdala activity during encoding was correlated with better memory for emotional pictures relative to neutral pictures. No significant correlation was found between amygdala activity and better memory for interesting pictures, however. These findings suggest that the neural mechanisms by which emotion leads to better memory differ from the neural mechanisms by which distinctiveness leads to better memory (also see Strange, Hurlemann, & Dolan, 2003).

Thus, emotional memories are not indelible. They fade over time and are subject to biases resulting from post-event information and appraisals. Yet, relative to affectively neutral memories, emotional memories tend to be long-lasting, vivid, and detailed (LeDoux, 2000). As metaphors go, then, indelible ink may be too strong, but a highlighter seems

about right. Emotion appears to increase the salience of information much like a highlighter increases the salience of text. In short, emotion makes memory better.

WHAT DO WE MEAN BY "BETTER?"

That is all well and good as far as it goes, but here we get to the heart of the matter—what do we mean by "better?" If emotion functions as a highlighter of sorts, what sorts of information does it highlight? Once one moves beyond the simple statement that emotion strengthens memory, things get complicated quickly. Whether or not emotion leads to enhanced memory for information has been shown to depend on whether the information is: generated by the self or by the experimenter; self-referential or not; recalled or recognized; assessed immediately or after a delay (for reviews see Blaney, 1986; Eich & Forgas, 2003).

Each of these factors is important, but rather than venture into that forest of research, this review will stick to the well-beaten path. Two answers to the question, "What do we mean by better" are by far the most common in the literature. One answer is that emotions enhance the availability of emotion-congruent information. That is, people tend to encode and retrieve information that matches the tone of their current emotional state. In an early demonstration of this effect, Bower, Gilligan, and Monteiro (1981) induced a happy or sad mood in participants. Participants then heard a story about two college students, one doing well and the other doing poorly. A memory test was given the next day when participants were in a neutral mood. Previously happy participants recalled more happy facts from the story; previously sad participants recalled more sad facts. Since then, numerous studies have demonstrated emotion-congruent biases in perception, judgment, encoding, and retrieval of information (Eich & Forgas, 2003).

Bower (1981) explained these findings in terms of associative network theory. He proposed that emotions function as nodes in an associative network of information. When an emotion is evoked, the node is activated, and activation spreads to other nodes in the network that are associated with it, such as past experiences, concepts, and emotional behaviors. This related information becomes more accessible as a result, and influences perception, judgment, and memory in an emotion-congruent manner.

Incorporating emotion into a model of semantic and episodic knowledge was a crucial development that generated an enormous amount of interest and stimulated research concerning the relations between emotion and cognition. As several investigators have argued, however, it may be inappropriate to treat such different beasts as emotions, episodic

information, semantic information, and behavioral tendencies as equivalent nodes in a common network (e.g., Leventhal & Tomarken, 1986). Further, there are findings that associative network models do not explain well. Irrespective of the particular emotion experienced, network models predict enhanced memory for information that matches the emotion in tone. Emotion-congruent memory has been found to be stronger for positive than negative emotions, however, and under certain conditions, people reliably retrieve emotion-incongruent memories. Researchers have explained these findings by extending network models to incorporate the different motivations and regulation strategies associated with positive and negative emotions (Eich & Forgas, 2003; Parrot & Spackman, 2000). Thus, recent research suggests that associative network theory provides an incomplete explanation of the effects of emotions on memory.

The other common answer is that better means “central.” In a series of laboratory studies, Christianson, Loftus, and their colleagues found that emotional arousal enhanced recall of information central to the event that elicited the emotion, but disrupted recall of peripheral details (e.g., Christianson & Loftus, 1991). In one such study, participants were presented with one of two matched slide sequences depicting either an emotional event (a boy hit by a car) or a neutral event (a boy walking beside a car). All participants wrote down the central feature of each slide. Participants who viewed the emotional slide sequence were better able to recall the central features than participants who viewed the neutral sequence, but they were less able to recognize the particular slides they had seen (Christianson & Loftus, 1987). As mentioned above, these findings suggest that consistency over time in memory for highly emotional events (i.e., flashbulb memories) would be more likely to be found for the central features of the events than for details of the reception context (Schaefer & Philippot, *in press*).

