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INVITED REVIEW

# Emotion and memory narrowing: A review and goal-relevance approach

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People typically show excellent memory for information that is central to an emotional event but poorer memory for peripheral details. Not all studies demonstrate memory narrowing as a result of emotion, however. Critically important emotional information is sometimes forgotten; seemingly peripheral details are sometimes preserved. To make sense of both the general pattern of findings that emotion leads to memory narrowing, and findings that violate this pattern, this review addresses mechanisms through which emotion enhances and impairs memory. Divergent approaches to characterising information as central versus peripheral are also addressed. By directly contrasting these approaches, and the evidence supporting them, this review helps to clarify when and how emotion enhances memory and provides directions for future research. Evidence shows that memory narrowing as a result of emotion, and a number of violations of the memory narrowing pattern, can be explained by the view that emotion enhances memory for information relevant to currently active goals.

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A wedding, a dispute, a grim diagnosis, a natural disaster ... our most vivid and lasting memories are typically emotional ones. These memories are

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selective, however. Like a spotlight that illuminates the centre of a scene, throwing the periphery into shadow, emotion enhances memory for central features of emotional events but impairs memory for peripheral details. Memory narrowing as a result of emotion has been demonstrated in numerous studies but several sources of controversy remain. Defining "central" is one. What constitutes the core of an emotional event? Does central refer to whatever people happen to be paying attention to at the time they are emotionally aroused? Does it refer only to information that forms an integral part of an emotional event? Or does it refer to information that bodes well or ill for a person's well-being? What constitutes peripheral information, destined to be forgotten? Another source of controversy concerns the mechanisms by which emotion fortifies some memories while allowing others to fade. Extending the scope of these questions, investigators recently have begun to ask whether all emotions, or only particular negative emotions, bring about a trade-off between memory for central and peripheral information. This paper reviews current research and theory on these issues.



We begin by reviewing evidence that emotion promotes memory narrowing. Not all studies show memory narrowing, however. In some cases, people show excellent memory for details of emotional events that might be considered peripheral; in other cases, people show poor memory for information that might be considered central. To make sense both of the general pattern of findings that emotion leads to memory narrowing, and of findings that appear to violate this pattern, we review mechanisms that underlie good memory for central information and poor memory for peripheral details. We also review different approaches to defining information as central versus peripheral. Contrasting these approaches helps clarify when and how emotion enhances memory and provides important directions for future research. We propose that memory narrowing as a result of emotion can be explained by the view that emotion enhances memory for information relevant to currently active goals. Defining central information in terms of goal relevance helps clarify when emotion leads to memory narrowing and when it does not. This approach also leads to specific predictions about the types of information that should be central, and hence well-remembered, in discrete emotional states.

## EMOTION AND MEMORY FOR CENTRAL VERSUS PERIPHERAL INFORMATION

Memory narrowing (e.g., Reisberg & Heuer, 2004), tunnel memory (Safer, Christianson, Autry, & Osterlund, 1998), and the memory trade-off effect (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007a) all refer to the finding

that memory is enhanced for central or core features of emotional events but memory for peripheral or background features is not enhanced and may even be impaired. This phenomenon has been demonstrated in real-world contexts where emotional intensity runs high as well as in controlled laboratory settings involving low levels of emotional intensity. In real-world contexts, people often show lasting and accurate memory for central features of traumatic experiences such as natural disasters (Bahrick, Parker, Fivush, & Levitt, 1998; Sotgiu & Galati, 2007), child sexual abuse (e.g., Alexander et al., 2005), and physical injuries (Peterson & Bell, 1996). For instance, in an examination of children's memory for stressful injuries and resulting emergency-room visits, Peterson and Whalen (2001) found that children were more accurate about central components of their injury experience than about peripheral details concerning their hospital visit. Robbery witnesses similarly showed more accurate memory for central than for peripheral details of the crime (Christianson & Hübinette, 1993; see Kihlstrom, 2006; Reisberg & Heuer, 2007, for reviews).

In the laboratory, enhanced memory has been found for central features of emotional stories, pictures, and word lists. In one early study, Christianson and Loftus (1987) showed people a slide sequence depicting either an emotional event (a boy hit by a car) or a neutral event (a boy passing beside a car), and asked them to write down the essential feature in each slide. Later, people who had viewed the emotional slide sequence were better able to recall these essential features than those who had viewed the neutral sequence; they were less able, though, to recognise the particular slides they had seen. Details that would have allowed them to distinguish between similar emotional slides were not well preserved in memory. Similar effects have been shown in studies of memory for unrelated emotional images. Kensinger et al. (2007a) had people view pictures of an emotionally aversive object against a neutral background (e.g., a snake by a river) and pictures of a neutral object against a neutral background (e.g., a chipmunk in a forest). People were better at remembering emotional than neutral objects. They showed worse memory, though, for neutral backgrounds of emotional objects than for neutral backgrounds of neutral objects.

Studies of very simple emotional stimuli have shown enhanced memory for information that constitutes a spatially integral part of the stimulus, such as the colour of the font in which an emotional versus neutral word was presented (MacKay & Ahmetzanov, 2005), or the location of an emotional word on a computer screen (Mather, 2007; Mather & Nesmith, 2008). Moving from spatial to temporal proximity, there may be a memory advantage for information encountered during rather than before or after an emotional event, though the length of this temporal window has yet to be determined (e.g., Burke, Heuer, & Reisberg, 1992; Schmidt, 2002). Strange, Hurleman, and Dolan (2003) presented people with lists of neutral words, each of which

included an embedded emotional word (e.g., murder). People were better at remembering emotional than neutral words, but memory was worst for the neutral word that immediately preceded an emotional word. Impaired memory for the word preceding an emotional word did not appear to be due to distinctiveness since words in distinctive colours or fonts did not impair memory for preceding words. Taken together these findings suggest that, both in the real world and in the laboratory, information that is central to an emotional stimulus, conceptually, spatially, or temporally, is likely to be remembered whereas information that is removed may not.

Evidence that emotion leads to a trade-off between memory for central and peripheral information is not as uniform as it may appear from the findings reviewed above, however. In some cases, emotion enhances memory for details that may be considered peripheral. For example, people presented with slides and narratives that evoked an empathic emotional response to the plight of the protagonist showed good memory for details as well as central events (Laney, Campbell, Heuer, & Reisberg, 2004). In other cases, emotion or stress impairs memory for information that could be considered central. Soldiers who endured an extremely stressful interrogation as part of military survival training, including food and sleep deprivation and physical confrontation, were less likely to recognise their interrogator than soldiers who underwent a less stressful interrogation (Morgan et al., 2004; also see Deffenbacher, Bornstein, Penrod, & McGorty, 2004). To make sense of emotion-induced memory narrowing, and of results that violate this pattern of findings, it is necessary to be more explicit about the mechanisms that underlie accurate and lasting memory for emotional material and poor memory for peripheral detail. It is also necessary to be more explicit about how to characterise the types of information that are integral, as opposed to peripheral, to an emotional event or stimulus. Below we address these issues in turn, beginning with mechanisms that underlie enhanced memory for emotional information.



## HOW EMOTION ENHANCES MEMORY

Unlike memories of neutral events, which fade quickly over time, memories of emotional events are often well preserved after delays as brief as minutes and as long as years. This is because emotion enhances information processing at multiple stages and in multiple memory systems. Research indicates that emotional and non-emotional information differ with respect to how quickly they are detected, how long they remain the focus of attention, how long they are retained, and how likely they are to be retrieved.

## Capturing attention

It is well-documented that people mull over and talk about emotional events after they have occurred, and that rehearsal aids memory (e.g., Finkenauer et al., 1998; Rimé, Mesquita, Philippot, & Boca, 1991). This raises the question of whether ordinary memory mechanisms such as rehearsal fully account for enhanced memory for emotional events (e.g., McCloskey, Wible, & Cohen, 1988). To find out, Hulse, Allan, Memon, and Read (2007) showed people an emotional video about a woman being attacked and a neutral video. About 10 minutes later, memory for the videos was assessed. An intervening task before memory assessment prevented people from rehearsing the videos. Eliminating the opportunity for rehearsal, however, did not eliminate the memory advantage for the emotional video after this brief delay (also see Harris & Pashler, 2005). Thus, early information processing, prior to rehearsal, likely contributes to enhanced memory for emotional information.

Studies measuring event-related potentials (ERPs) bear this out. Measurements of electrical changes over the scalp immediately after a stimulus is presented indicate that emotion impacts even the earliest stages of information processing. When presented with emotional versus neutral stimuli, people react to the emotional stimuli faster—within the first 100 to 300 milliseconds after exposure (e.g., Kissler, Herbert, Peyk, & Junghofer, 2007; Koster, Crombez, Verschuere, Vanvolsem, & De Houwer, 2007). Indeed, even before people are aware that they have perceived a stimulus, its emotional value can produce an autonomic response and influence evaluative judgements. For example, Öhman and Soares (1998) found that fear-conditioned visual stimuli evoked an autonomic response even though stimuli were backward masked and presented so briefly that people were unable to identify what they had seen. Thus registration of emotional significance occurs very rapidly.

Emotional information is also more likely to reach conscious awareness than neutral information. It can be difficult to detect a visual stimulus if it follows too closely after the presentation of a preceding visual stimulus—a finding referred to as the "attentional blink". If subsequent information is emotional, though, people are more likely to detect it (e.g., Anderson & Phelps, 2001). People are also faster at shifting attention to the spatial locations of emotional words than neutral words (Stormark, Nordby, & Hugdahl, 1995). Greater attention to emotional than neutral pictures has been shown to account in part (though not entirely) for the greater memorability of emotional pictures after brief delays (e.g., Talmi, Anderson, Riggs, Caplan, & Moscovitch, 2008). Relative to neutral stimuli, then, emotional stimuli benefit from faster, more efficient, and more extensive early processing (see Compton, 2003; LaBar & Cabeza, 2006; Mather, 2007, for reviews).

## Working memory

Given emotion's effects on preattentive processes and on attention, it is reasonable to hypothesize that emotion should similarly enhance working memory, providing another pathway to accurate and lasting memory. Working memory refers to the processes involved in the short-term maintenance, manipulation, and rehearsal of information. It serves as the gateway for long-term retention and retrieval (Baddeley & Logie, 1999). Few studies have examined working memory for information with emotional content, however, and the evidence generated by these studies is mixed.

Edelstein (2006) examined individual differences in working memory for information varying in emotional valence and relevance to close relationships. People were asked to remember several series of words (which were matched for semantic relatedness) while solving simple math problems. The number of to-be-remembered words became progressively longer throughout the task, placing an ever-greater demand on working memory. The results showed that working memory capacity was higher for positive and negative emotional words than for neutral words. Interestingly, one group of participants proved an exception to the general tendency to hold more emotional words in working memory. People with an avoidant attachment style, who are motivated to avoid relationships (e.g., Edelstein et al., 2005), showed impaired working memory capacity for those emotional words that had relationship-related themes. Overall, then, people were able to hold more emotional than neutral words in working memory but individual differences in goals moderated this effect.

Other findings, however, show no advantage or a disadvantage for emotional stimuli in working memory. Kensinger and Corkin (2003) compared working-memory performance for negative, positive, and neutral information. Several working-memory tasks were used across five studies including backward and alphabetical word-span tasks (in which people must repeat a series of presented words in reverse or alphabetical order, respectively), and *n*-back tasks (in which people must indicate whether a stimulus was presented *n* trials previously). The information to be remembered varied across studies and included both emotional words and pictures. With the exception of one task, an *n*-back task employing emotional faces, in which emotion hindered working memory, task performance was unrelated to the emotional content of the stimuli. When long-term memory for the same stimuli was assessed, however, the typical enhancement of memory for emotional versus neutral information was obtained. It should be noted, though, that unlike the working-memory tasks, assessments of long-term memory required people to retain only the emotional items themselves and not contextual information such as the order in which the items appeared.

Together, these studies paint a mixed picture of the effects of emotion on working memory. Further research is clearly needed to elucidate the conditions under which emotion enhances and impairs working memory. Kensinger and Corkin (2003) argued that the differing effects of emotion on working versus long-term memory may reflect the different processes that benefit these two memory systems. For instance, elaborating on emotional stimuli may promote long-term retention but may lessen the amount of emotional information that can be maintained in working memory. Another possibility is that working-memory tasks that require people to remember only emotional items themselves show enhancement (e.g., Edelstein, 2006) whereas working-memory tasks that require maintaining information that is not integral to the emotional items, such as the order in which they were presented or their locations relative to each other, do not (Kensinger & Corkin, 2003). Thus, a challenge for future research will be to vary, not just whether or not the items to be remembered are emotional, but also whether the working-memory task requires maintenance of central or peripheral information about those items. Edelstein's (2006) findings also suggest that assessments of people's goals in emotional situations (e.g., goals to approach or avoid relationships) may provide important information about the conditions under which emotion facilitates or hinders working memory (also see Rusting & Larsen, 1998; Yuille & Daylen, 1998).

Investigators have also examined the amount of time that information remains in working memory and the depth with which information is processed. Results show that emotional stimuli benefit from increased rehearsal in working memory. Indeed, the more relevant information is to people's goals, the more time they spend thinking about it. For example, extroverts, who tend to set goals to attain positive outcomes, dwell longer than introverts on stimuli associated with reward. Introverts and anxious people, who tend to set goals to avoid negative outcomes, dwell longer on, and have greater difficulty disengaging their attention from, stimuli associated with threat (Derryberry & Reed, 1994; Fox, Russo, Bowles, & Dutton, 2001; Mineka, Rafaeli, & Yovel, 2003). Once a stimulus has attracted attention, then, emotional information is more likely than neutral information to hold attention and be rehearsed in working memory, increasing the likelihood that it will be stored in long-term memory.

## Long-term memory

We have seen that emotional stimuli are more likely than neutral stimuli both to attract attention and to remain the focus of attention. These influences promote the encoding of emotional material, resulting in memory enhancements that are evident at brief delays (Ochsner, 2000; Sharot & Phelps, 2004). Over time, memory advantages for emotional material are further

augmented while memory for neutral material tends to fade. For example, after controlling for differences in attention, Sharot and Phelps (2004) found no differences between memory for emotional and neutral words on an immediate recognition test but better memory for emotional than neutral words after a 24-hour delay. Other studies have also shown that the retention advantage for emotionally arousing words relative to neutral words is greater when memory is tested after delay periods ranging from an hour to a day than after delays of minutes (Kleinsmith & Kaplan, 1963; LaBar & Cabeza, 2006; LaBar & Phelps, 1998).

Distinctiveness and rehearsal contribute to (e.g., Finkenauer et al., 1998), but are not sufficient to explain, enhanced memory for emotional stimuli after long delays. With respect to distinctiveness, different neural processes are associated with accurate memory for emotional stimuli versus stimuli that are affectively neutral but distinctive. Specifically, accurate memory for emotional stimuli is predicted by correlated activity in the amygdala, hippocampus, and orbitofrontal cortex during encoding; accurate memory for distinctive stimuli is primarily associated with activity in the hippocampus (e.g., Hamann, Ely, Grafton, & Kilts, 1999). With respect to rehearsal, Guy and Cahill (1999) had people watch a series of emotional and neutral film clips and recall the topics of the films a week later. Regardless of whether people were told to talk about the films during that week, or were told not to talk about them, they recalled more emotional than neutral films. Thus, just as rehearsal does not fully account for enhanced memory for emotional events after brief retention intervals (Harris & Pashler, 2005; Hulse et al., 2007), it does not fully account for enhanced memory for emotional events after a delay.

Retention of emotional events also benefits from greater consolidation of information in long-term memory. For a period of time following encoding, memories are particularly subject to loss. Consolidation refers to a biochemical process, involving activation of hormonal and brain systems, that strengthens memories and renders them more likely to endure. When events evoke emotions, the sympathetic nervous system releases hormones such as epinephrine. These hormones in turn activate noradrenergic systems in the basolateral amygdala, which mediate consolidation of long-term memory in other brain regions (Cahill, Prins, Weber, & McGaugh, 1994; see McGaugh, 2004, for a review). The amygdala plays a critical role in this strengthening of emotional memories. For example, infusing norepinephrine directly into the basolateral amygdala enhances long-term memory for emotional events. Inactivating this region, using lesions or drugs, attenuates the enhancing effects of such hormones on memory (McGaugh, 2004). Thus, distinctiveness, rehearsal, and consolidation all contribute to long-term retention of emotional events.