Overall, the finding of enhanced memory for central aspects of emotional events has been well-supported (e.g., Adolphs, Denburg, & Tranel, 2001; Berntsen, 2002; Brown, 2003; Burke, Heuer, & Reisberg, 1992; Safer, Christianson, Autry, & Osterlund, 1998), but emotional arousal has been found to sometime enhance and sometimes disrupt memory for detail, raising the issue of how one determines whether a given detail should be classified as central or peripheral (Heuer & Reisberg, 1992; Reisberg & Heuer, 2004).

This brings us to the part that we are grumpy about. Neither of the common answers to the question of what “better” means takes into account some of the fundamental properties of emotions. The vast majority of research on the effects of emotion on memory treats emotion as “arousal”—a variable that can be measured on a single scale ranging

from relaxed to very emotionally aroused. A more complete understanding of how emotions affect memory will depend upon taking into account that, while arousal is an essential component of emotion that certainly affects memory, emotion is more than arousal. Arousal is to emotion what brightness is to color; an essential component to be sure, but one that fails to capture some of the most fundamental properties of the phenomenon.

AN ALTERNATIVE APPROACH BASED ON COGNITIVE APPRAISAL THEORY

Meanwhile, in a galaxy far away from most emotion and memory research, a separate line of theory and research has focused on identifying the functions that specific emotions fulfill within the cognitive system. According to appraisal theories, people constantly evaluate the relevance of environmental changes for their well-being. People experience emotions when they perceive that a goal has been attained or obstructed and it becomes necessary for them to revise prior beliefs and construct new plans (Arnold, 1960; Lazarus, 1991; Oatley & Johnson-Laird, 1987; Simon, 1967). Once evoked, emotions direct attention to aspects of a situation that are functional—that is, relevant for responding to the type of situation that evokes the emotion.

Specific emotions most likely evolved to enable organisms to respond adaptively to different types of environmental changes. According to appraisal theorists, then, one cannot distinguish emotions such as fear and anger simply on the basis of levels of arousal and pleasantness (Ellsworth & Scherer, 2003). Fear is elicited by the perception of a future threat to well-being that must be avoided. Anger is elicited by the perception of a present obstacle to well-being that must be removed. A great deal of evidence now indicates that specific emotions are evoked by different interpretations of events and are associated with different motivations and problem-solving strategies (e.g., Ellsworth & Scherer, 2003; Frijda, 1987; Oatley & Johnson-Laird, 1987; Roseman, Antoniou, & Jose, 1996; Scherer, 1998; Smith & Lazarus, 1993; Stein & Levine, 1987; Stein, Trabasso, & Liwag, 2000; Weiner, 1985). From this perspective, it makes little sense to limit research to the effects of emotional arousal on memory. People may feel elated, terrified, despairing, or furious—but they are never just “aroused.”

Given the long histories of both appraisal theories and research on memory and emotion, it is surprising that so little research on memory has taken into account the differing functions of discrete emotions. Taking this view seriously would require researchers to go beyond classifying to-be-remembered information as emotion-congruent or

incongruent, central or peripheral. The information-processing strategies that are adaptive in one emotional state may not be adaptive in another. The types of information that are central in one emotional state may not be central in another. Thus, a better meaning of "better" is "relevant to the motivations associated with discrete emotions."

What advantages are there to using discrete emotions, rather than general arousal, as the level of analysis for assessing the effects of emotion on memory? After all, studies examining overall recognition accuracy or speed have sometimes found no differences as a function of positive versus negative valence, to say nothing of discrete emotions (e.g., Bradley, Greenwald, Petry, & Lang, 1992; Hamann et al., 1999). More fine-grained analyses reveal a different picture, however. Social psychologists have generated considerable evidence that happiness and negative emotions are associated with different information-processing strategies. These information-processing strategies, as it turns out, affect memory as well. Moreover, there is a growing body of evidence indicating that discrete emotions affect the types of information people attend to, encode, and retrieve. It is to this evidence that we now turn.