## Retrieval

In contrast to the large body of research on attention and encoding processes, relatively little research has addressed the effects of emotion on memory retrieval in humans. This research indicates that emotional information is more reliably retrieved than neutral information, and suggests overlap in brain regions, such as the amygdala, involved in the encoding and retrieval of emotional information (e.g., Buchanan, 2007; Dolan, Lane, Chua, & Fletcher, 2000; Dolcos, LaBar, & Cabeza, 2005; Maratos, Dolan, Morris, Henson, & Rugg, 2001). In one study, emotional pictures were more accurately recognised than neutral pictures, even after a one-year delay. Greater activity in the amygdala and hippocampus at retrieval was associated with the more accurate recollection of emotional pictures (Dolcos et al., 2005). Similarly, when retrieving autobiographical memories, greater emotional intensity and personal significance were associated with greater retrieval accuracy and with activation in several brain regions including the amygdala (Daselaar et al., 2008; Sharot, Martorella, Delgado, & Phelps, 2007).



It can be difficult, though, to disentangle effects of emotion on encoding versus retrieval. Insofar as emotional information initially captures attention and promotes encoding, more accurate retrieval of emotional than neutral information could simply be due to these initial processing differences (Maratos et al., 2001). Moreover, most recognition memory tasks present emotional stimuli such as pictures both at study and at test. Thus, activation of particular brain regions at test could be due to re-exposure to emotional stimuli as part of the recognition test rather than to processes involved in the retrieval of emotional stimuli. To begin to address this issue, Smith, Stephan, Rugg, and Dolan (2006) examined recognition memory for neutral pictures (e.g., tools, clothing) that had been superimposed at encoding on emotional or neutral backgrounds. At retrieval, memory was tested only for the neutral pictures and not for the backgrounds with which they had been encoded. In this way, retrieval of information studied in emotional versus neutral contexts could be assessed, without presenting the emotional stimuli again at retrieval. Smith et al. found greater recognition accuracy for pictures that had been studied in emotional compared to neutral contexts. Brain activity during retrieval, assessed using fMRI, also differed depending on the context in which items were studied. Activation in the hippocampus and amygdala was more highly correlated when items studied in emotional contexts were retrieved; a finding similar to those obtained during the encoding of emotional images (e.g., Dolan, 2002; Hamann, Ely, Hoffman, & Kilts, 2002).

Buchanan (2007) suggested that reminders of an emotional event during retrieval elicit affective states comparable to those experienced when the event was initially experienced and encoded. Thus, similarities in brain activity during emotional encoding and retrieval may reflect the common

emotional experience occurring at these two stages of information processing. Although the evidence so far suggests considerable overlap in the processes supporting encoding and retrieval of emotional information, most studies consider the various stages of information processing in isolation rather than manipulating processes occurring at different stages in the same study. Thus, further work is needed to gauge the relative contributions of encoding and retrieval processes to enhanced memory for emotional information. Changes in the goals that experimenters set for participants (e.g., increasing or decreasing the incentive value of stimuli) can render information that was emotional at the time of encoding insignificant at the time of retrieval; such changes can also imbue information that was emotionally neutral at the time of encoding with emotional significance at the time of retrieval. In future research, by systematically varying the emotional significance of stimuli at encoding and retrieval, it may be possible to further tease apart the effects of emotion on these two memory processes.

How, then, is memory enhanced for central features of emotional events? Further research is needed to clarify the effects of emotion on working-memory capacity and to disentangle effects of emotion on retrieval from those on encoding. It is well established, though, that events with emotional significance receive privileged processing in several memory systems. Preferential access to early information-processing resources, more rehearsal, greater consolidation, and the presence of retrieval cues all contribute to enhanced memory for emotional information relative to neutral information.



## HOW EMOTION IMPAIRS MEMORY

The other piece of the memory-narrowing puzzle is that neutral information can be especially poorly remembered when it appears in proximity to an emotional stimulus or event (e.g., Burke et al., 1992; Kensinger et al., 2007a; Touryan, Marian, & Shimamura, 2007). The negative effect of emotion on memory for peripheral details can be attributed, at least in part, to neglect. If attention is directed toward emotional stimuli, information that is not emotional does not receive as much attention and is less likely to be encoded (e.g., Compton, 2003; Öhman, Flykt, & Esteves, 2001). If encoded, neutral information may not be rehearsed or processed deeply, making storage in long-term memory less likely (e.g., Finkenauer et al., 1998). In long-term memory, neutral information does not benefit from amygdala activation that promotes consolidation (e.g., Cahill et al., 1994; LaBar & Phelps, 1998). Indeed, the same adrenergic mechanisms that subserve consolidation of memory for central emotional information contribute to the neglect of

peripheral details (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007b; Strange et al., 2003). At retrieval, people tend to dwell on information they consider important and relevant to their well-being, providing retrieval cues for emotional information. Fewer retrieval cues are available for neutral information (e.g., Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998). To the extent that attention and memory processes are limited in capacity, then, emotional information dominates processing, leaving fewer resources for peripheral details.

Memory impairment can also result from stress (e.g., Deffenbacher et al., 2004; Morgan et al., 2004). Stressful events are those that not only elicit arousal (leading to the release of norepinephrine in the basolateral amygdala), but also activate the hypothalamus pituitary adrenal axis, leading to the release of glucocorticoid stress hormones. Norepinephrine release has been shown to enhance memory (McGaugh, 2004), but over an extended period of time, glucocorticoids can damage brain structures, including the hippocampus, necessary for encoding coherent episodic memories with contextual details (e.g., Belanoff, Gross, Yager, & Schatzberg, 2001; McEwen & Sapolsky, 1995).

With respect to acute stress, a range of elicitors (e.g., trauma, glucocorticoid administration, public speaking, and, in rats, footshock) has been shown to impair working memory (e.g., Klein & Boals, 2001; Morgan, Doran, Steffian, & Southwick, 2006; Oei, Everaerd, Elzinga, Van Well, & Bermond, 2006) and retrieval (e.g., Het, Ramlow, & Wolf, 2005; Roozendaal, 2002), though this work has not assessed memory for information related to the source of stress. Findings concerning the effects of acute stress on encoding and memory consolidation have been mixed. Some research shows that acute stress can either hinder or improve memory for material such as word lists and pictures, depending on moderating variables such as natural variations in cortisol levels in the morning versus afternoon (Het et al., 2005). Other research shows that acute stress accompanied by arousal enhances encoding and consolidation (Roozendaal, 2002; Roozendaal, Okuda, Van der Zee, & McGaugh, 2006), particularly when the information being encoded is emotional (Buchanan & Lovallo, 2001; Cahill, Gorski, & Le, 2003; Payne et al., 2006; but see Kuhlmann, Piel, & Wolf, 2005). Thus, the effects of acute stress on memory are complex and appear to vary depending on the memory processes involved (working memory and retrieval versus encoding and consolidation), the level of stress hormones, and the type of information being remembered. Long-term, chronic stress, however, reliably impairs memory.

Finally, emotion can impair memory by launching efforts directed at regulating distress. Several forms of emotion regulation, including distraction and expressive suppression, impair memory for emotional events (Edelstein, 2006; Raes, Hermans, Williams, & Eelen, 2006; Richards & Gross, 2000,

2006). For example, people who suppress behavioural displays of emotion, either habitually or following experimental instructions, have worse memory for emotion-eliciting events than people who do not use this regulatory strategy (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Richards & Gross, 2000, 2006). Thus, emotion regulation strategies that focus attention away from emotional events impair memory for these events.

In summary, emotion can enhance and impair memory via a range of mechanisms. Preferential access to early information-processing resources, rehearsal, consolidation, and the presence of retrieval cues all contribute to enhanced memory for emotional information relative to neutral information. Because the capacities of attention and working memory are limited, emotional information can dominate processing leaving fewer resources for peripheral details. Thus, the source of emotional arousal benefits from privileged processing, resulting in the typical pattern of enhanced memory for core features of emotional events and poorer memory for peripheral features (e.g., Adolphs, Denburg, & Tranel, 2001; Burke et al., 1992; Cahill et al., 1994; Christianson, 1992; Kensinger et al., 2007a; Safer et al., 1998).

Complicating the picture, though, emotion sometimes enhances memory generally, including both central and peripheral information (Hulse et al., 2007; Laney et al., 2004), and sometimes impairs memory generally (Deffenbacher et al., 2004; Morgan et al., 2004). One way to account for these varying effects of emotion focuses on the intensity of emotional arousal (e.g., Yerkes & Dodson, 1908). At low to moderate levels of arousal, emotion may enhance memory across the board. As the intensity of arousal increases, the range of stimuli to which an organism can attend may decrease (Easterbrook, 1959) resulting in poor memory for peripheral information. At extremely high levels of arousal, the range of attention may be so narrow as to impair memory generally. Several findings lead us to question this explanation, however. Memory narrowing has been demonstrated repeatedly in the laboratory with stimuli such as emotional words and pictures that elicit low or moderate levels of arousal (Mather, 2007). Memory narrowing has also been demonstrated with traumatic events, such as injuries leading to emergency-room visits that likely elicited a high level of arousal (e.g., Peterson & Whalen, 2001; see Reisberg & Heuer, 2004, for a review). Thus the intensity of emotional arousal alone is not sufficient to explain when emotion enhances, and when it impairs, memory.

Taking another approach, Christianson (1992) argued that studies showing memory enhancement as a result of emotion have focused on the accuracy of memory for the central or core features of emotional events whereas studies showing memory impairment have focused on errors in memory for peripheral details. This leads directly to a critical question: What are the core features of emotional events? What types of information are central versus peripheral to a person experiencing emotion? To understand

emotional memory narrowing, it is essential to address not only "how" the emotional spotlight works (mechanisms through which emotion enhances and impairs memory), but also "what" the emotional spotlight illuminates and what it excludes.

## DEFINING CENTRAL AND PERIPHERAL INFORMATION

Investigators differ about the best way to characterise the types of information that are "central" and preserved in memory as a result of emotion, and the types that are "peripheral" and unlikely to be encoded or retained. Table 1 summarises some important approaches. Central information has been characterised as: (a) information that captures an emotionally aroused person's attention; (b) information that constitutes an integral part of an emotional stimulus, either spatially, temporally, or conceptually; and (c)



TABLE 1
Common definitions of central features of emotional events and examples of research or reviews using each definition

| *Central features* | *Definition* | *Examples* | *Research* |
|---|---|---|---|
| Attention magnets | Features of an emotional event that capture a person's attention | A car accident; a bloody face; a weapon; erotic images | Laney et al., (2003, 2004); Reisberg & Heuer, (2004) |
| Spatially integral features | Features that are perceptually or spatially part of, rather than distant from, an emotional event | Colour of an injured person's clothing; location of an emotional picture on a computer screen | Christianson & Loftus, (1991); Mather & Nesmith, (2008); Safer et al., (1998) |
| Temporally integral features | Features that occur during, rather than before or after, an emotional event | Pictures of a car accident or nude model rather than preceding or subsequent pictures | Burke et al., (1992); Schmidt, (2002); Strange et al., (2003) |
| Conceptually integral features | Gist or features that cannot be changed without changing the basic nature of the emotional event | A child's experience of being injured; a picture of a surgeon operating on an accident victim | Adolphs et al., (2001); Heuer & Reisberg; (1990); Peterson & Whalen, (2001) |
| Goal-relevant features | Features of an emotional event that increase or decrease the likelihood of goal attainment or change the salience of a goal | Person who caused a valued project to fail; consequences of failure; images signalling loss or threat, or eliciting desire | Compton, (2003); Gable & Harmon-Jones, (2008); Levine & Burgess, (1997); Levine & Pizarro, (2004) |

information that is relevant to currently active goals. These three perspectives, which are described in detail below, are not mutually exclusive and many investigators identify information as central using combinations of these definitions. Moreover, as can be seen in Table 1, certain features of emotional events (such as a gruesome injury) are considered central under a variety of definitions. Different predictions follow from each approach, however. By laying out these predictions and examining the extent to which current data support them, we hope both to sharpen understanding of emotional memory narrowing and to encourage further research on this issue.

## Attention magnets

According to Laney, Heuer, and Reisberg (2003), the general effect of emotion on memory is to make it better. Emotion enhances memory for whatever information a person is attending to at the time they are emotionally aroused. This attentional focus may be narrow but is not necessarily so. Impaired memory for peripheral detail is most likely to occur in the presence of a shocking visual stimulus that dominates attention. Laney et al. point out that most situations in which memory narrowing has been observed include a specific gruesome or shocking stimulus (e.g., a child whose legs have been severed, a bloody face, or a weapon). Thus memory narrowing may not be due to emotion per se but rather to the presence of stimuli that are visually unusual or striking and serve as what Laney et al. called "attention magnets", becoming the focus of subsequent recall. If so, emotional events that lack attention magnets should not produce memory narrowing (see Reisberg & Heuer, 2007, for a review).

To test this hypothesis, Laney et al. (2004) showed people a slide sequence with an accompanying narrative that elicited emotion by virtue of empathy with the characters rather than through the use of shocking or gory images. People in neutral and emotional narrative groups viewed slides that were identical except for one slide late in the sequence. The neutral narrative group heard about a woman who felt relaxed and happy about going on a date, had a pleasant time, and later called her friend to tell her about the date. The emotional group also heard about a woman going on a date but early warning signals aroused the woman's apprehension about the man. He later attacked her and she called her friend to discuss her distress. Significant differences in heart rate suggested that the emotional group was more aroused by the narrative than the control group. Memory was tested for the slides and narratives. No evidence of memory narrowing was found for the emotional narrative group. Instead, people remembered the slides accompanied by emotional stories better than those accompanied by the neutral stories, including both central and peripheral details. In a second experiment, the emotional and neutral narrative groups viewed identical slides that

were presented for a fixed length of time. The emotional narrative described a college student's problems and suicidal thoughts; the neutral narrative described her doing well in school and having a birthday. Again, people remembered more central and peripheral information from the emotional story than from the neutral story.

The authors concluded that memory narrowing is not an inevitable outcome of emotional arousal and does not occur when emotion is elicited by involvement with unfolding events rather than by a visually salient target. To find out whether naturally occurring emotional events typically include attention magnets, Laney et al. (2003) asked people to provide detailed descriptions of autobiographical events that elicited intense emotion. They coded the descriptions with respect to whether or not they included a clear visual focus or attention magnet (e.g., blood, gore, a weapon). Memories without a clear visual focus were classified as "thematic" (e.g., a phone call in which a participant learned that her father had died; a marriage proposal). The vast majority of the memories collected lacked shocking visual images and instead focused on human concerns such as love, death, beauty, and sex. They conclude that, to the extent that naturally occurring emotional events typically lack attention magnets, memory narrowing may be the exception rather than the rule—an artefact of the way in which emotion and memory experiments are often conducted in the laboratory.

This is an important claim that invites further research. Memory narrowing has been found for emotional events outside of the laboratory (e.g., Bahrick et al., 1998; Peterson & Bell, 1996; Peterson & Whalen, 2001; Sotgiu & Galati, 2007). It is not known though whether these events included images that served as attention magnets. Thus, research is needed to assess the extent to which real-world emotional events include attention magnets, and to assess the extent to which emotional events without vivid sensory experiences produce memory narrowing. The views outlined by Laney et al. (2003) also raise the question of why certain stimuli and not others serve as attention magnets. What is it about gory images, for example, that make them so riveting? Does emotion enhance memory for any information to which a person is attending at the time they are emotionally aroused or only for specific types of information? Two other approaches to defining central information take up these questions.

## Integral features of emotional events

Investigators have also defined central information as features that are integral to an emotional event. Integral features can be spatially part of, rather than distant from, an emotional event; temporally integral, occurring during, rather than before or after, an emotional event; or conceptually integral, consisting of the gist or elements that cannot be omitted or altered

without changing the basic nature of the event (e.g., Adolphs et al., 2001; Adolphs, Tranel, & Buchanan, 2005; Burke et al., 1992; Christianson & Loftus, 1991; Heuer & Reisberg, 1990; Kensinger & Schacter, 2006a). Drawing on Easterbrook's (1959) cue-utilisation hypothesis, Christianson (1992) argued that attention to information that elicits an emotional response, and elaboration on that information, enhances memory. Because emotion-eliciting information dominates processing, memory for other information suffers.