INFORMATION-PROCESSING STRATEGIES ASSOCIATED WITH EMOTIONS

What types of information-processing strategies would be adaptive in different emotional states? Although research on discrete emotions is limited, social psychologists have investigated the information-processing strategies associated with positive versus negative emotions. Several investigators have argued that people feel happy when goals have been attained and no immediate problem demands to be solved. In these circumstances, general knowledge is typically adequate for maintaining a state of well-being. Therefore, when happy, people would be expected to draw freely on general knowledge and use less effortful heuristics to process information. Consistent with this view, research shows that when happy people evaluate arguments or make social judgments they tend to rely more on general knowledge, stereotypes, or heuristics than do people in a neutral or negative mood (e.g., Bodenhausen, Kramer, & Susser, 1994; Fiedler, Asbeck, & Nickle, 1991; Forgas, 1998). Happiness has also been shown to facilitate flexibility and creativity in problemsolving tasks (e.g., Isen, Daubman, & Nowicki, 1987; Fredrickson, 2001). In contrast, negative emotions are experienced when goals are threatened or have failed. Research shows that when people are experiencing negative emotions, they tend to engage in effortful processing, evaluating information in a careful, systematic manner and relying less on general knowledge and heuristics. Thus, emotional

valence, which reflects whether or not there is a problem to be solved, influences people's information processing strategies (for a review see Bless & Schwarz, 1999).

The key question here though is, do these differing information processing strategies influence memory? There is evidence that they do, and that taking them into account can help to address some puzzling findings in emotion and memory research. Specifically, a puzzle exists concerning the effects of emotional valence on autobiographical memory. People typically rate positive life events as better remembered than negative life events (e.g., Matlin & Stang, 1978; Rubin & Berntsen, 2003; Thompson et al., 1996; Walker, Vogl, & Thompson, 1997). When researchers look at the objective accuracy of people's accounts, however, they sometimes find no valence effect (e.g., Holmes, 1970), or even superior memory for negative events (e.g., Banaji & Hardin, 1994; Bluck & Li, 2001; Kreitler & Kreitler, 1968).

Research suggests that this inconsistency is related to the differing information-processing strategies associated with positive and negative emotions. For example, Bless et al. (1996) induced a happy or sad mood in participants, and then presented them with information about common activities such as eating at a restaurant. Some of the information was script-typical (e.g., "the hostess placed the menus on the table") and some was script-atypical (e.g., "he put away his tennis racket"). About 15 minutes later, participants were given a surprise recognition test with both old and new information. They found that happy participants were more likely than sad participants to "recognize" script-typical information, independent of whether or not the information had actually been presented. Sad participants were more conservative, and more accurate, in their recognition judgments. Similarly, Park and Banaji (2000) found that happy participants showed a bias toward greater leniency in recognizing ethnic names as members of stereotypical categories, leading to many instances of false recognition. In contrast, participants in a negative mood used a more stringent criterion when making recognition judgments. Thus laboratory studies, typically lasting an hour or so, have shown that happiness can lead to greater reliance on general knowledge or stereotypes and to intrusion errors in memory.

Levine and Bluck (2004) wanted to know whether people make reconstructive errors of this sort when they remember real-world events that made them happy. They assessed participants' emotions and memories concerning the televised announcement of the verdict in the murder trial of O. J. Simpson. Memory was assessed for actual events and plausible foils. They found that people who were happy about the verdict recognized more events after a year than people who felt angry and sad, irrespective of whether or not the events had actually occurred. People

whose reaction to the verdict was negative tended to err in a conservative fashion by rejecting events. Signal detection analyses confirmed that the threshold for judging events as having occurred was lower for people who were happy about the verdict than for people whose reaction was negative.

Thus, one source of the inconsistent findings concerning emotional valence and autobiographical memory may be that people recalling happy events believe they remember events better than they actually do. These errors may come from people's tendency when happy to rely on general knowledge about what might have happened to fill in gaps in their representations. Events that made people happy are consistent with their goals. Drawing flexibly on general knowledge when remembering such events would allow people to build on past experiences of goal achievement without the risk that slight memory errors will lead to new difficulties in the present (Fredrickson, 2001). In contrast, events that evoked negative emotions are discrepant from goals and indicate a problem to be resolved. When remembering such events, people may engage in more focused retrieval of information relevant to repairing past negative outcomes or avoiding future ones. Consistent with this view, Berntsen (2002) found that people report a wide variety of details when recounting their happiest memories but focus on central information when recounting their most shocking (negative) memories.

The broader point is that findings such as these are very difficult to explain in terms of general emotional arousal. People experiencing positive and negative emotions have different motivations. They process information differently as a result, and these differences affect memory. The distinction drawn between positive and negative valence in these studies still neglects important differences between same-valence emotions such as anger and fear (Bodenhausen et al., 1994; Tiedens & Linton, 2001), but simply adding the dimension of valence helps to address a puzzle concerning autobiographical memory that cannot be explained solely in terms of emotional arousal.

TYPES OF INFORMATION REMEMBERED IN DIFFERENT EMOTIONAL STATES

We also suggested that the types of information that are central in one emotional state may not be central in another. So what types of information are relevant or central in specific emotional states? Predictions based on appraisal theories are summarized in Table 1. If fear motivates people to avoid the threat of goal failure, frightened people may selectively encode and retrieve information associated with threats and means of avoiding them. If anger motivates people to overcome obsta-

TABLE 1. Information Processing Strategies Associated with Positive and Negative Emotions and Types of Information Expected to be Central in Discrete Emotional States

Emotional Valence	Motivational State	Information-Processing Strategy
Positive	Goal attained: No immediate problem to be solved	Flexible processing; increased reliance on general knowledge and heuristics
Negative	Actual or threatened goal failure: Change beliefs, plans, or behaviors	Analytic, data-driven processing
Discrete Emotions	Motivational State	Central Information
Happiness	Maintain current state; attain new goals	Broad range of information from general knowledge and the environment
Fear	Avoid or escape threat of goal failure	Sources of threat; means of avoiding threat
Anger	Remove obstacle to goal attainment	Goal; agents obstructing goal attainment
Sadness	Adjust to irrevocable goal failure	Outcomes and consequences of goal failure

cles to their goals, angry people may selectively encode and retrieve information concerning goals and the agents causing goals to be obstructed. This information would be useful for constructing plans to change negative situations and reinstate goals. In contrast, sadness is experienced when people believe that goal failure is irrevocable. When a goal fails and cannot be reinstated, the risks and causes of failure (central information in states of fear and anger, respectively) become irrelevant or peripheral. It becomes essential, however, to understand the outcomes of failure and the consequences that the failure of one goal may have for related goals. In short, experiencing an emotion may influence the salience and accessibility of information relevant to the motivational state associated with that emotion.

According to this view, emotions serve as a powerful organizing force, not just for behavior, but for perception, judgment, and memory (also see Dalgleish, 2004). In the service of responding to the types of circumstances that lead to their elicitation, discrete emotions cause people to become attuned to, and indeed to search for, relevant information. Thus, a frightened person would search the environment and memory for

sources of threat and means of avoiding it; an angry person would search the environment and memory for agents responsible for obstructing their goals and means of removing them. Evidence for this view is accumulating, but most of this evidence comes from research on the effects of discrete emotions on attention and judgment. We summarize these findings below. Although research on the effects of discrete emotions on memory is sparse, we also review several findings from memory research that support this view.

A growing body of research on attention and judgment supports the view that motivations affect memory (McDonald & Hirt, 1997), and that discrete emotions lead to enhanced attention to, and accessibility of, motivationally relevant information (Williams, Mathews, & McLeod, 1996). In the case of fear, we argued that this information would consist of threats and means of avoiding them. Consistent with this view, research on attention and judgment shows that fearful people attend preferentially to threat-related information (Loewenstein, Weber, Hsee, & Welch, 2001; Öhman, Flykt, & Esteves, 2001) and interpret ambiguous situations as threatening (Eysenck, 1997). Additionally, fear and anger, though both arousing, have been shown to have opposite effects on judgments concerning risk. Fear leads to greater estimates of risk and to choices that involve avoiding risk, whereas anger leads to lower estimates of risk and to risk-seeking choices (Lerner & Keltner, 2000, 2001).