Extending this view, investigators have recently posited that the effects of arousal on encoding depend on the type of association being encoded. In an excellent review of laboratory research on memory for emotional images and words, Mather (2007) noted that forming a representation of a single stimulus and its integral features (e.g., the colour of an emotional image) involves different processes than forming a representation of the associations between different stimuli or between a stimulus and its context. She argued that attention to the source of emotional arousal is likely to promote the binding of intrinsic features of an emotional stimulus into a coherent representation during initial encoding and in working memory. This would enhance long-term retention of emotional events. Maintaining contextual associations among different stimuli is taxing, though, and requires focusing on the big picture. So, attention allocated to intrinsic features of an emotional stimulus is likely to interfere with the formation of other associations in working memory, making it more difficult for these associations to be encoded (also see Kensinger & Schacter, 2006a; Mather et al., 2006).

In support of this view, laboratory research on memory for emotional words and images shows that, in general, information that can be considered an intrinsic part of an emotional stimulus, such as the colour and location of emotional objects, is preserved in memory (e.g., MacKay & Ahmetzanov, 2005; Mather & Nesmith, 2008; see Mather, 2007, for a review). In contrast, the presence of an emotional stimulus either impairs or has no effect on memory for separate but associated stimuli and contextual information. For example, Kensinger and Schacter (2006a) examined people's memory for emotional and neutral words and for source judgements about those words. As each word was presented, people were asked whether the word referred to something animate, or they were asked whether the word referred to something commonly encountered. People later remembered the emotional words better than the neutral words but emotion did not enhance memory for the judgements they had made about the words. Moreover, greater amygdala activity was associated with successful encoding of emotion words but not with successful encoding of source judgements.

In another study, Touryan et al. (2007) showed people negative pictures (e.g., a robbery on a subway) and neutral pictures, each of which included an unrelated neutral object that had been added in the corner of the picture

(e.g., mitten, feather). Memory was tested for the pictures and for whether people could match pictures to the correct neutral objects. People remembered emotional pictures better than neutral pictures. They displayed equivalent memory for the neutral objects displayed in the corner of emotional and neutral pictures. But people's memory for which neutral object appeared with which picture was worse for emotional than for neutral pictures. These findings suggest that associations among items are harder to remember than the items themselves. When information is not an integral part of an emotional stimulus, memory for its association with the emotional stimulus is impaired.

But what constitutes an integral part of an emotional stimulus? Mather (2007) suggested that perceptual principles such as continuity, similarity, and closure may help to make that determination when the emotional stimuli in question are simple images or words. As one moves to even slightly more complex stimuli such as emotional words embedded in sentences, however, the issue of identifying the constituent features of the emotional stimulus becomes far from trivial. It becomes more difficult still as one considers real-world emotional experiences. Taking sentences as an example, Brierley, Medford, Shaw, and David (2007) had people read statements such as, "the sailor was responsible for the rape", which contained an emotional target word (rape) and a neutral word (sailor). Another group read neutral statements containing the same neutral word such as, "the sailor was responsible for the dock". Surprise memory tests showed that people remembered emotional words better than neutral words. But memory for neutral words (e.g., sailor) was enhanced when the neutral words had been presented in a sentence that contained an emotional word. The investigators suggested that neutral words that are embedded in sentences with emotional words become semantically associated with the emotion words; the whole sentence thus picks up an "emotional flavour", resulting in enhanced memory. This study thus highlighted the need to better understand the types of information that are an integral part of an emotional stimulus and the types that are truly peripheral.

Moving to stimuli that more closely approximate emotional events, several investigators have suggested that the features that will be bound together in memory as constituent parts of an emotional stimulus may depend on a person's goals (e.g., Compton, 2003; Levine & Pizarro, 2004; Mather, 2007; Ochsner, 2000; Reisberg & Heuer, 2004). This is a promising approach that may prove to explain violations of the pattern of results showing memory narrowing. For example, Wessel, van der Kooy, and Merckelbach (2000) presented people with a series of slides about a student on the way to the university to take an exam. Groups viewed one of three versions of the slide sequence, which were identical except for a critical slide that depicted a girl on a pedestrian crossing. The girl was either lying down

and bleeding from a head injury (emotional), in a gymnastic position (unusual), or walking (neutral). In this critical slide, features of the girl were considered to be central information; a pink bicycle at the margin of the slide served as the peripheral detail. In a cued recall task, the crossing slide was presented without the girl or the bicycle. People were asked to recall the missing items in as much detail as possible including their colour, shape, size, and position. In contrast to previous findings (Christianson & Loftus, 1991), people who viewed the emotional slide did not show enhanced memory for central information, nor did they display impaired memory for peripheral information. The information defined as central in this study (e.g., the colour of the injured girl's shirt; the location of the injured girl on the crossing) were spatially integral parts of the emotional image. But, as the investigators pointed out, this information may not have been well remembered because it had no significance for the theme or goal activated by the image, which likely concerned the girl's well-being.

In summary, Mather's (2007) review showed that intrinsic features of emotional stimuli are most likely to be bound together and retained in memory. In light of this finding, it becomes essential, as we move from considering simple stimuli such as emotional words and images to more complex emotional sentences and events, to determine what features constitute an integral part of an emotional stimulus. Turning to the suggestion that goal relevance may be important, we consider evidence for this next.



## Goal relevance

According to functional theories of emotion, goals are at the heart of what it means for an event to be emotional. Goals are states that people want to attain or avoid. They can be universal (e.g., survival, nurturing offspring, maintaining social relationships, avoiding injury), situation specific (e.g., catching a flight), or person specific (e.g., avoiding heights). People are attuned to the relevance of incoming information for their goals. They experience emotions when they perceive that a goal has been attained or obstructed and it becomes necessary for them to revise prior beliefs or construct new plans. Once evoked, emotions are thought to direct subsequent cognition in a manner that is likely to be useful for preventing, altering, or adjusting to the change in the status of their goals (Arnold, 1960; Frijda, 1987; Lazarus, 1991; Lerner & Keltner, 2000; Oatley & Johnson-Laird, 1987; Scherer, 1998; Stein & Levine, 1987). Given limitations on attention and working memory, it is adaptive to prioritise processing of those features of emotional events that facilitate or obstruct goals (see Compton, 2003; Levine & Pizarro, 2004, for reviews). So, "central" information may be information that is relevant to currently active goals.

What determines whether information is goal relevant and hence likely to be remembered? Relevant information has been defined as that which furthers or impedes the likelihood of accomplishing a goal (Gorayska & Lindsay, 1993; Hjørland & Sejer Christensen, 2002) or changes the salience or importance of a goal (Evans & Over, 1996). Rather than being "all or none", goal relevance is a matter of degree and depends on context. At any given time, people are assailed by information from multiple sources that could have at least some relevance to one of their goals, but they cannot attend to it all. Sperber and Wilson (1995, p. 252) argued that, "what makes an input worth picking out from the mass of competing stimuli is not just that it is relevant, but that it is *more* relevant than any alternative input available to us at that time". In a laboratory study, then, a picture of a skull embedded in a series of neutral pictures is likely to be noticed and remembered. In this context—impoverished of goal-relevant information other than the participant's goal of earning partial course credit—the skull at least increases the salience of the universal goal of survival. The same picture, encountered flipping through a magazine while waiting for a late plane is unlikely to be noticed, and, if noticed, unlikely to be remembered later. In that context, other information such as the implications of missing a connecting flight, announcements from airline personnel, and whether passengers are lining up to board, is more relevant. Because information processing capacity is limited, the information most relevant to a person's goals in a given context is likely to be noticed and remembered, whereas less-relevant information is likely to be ignored or quickly forgotten (Sperber & Wilson, 1995).

Several investigators have argued that goal relevance plays a role in emotional memory narrowing (e.g., Compton, 2003; Conway & Pleydell-Pearce, 2000; Davis, Quas, & Levine, 2008; Lang, Bradley, & Cuthbert, 1997; Levine & Pizarro, 2004; Mather, 2007; Ochsner, 2000; Öhman et al., 2001; Reisberg & Heuer, 2004). It is well documented that people's goals influence the salience of information in memory and the information-processing strategies they use. Moreover, certain findings concerning the effects of goals on memory map remarkably well onto the emotional memory narrowing effect. For example, not only does goal-relevant information capture attention and remain highly accessible in memory, the accessibility of information relevant to fulfilled and competing goals may actually be suppressed. We review these findings below and then discuss how they lead to specific predictions about emotional memory narrowing.