Studies comparing the effects of anger and sadness on judgment have shown differential accessibility of information concerning the agents responsible for causing harm and irrevocable loss, respectively. For example, in a study in which participants were asked to render judgments about cases of alleged misconduct, angry participants relied more on heuristic cues concerning the agents responsible for causing harm (i.e., ethnicity) than did sad participants (Bodenhausen, Sheppard, & Kramer, 1994). In another study, inducing anger in participants led to greater estimates of the likelihood of events in which others intentionally caused harm (e.g., being knowingly sold a "lemon" by a dishonest car dealer), whereas inducing sadness led to greater estimates of the likelihood of losses (e.g., a best friend moving away) (DeSteno, Petty, Wegener, & Rucker, 2000).

Research on memory and discrete emotions reveals a similar pattern of findings. Fearful individuals display enhanced memory for threat-related information and poorer memory for threat-irrelevant details. For example, Wessel and Merckelbach (1998) investigated the effects of fear on memory in a sample of spider phobics. Phobic and low-fear control participants were shown a bulletin board to which central (pictures of spiders) and peripheral (pictures of babies and pens) stimuli were attached. Spider phobics displayed an increase in physiological markers

of fear when viewing the display. Later, when asked to recall the display, spider phobics showed enhanced memory for central information and impaired memory for peripheral information (also see Wessel & Merckelbach, 1997). The association between fear and enhanced memory for threatening stimuli has also been noted by investigators assessing the accuracy and completeness of eyewitness testimony. "Weapon focus" refers to witnesses' tendency to focus on and remember the weapon used to commit a crime, often at the expense of memory for other information such as the culprit's face (e.g., Kramer, Buckhout, & Eugenio, 1990; Loftus, Loftus, & Messo, 1987; Steblay, 1992).

It should be noted that, in laboratory studies with humans, fearful people sometimes turn their attention away from threatening stimuli and later show poorer recall or recognition of it (for a review see Minetka, Rafaeli, & Yovel, 2003). In contrast, in animal research, enhanced memory for threatening stimuli is assessed in terms of avoidance behaviors (e.g., ceasing exploration; avoidance of a context in which the animal had an aversive experience). In this literature, the effects of fear on memory are extremely well-documented (e.g., LeDoux, 2000; McGaugh & Cahill, 2003).

But are these memory effects due to fear or simply to arousal? Would witnesses feeling enraged or saddened by a crime in progress, rather than frightened, later remember the threatening weapon or would different types of information be central for those individuals (i.e., the agent committing the crime, the irrevocable losses entailed)? One way to answer this question is to examine the effects of intense but motivationally distinct emotional states on memory. Consistent with predictions from appraisal theory, when individuals in a depressed mood are asked to recall autobiographical events, they tend to focus not on sources of threat, but on negative outcomes such as personal losses and defeats. For instance, Lyubomirsky, Caldwell, and Nolen-Hoeksema (1998) found that, across four studies, moderately sad or depressed individuals recalled more negative autobiographical events (e.g., failing a test, losing a girlfriend, their parents divorce), than did nondepressed individuals.

Levine and Burgess (1997) assessed the effects of happiness, anger, and sadness on the encoding of different types of information in a narrative. Emotions were evoked in undergraduates by randomly assigning grades of "A" or "D" on a surprise quiz. Immediately afterward, students participated in what they believed to be an unrelated study during which they heard and recalled a narrative about a student's first term in college. At the end of the study they were asked to rate how happy, angry, and sad they had felt when they received their quiz grades. In contrast to happy students, who demonstrated enhanced memory for the

narrative as a whole, students who reported feeling primarily sad or primarily angry tended to recall specific types of information. As predicted, sad students recalled significantly more information concerning event outcomes than did angry participants (e.g., "They receive a bad grade on the speech"). Angry students showed a nonsignificant tendency to recall more information about the protagonist's goals than did sad students (e.g., "Mary wants her speech to be really good"). In addition, a significant positive correlation was found between the intensity of anger reported and the amount of goal-related information recalled.