Emotional information may capture attention because it is relevant to people's goals. People are often functionally blind to irrelevant stimuli they encounter if they are performing an attention-demanding task at the same time; a phenomenon known as "inattentional blindness". Stimuli related to a person's current goals or interests, though, tend to escape inattentional

blindness (Koivisto & Revonsuo, 2007). Thus, preattentive processing of goal-relevant information may allow people to notice the kinds of things in which they are currently interested, including emotional stimuli. The tendency for emotional information to activate the amygdala is also modulated by the extent to which that information is relevant to a person's goals. During functional magnetic resonance imaging (fMRI), Cunningham, Van Bavel, and Johnsen (2008) had participants rate their reactions to famous people (e.g., Adolph Hitler, Paris Hilton, Mother Teresa, George Clooney). Participants were given one of three different goals: to rate how positively they reacted to each person (ignoring anything negative), to rate how negatively they reacted to each person (ignoring anything positive), or to rate each person on a bivalent scale ranging from negative to positive. Amygdala activation was greatest when people evaluated positive stimuli in the positive condition; negative stimuli in the negative condition; and both positive and negative stimuli in the condition in which they used a bivalent scale. These findings suggest that the amygdala's role in processing emotional information is a flexible one that is responsive to people's current goals (also see Smith et al., 2006).

In addition to capturing attention and being associated with amygdala activation, goal-relevant information benefits from increased accessibility in memory. For example, information processed in terms of universal goals such as survival is exceptionally well remembered (Nairne, Pandeirada, & Thompson, 2008). Once goals have been fulfilled, however, information that was previously relevant becomes less accessible (e.g., Förster, Liberman, & Higgins, 2005). In early work on this phenomenon, Zeigarnik (1967) found that people tend to remember uncompleted or interrupted tasks better than completed tasks. In a recent extension of this work, Förster, Liberman, and Higgins (2005) had people search a series of pictures with a specific goal in mind (e.g., finding a picture of eyeglasses followed by scissors). One group found the target picture sequence; a second group did not; a control group looked at the same stimuli, for the same amount of time, with no goal in mind. Later, lexical decision and Stroop tasks were administered to assess the accessibility of words related to the target picture sequence and the accessibility of unrelated words. The results showed that, relative to the control group (no goal), people who had not achieved their goal (target not found) showed greater accessibility of goal-related words. Moreover, relative to the control group, people who had achieved their goal (target found) showed reduced accessibility of goal-relevant words. Thus, having a currently active goal enhanced the accessibility of goal-related information but goal fulfilment reduced this accessibility (also see Förster, Liberman, & Friedman, 2007).

When people are committed to a goal, not only is goal-relevant information more accessible, information relevant to competing goals may

be inhibited. Shah, Friedman, and Kruglanski (2002, Study 3) asked people to list three goals, that is, activities they planned to accomplish in the coming week (e.g., studying, reading, running). They also had people list non-goals; desirable activities that they did not plan to pursue (e.g., skiing). Later, people were primed with a goal or non-goal and engaged in a lexical decision task. When primed with a goal, people were slower to recognise competing goals (activities they intended to pursue that had not been primed) than when primed with a non-goal. Moreover, the more committed people were to a goal, the greater the inhibition of information related to competing goals.

In summary, goal-relevant information benefits from preattentive processing and increased accessibility in memory. Emotional stimuli that are goal relevant benefit from increased activation of the amygdala. In contrast, decreased memory accessibility is found for information related to fulfilled goals and competing goals. How might these findings inform our understanding of the effects of emotion on memory? Given that emotions are evoked when situations impact people's goals, a promising definition of "central" information might be goal-relevant information. A promising definition of "peripheral" information might be information that is irrelevant to the current goal or relevant to a competing goal. To fulfil this promise, though, findings concerning the accessibility of goal-relevant information must help to explain when emotion leads to memory narrowing and when it does not. So, we turn next to considering the predictions that follow from a goal-relevance model of emotional memory narrowing.



## GOAL RELEVANCE AND EMOTIONAL MEMORY NARROWING

Defining central information in terms of goal relevance leads to three predictions about when emotion should lead to memory narrowing and when it should not. First, the more relevant information is to currently active goals, the better it should be remembered. Examining the relevance of information to current goals helps to explain why people sometimes have excellent memory for details of emotional events that might be considered peripheral (e.g., Hulse et al., 2007; Laney et al., 2004), and sometimes forget information that might be considered central (e.g., Morgan et al., 2004; Talarico & Rubin, 2003; Wessel et al., 2000). Second, emotions should not produce memory narrowing under all conditions. Having an active goal enhances the accessibility of relevant information only so long as that goal has not been attained (e.g., Förster et al., 2005). Thus, negative emotion, elicited by threats to goals, should produce memory narrowing but positive emotion, elicited by goal attainment, should not. Third, when a specific goal is activated, information relevant to competing goals may be suppressed (e.g., Shah et al., 2002). Discrete emotions such as fear, anger, and sadness

increase the salience of different goals such as avoiding, altering, or adjusting to negative outcomes, respectively. Feeling fear, anger, or sadness, then, should enhance memory for information relevant to the salient goal in that discrete emotional state but should impair memory for irrelevant information, including information that would be relevant in alternative emotional states. Evidence supporting these three predictions is described below.

## Emotion enhances memory for information relevant to goals

The greater the relevance of emotional information to currently active goals, the better it is typically remembered. In studies of emotional narratives, for example, details that are closely tied to the plot or goals of protagonists are remembered best (Burke et al.,1992; see Reisberg & Heuer, 2004, for a review). Even seemingly neutral details, that are not part of an emotional stimulus, are nevertheless well remembered if those details are causally connected to the goal made salient by the stimulus. For example, in the study discussed above of memory for emotional and neutral words in sentences (e.g., "the sailor was responsible for the rape"; Brierley et al., 2007), memory was enhanced not only for emotional words but for neutral words that were causally related to emotional words. In contrast, information that is irrelevant to people's goals is less likely to be remembered (e.g., MacLeod & Mathews, 2004).

Some studies, though, have shown general enhancement, rather than memory narrowing, when people recall emotional as opposed to neutral events (e.g., Hulse et al., 2007; Laney et al., 2004). Defining central information in terms of goal relevance helps account for these findings. In comprehending sequences of events in daily life and in narratives and films, people try to impose meaning and coherence on their experiences by drawing on their knowledge of the causal links among events. Research on text comprehension shows that events can be linked locally (i.e., sequentially) to their immediate causes or consequences, but extended sequences of events are best understood and remembered if they are organised globally in terms of goals, plans to attain those goals, and their outcomes (Goldman & Varnhagen, 1986; Graesser, Singer, & Trabasso, 1994). Because emotions are evoked when events impact people's goals, narratives that depict or evoke emotion, particularly negative emotion, tend to be more cohesive than neutral narratives (e.g., Fivush, McDermott Sales, & Bohanek, 2008). Even when emotionally evocative and neutral narratives are carefully matched, the greater cohesiveness of emotional event sequences would be likely to enhance memory.

As an example, Hulse et al. (2007) compared memory for a neutral video and an emotional video that contained no gory sensory details that would be likely to capture attention. To prevent rumination, people engaged in a

challenging cognitive task after watching a critical scene in the videos. The emotional and neutral videos were carefully matched. The first and final scenes, as well as several events in the critical middle scene, were identical across conditions. Nonetheless, people showed better memory for the emotional than the neutral video, including both central information and peripheral details. The findings were taken as support for the claim that, in the absence of attention magnets, emotion enhances memory generally—both for central information and peripheral details.

Greater cohesiveness among the emotional than neutral events, however, may have endowed details that were peripheral in the neutral video with significance in the emotional video. Specifically, although both the neutral and emotional video showed a woman taking a ride in a taxi, the links among events in the neutral video were primarily sequential. During the ride, the taxi driver prolonged the journey by taking a wrong turn and then by stopping to take a cell phone call; the woman was mildly annoyed. In the emotional video, each event was causally linked to a central threatening event. During the ride, the taxi driver took a wrong turn so he could stop the taxi in a deserted area and assault the woman; she reacted with distress. Even the final scene—identical in the emotional and neutral videos—had greater significance in the emotional video. The woman's daughter decided not to call to check on her mother. In the neutral video, her decision was unrelated to the events that occurred during the taxi ride. People watching the emotional video would be hard-pressed not to relate the daughter's decision to the events that had just occurred. Thus, more details from the emotional video than the neutral video were causally related to a salient goal—a characteristic that would be expected to enhance memory for the emotional video.

Even when events in emotional and neutral narratives are matched in terms of language complexity, familiarity, phrasing, and structure (e.g., Laney et al., 2004, Experiment 2), empathising with the emotions of others may lead people to adopt protagonists' goals and draw more connections among story details. Bourg, Risden, Thompson, and Davis (1993) presented two groups of sixth graders with the same story. One group was instructed to read the story aloud; the other, to read the story aloud and empathise with the story characters. Relative to children who merely read the story aloud, children encouraged to empathise with the characters performed better on cued recall questions that required integrating the information presented in the story. Bourg (1996) argued that empathising with characters in a narrative provides a motive for attending carefully to the goals and outcomes important to the character and for actively trying to determine the relations among events. Moreover, people come to understand characters' emotions by imagining how they themselves would feel if they had similar experiences (Ames, Jenkins, Banaji, & Mitchell, 2008). Using

personal experiences as a foundation for forming expectations about events enhances memory. Thus, when presented with an emotional narrative in which a critical goal is at stake (e.g., the risk of suicide; Laney et al., 2004) people are likely to draw causal relations connecting details to the emotional core of the story. To the extent that people draw more causal inferences when comprehending emotional events, fewer details may be peripheral in emotional than in neutral event sequences.

Why, then, do investigators sometimes find general memory enhancement as a result of emotion? We have argued that event sequences that evoke emotion are typically more cohesive than event sequences that do not. Moreover, empathising with emotions leads people to draw more causal links among events, further enhancing comprehension and memory. Thus, the links between emotions and goals, and failure to limit the details assessed to those that are truly irrelevant, may explain why investigators sometimes find general memory enhancement for emotional events rather than memory narrowing. To test this view, it will be necessary to compare events with and without shocking sensory stimuli. It will also be necessary to parse details based on whether or not they are relevant to the goals made salient by emotional events. This will clarify whether, in the absence of shocking sensory stimuli, emotion improves memory across the board or, as we would expect, specifically for goal-relevant information.



## Emotional valence and memory narrowing

The vast majority of research on the effects of emotion on memory treats emotion as "arousal"; a state ranging from relaxation to excitement. Positive and negative emotions, of equivalent intensity, sometimes affect memory differently, however. Defining central information in terms of goal relevance clarifies when positive and negative emotions have similar effects on memory and when they do not. Irrespective of whether the valence of the stimuli is positive or negative, goal-relevant stimuli capture attention (e.g., Brosch, Sander, Pourtois, & Scherer, 2008). Relative to neutral stimuli, both positive and negative stimuli activate the amygdala (Cunningham et al., 2008; Hamann et al., 2002), and are likely to be remembered after short and long delays (Hamann et al., 1999). Moreover, like negative stimuli, positive stimuli can lead to memory narrowing. In one study, investigators assessed people's memory for central and peripheral information in positive, negative, and neutral anime film clips. Relative to memory for the neutral film, people showed enhanced memory for erotic and comical events, and poor memory for peripheral details, in the positive film (Moyer, 2002, unpublished study cited in Reisberg & Heuer, 2004).

Sometimes positive and negative emotions differ in their effects, though, with negative emotion promoting narrowing, and positive emotion promoting

broadening, of attention and memory. Examining the relation between emotional valence and goals helps explain why. People feel negative emotion when goals are threatened; they feel positive emotion when goal attainment is anticipated or has been achieved. Research on goals indicates that information relevant to uncompleted goals tends to be well remembered whereas information relevant to completed goals tends to be forgotten (e.g., Förster et al., 2005). In the service of future goal attainment, then, both negative emotion elicited by threatened goals, and positive emotion elicited by anticipated goals, should promote accurate and detailed memory for goal-relevant information. However, positive emotion following goal attainment should not.

Consistent with this view, Berridge and colleagues argued that positive emotion (or reward) has two separable components: a motivational component ("desire") and the affective consequence of attaining the desired state or goal ("pleasure"). These two components have different neural substrates, are dissociable, and serve unique functions. Desiring a stimulus or outcome depends on dopaminergic systems and is associated with activation in the basolateral amygdala and nucleus accumbens core—brain systems that overlap those activated by aversive events. Manipulation of dopamine increases or decreases the desire to attain rewards and consumption behaviours. In contrast, opioid stimulation in other brain regions (including the nucleus accumbens shell, ventral pallidum, and brainstem) has a causal role in increasing or decreasing the pleasure experienced when a goal is attained (Berridge & Kringelbach, 2007; Berridge & Robinson, 2003; also see Panksepp, 1998).

Recent research suggests that it is the motivational component of positive emotion (an active goal state) that, like negative emotion, leads to narrowing of attention and memory. In contrast, pleasure following goal attainment leads to broadening of attention. For example, to induce desire, Gable and Harmon-Jones (2008) had people watch a film about delicious desserts. To induce pleasure, another group watched a humorous film about cats. The breadth of people's attention was then assessed with a global/local judgement task (i.e., asking people whether target shapes were most similar to other shapes that shared their global outline or their constituent details). The results showed that inducing desire narrowed attentional focus whereas inducing pleasure broadened attentional focus.

Gable and Harmon-Jones argued that desire, unlike pleasure, causes people to shut out irrelevant stimuli as they approach desired objects. Other studies have also shown that positive stimuli that elicit desire, e.g., pictures of babies, nudes, appetising foods, capture attention much more reliably than positive stimuli that elicit pleasure, e.g., pictures of happy faces, sunsets (Brosch et al., 2008; also see Tamir & Robinson, 2007). In contrast, positive emotion induced by giving people gifts, having them view funny films, or

asking them to recall events that made them happy has been associated with a broadening of attention and with flexibility and creativity in problem solving (e.g., Fredrickson, 2001; Isen, Daubman, & Nowicki, 1987; Talarico, Berntsen, & Rubin, 2009). Thus the key feature that determines whether positive emotion promotes narrowing or broadening of attention appears to be whether positive emotion consists of the desire to attain a goal or pleasure experienced after a goal has been attained (Gable & Harmon-Jones, 2008).

Turning from attention and problem solving to memory, the information-processing strategies adopted by people feeling positive versus negative emotions have implications for memory accuracy. Many information-processing models make a fundamental distinction between bottom-up, item-specific, or verbatim processing, on one hand, and top-down, relational, or gist processing on the other (e.g., Anderson, 1972; Hunt & Einstein, 1981; Reyna & Brainerd, 1995). When making sense of an event, people using a bottom-up processing strategy focus on its specific features; people using a top-down processing strategy draw on general knowledge about how the event relates to other events. These two information-processing strategies have different implications for memory. Top-down processing promotes creativity by drawing connections among disparate events, but can lead to errors in which events are falsely remembered as more consistent with general knowledge than they actually were. Bottom-up processing is detail-oriented and associated with less creativity but greater memory accuracy (e.g., McCabe, Presmanes, Robertson, & Smith, 2004; Roediger, Balota, & Watson, 2001).

Because negative and positive emotions are evoked by different appraisals of the effects of events on people's goals, people might be expected to process information differently when they experience emotions of differing valence. Negative emotion signals the threat of goal failure and indicates that there is a problem to solve. Solving problems requires monitoring the details of incoming and remembered information. So, negative emotion should promote bottom-up processing, leading to detailed and accurate recall of goal-relevant information. In contrast, positive emotion following goal attainment should promote a top-down processing strategy, leading people to draw on relational knowledge. Perceiving broad relations among events may facilitate attaining future goals but also leads to reconstructive memory errors (Bless et al., 1996; Clore et al., 2001; Levine & Bluck, 2004; Levine & Pizarro, 2004).