Although caution is appropriate when generalizing from psychopathology to everyday emotional experience, the effects of clinical depression and post traumatic stress disorder (PTSD) on memory may be instructive. Depression and PTSD are both associated with intrusive memories. Consistent with the differing motivations associated with sadness and fear, however, depression is characterized by rumination on past negative events and their consequences for the self, whereas PTSD is characterized by intrusive memories related to past threats to safety (Reynolds & Brewin, 1999; Watkins & Teasdale, 2001). The finding that depressed people sometimes retrieve less specific (i.e., over-general) memories relative to nondepressed controls may seem to conflict with the view that sadness is associated with enhanced encoding and retrieval of information about irrevocable losses and their consequences. Most studies have found, however, that depressed patients have over-general memories for positive rather than negative events (Minetka et al., 2003). Over-general memory for negative events, when found, may be associated with attempts to avoid intrusive memories of losses (Healy & Williams, 1999). For example, Brewin, Watson, McCarthy, Hyman, & Dayson (1998) found that greater over-general memory in depressed cancer patients was associated with reporting more attempts to avoid intrusive memories, typically memories of the deaths of people close to the patient. Recent research demonstrating distinct neural correlates of emotions such as sadness and anxiety is also consistent with the view that understanding the effects of these emotions on memory will require going beyond a focus on general arousal or valence (Liotti et al., 2000; Panksepp, 2000; also see Levenson, 1992).

Further research is needed to identify the mechanisms underlying the effects of discrete emotions on memory. The findings reported above, however, support the view that discrete emotions evoke "appraisal tendencies" (Lerner & Keltner, 2000) as well as "action tendencies" (Frijda, 1987). The types of situations that evoke emotions such as fear, anger, and sadness vary dramatically with respect to the responses required of the individual. Once evoked, these emotions appear to trigger selective processing, encoding, and retrieval of information that is important for

responding to these differing emotion-eliciting situations. The selective encoding and retrieval of motivationally relevant information would typically be adaptive, but depression and anxiety disorders remind us that this is not always the case. As Descartes put it, "the utility of the passions consists alone in their fortifying and perpetuating in the soul thoughts which it is good it should preserve... and again, all the harm which they can cause consists in the fact that they fortify and conserve these thoughts more than necessary" (Article LXXIV, 1649/1989).

So, in what ways might emotions make memory better? With the reader's indulgence, we will sum up by stretching the highlighter metaphor a little further. If happiness serves as a highlighter, it appears to be a broad and inclusive one that increases the salience of a wide swath of information, some from general knowledge, some from the environment. The composite representations that result tend to be vivid and creative but not very discriminating. Negative emotions, on the other hand, may work like fine-tip highlighters that increase the salience of a narrow range of information in the service of either preventing, fixing, or adjusting to goal failure. Given the differing motivations associated with specific negative emotions such as fear, anger, and sadness, the types of information likely to be encoded and retrieved in these states should differ.

CONCLUSIONS

There have been exciting developments in emotion and memory research in the past couple of decades, just a few of which have been addressed in this overview. Nonetheless, the field has progressed to the point that we can address the validity of certain broad claims with confidence. We now know that emotional memories are not indelible. In fact, they are subject to some of the same reconstructive forces as memories for nonemotional events. We also know that emotional events are remembered better than nonemotional events, and that the amygdala plays an important role in this process. Considerable progress has been made toward identifying the mechanisms underlying these findings.

Another area of emotion and memory research, however, is still in its infancy. We have argued that a key next step will be to specify, with more precision, the ways in which emotional information is remembered better. Recent findings from research on appraisal theories of emotion, social-psychological laboratory studies, and even some research on memory, suggest that this step will require taking fundamental properties of emotion into account: Namely, that emotions are responses to changes in the status of goals; that they motivate thoughts and actions directed toward maintaining, preventing, or coping with

those changes; and that specific emotions are associated with different motivations. If the sparseness of the evidence currently available on the effects of discrete emotions on memory has made the reader grumpy too, we apologize. But perhaps grumpiness will enhance memory for a promising research direction: Examining *how* information is remembered (i.e., information processing strategies), and *what* information is remembered, in specific emotional states.

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