A growing body of evidence supports the view that negative emotion and positive emotion following goal attainment are associated with differing information-processing strategies that influence memory accuracy (Bless et al., 1996; Forgas, Laham, & Vargas, 2005; Gasper & Clore, 2002; Johnson & Fredrickson, 2005; Levine & Bluck, 2004; Ochsner, 2000; Park & Banaji, 2000; Storbeck & Clore, 2005). For instance, Bless et al. (1996) induced a

happy or sad mood in people, and then presented them with information about common activities (e.g., eating at a restaurant). Some of the information presented was consistent with general knowledge (e.g., "The hostess placed the menus on the table") and some was not (e.g., "He put away his tennis racket"). The results of a subsequent surprise recognition test showed that happy people were more likely than sad people to "recognise" information consistent with general knowledge—independent of whether that information had actually been presented. In contrast, sad people were more accurate in their recognition judgements. Storbeck and Clore (2005) examined memory for lists of closely associated words. They found that sad people were less likely than people in a happy or neutral state to falsely remember closely associated words that had not been presented. Thus, laboratory studies suggest that positive emotion leads to greater reliance on general knowledge, and to intrusion errors in memory, whereas negative emotion makes people resistant to such errors.



Levine and Bluck (2004) demonstrated that these findings extend beyond brief laboratory studies to memory for real-world events and over prolonged retention intervals. People's emotions and memories were assessed concerning the televised announcement of the verdict in the murder trial of O. J. Simpson. In the memory assessment, half of the events presented had occurred; half were plausible but had not occurred. The results showed that, after more than a year, people who were happy about the verdict recognised more events than people whose reaction was negative, independent of whether the events had actually occurred. Replicating and extending these findings, Kensinger and Schacter (2006b) had Red Sox and Yankees fans describe their memories of the final game of the 2004 playoff series that resulted in victory for the Red Sox. The valence of the fans' response to the game did not affect the quantity of information they remembered but did influence the likelihood of memory distortions. Red Sox fans, who were happy about the outcome, showed more memory inconsistencies than did Yankees fans. These findings again suggest that, compared to positive emotion, negative emotion may lead to a focus on specific details, reducing the likelihood of reconstructive memory errors. Because the intensity of positive and negative emotion was equivalent in both Levine and Bluck's and in Kensinger and Schacter's studies, these findings are difficult to explain in terms of a simple model based only on emotional arousal. Instead they suggest that people experiencing positive and negative emotions have different motivations, process information differently as a result, and these differences affect memory.

Further research is needed before definitive conclusions can be drawn about the differing effects of negative and positive emotion on memory narrowing and memory accuracy. Findings suggest the following pattern, however. When experiencing negative emotion or desire (signalling that a goal

is threatened or anticipated), people tend to adopt a detail-oriented, bottom-up strategy when encoding and retrieving events. When experiencing positive emotion (signalling that goals have been attained), people tend to draw on relational knowledge, sometimes confusing plausible and actual events. These different information-processing strategies affect memory narrowing, with negative emotion and desire leading to detailed and accurate memory for goal-relevant central information, and positive emotion following goal attainment leading to a broader focus and less accuracy.

## Discrete emotions and memory narrowing

Moving beyond emotional valence, researchers have recently begun to examine the effects of discrete emotions on memory. Enhanced memory for goal-relevant information would be expected regardless of the discrete emotion experienced. But people have different goals when they are experiencing discrete emotions; for instance, avoiding danger for fear, adjusting to irrevocable loss for sadness, removing obstacles to goal attainment for anger. Because people's goals differ, the content of their memories (i.e., the types of information that are central and hence well-remembered) would also be expected to differ when they are experiencing discrete emotions (Davis et al., 2008; Lench & Levine, 2005; Levine & Bluck, 2004; Levine & Burgess, 1997; Levine & Pizarro, 2004). In contrast to mood-congruent memory, which is thought to result from spreading activation among information that is semantically related to a particular emotional state (e.g., Eich & Forgas, 2003), enhanced memory would be expected for information relevant to people's goals in specific emotional states. For example, for a person who is angry that his wallet has been stolen, references on the evening news to "thieves" and "credit cards" (not mood congruent but goal relevant) should be more memorable than references to "road rage" (mood congruent but not goal relevant). Förster et al. (2007) provided a detailed review of how goal relevance differs from non-goal constructs such as semantic relatedness.

Integrating these findings with work on the effects of emotional valence on memory leads to a model of the effects of discrete emotions on memory. According to the goal-relevance model (Levine & Pizarro, 2004), happiness following goal attainment promotes top-down processing, leading to memory intrusion errors consistent with general knowledge. Negative emotion promotes bottom-up processing; a focus on details in the service of responding to goal failure. However, people should be most likely to engage in bottom-up processing of information that is of central importance in their discrete emotional state. Thus, bottom-up processing (and hence accurate memory for details and few intrusion errors) should be found when fearful people remember information about risks, when sad people

remember information about losses, and when angry people remember information about the agents or causes of goal obstruction. Poorer memory should be found for information peripheral to people's goals in discrete emotional states. In short, people look for, notice, and remember information relevant to currently active goals. Since people's goals differ depending on their current emotion, the information that is most salient and memorable for them should also differ in systematic ways.

To test these predictions, it is necessary to directly contrast the types of information remembered in discrete emotional states. To date, few studies have done so, but work focusing on individual emotions suggests that this would be a fruitful direction for future research. For example, fearful people display enhanced memory for threat-related information and poorer memory for threat-irrelevant information (e.g., Lench & Levine 2005; MacLeod & Mathews, 2004; Mathews & Klug, 1993; Wessel & Merckelbach, 1998). In contrast, people in a sad mood who are asked to recall autobiographical events tend to focus, not on sources of threat, but on losses and defeats (e.g., Lyubomirsky et al., 1998). Moreover, although post-traumatic stress disorder (PTSD) and depression are both characterised by the presence of intrusive memories, the content of the intrusive information for these two disorders differs. Consistent with the goal of avoiding danger, PTSD is characterised by intrusive memories related to past threats to safety. Consistent with the goal of adjusting to loss, depression is characterised by rumination on past losses and their consequences for the self (e.g., Lyubomirsky et al., 1998; Reynolds & Brewin, 1999; Watkins & Teasdale, 2001).

Levine and Burgess (1997) examined the effects of discrete emotions on memory for a narrative. Emotions were evoked in undergraduates by randomly assigning grades of "A" or "D" on a surprise quiz. As part of a purportedly unrelated study, participants then heard and later recalled a narrative about a student's first term in college. Finally, participants rated how happy, sad, and angry they had felt when they received their quiz grade. Happy participants demonstrated good memory for the narrative as a whole, but those who reported feeling primarily sad or primarily angry tended to recall specific types of information. Consistent with the view that sad people focus on consequences of goal failure, sad participants recalled significantly more information concerning event outcomes such as losses than did angry participants (e.g., "They receive a bad grade on the speech"). Consistent with the view that angry people focus on goal reinstatement, angry participants showed a non-significant tendency to recall more information about protagonists' goals than did sad participants (e.g., "Mary wants her speech to be really good"). In addition, a significant correlation was found between the intensity of anger reported and the amount of information that participants recalled about goals.

Finally, priming a goal makes goal-relevant information more accessible than neutral information, but further suppresses the accessibility of information relevant to competing goals (e.g., Shah et al., 2002). These findings have implications for the salience and accessibility of different types of information in discrete emotional states. When a person is feeling a specific emotion, the accessibility of goal-relevant information should be enhanced relative to neutral information; the accessibility of information relevant in alternative emotional states should be suppressed relative to neutral information. For instance, for an angry person, information relevant to the blameworthiness of a perpetrator should be highly accessible in memory. However, memory for situational factors that constrained the perpetrators' actions (making the perpetrator less culpable and goal failure irrevocable) may actually be suppressed. Characterising central emotional information as goal relevant thus opens up exciting new avenues for research on the effects of discrete emotions on memory.



## SUMMARY AND CONCLUSIONS

Emotional memories are vivid, lasting, and selective. Whether people are remembering real-world events (a celebration, injury, or dispute) or laboratory stimuli (emotional words, images, or narratives), they typically show good memory for central features of emotional events and poorer memory for peripheral features. One goal of this review was to examine the mechanisms through which emotion spotlights central information at the expense of peripheral information. Research shows that emotional information is more likely than neutral information to capture and to remain the focus of attention (Compton, 2003; LaBar & Cabeza, 2006; Mather, 2007). Attention and rehearsal in turn promote encoding, resulting in enhanced memory for emotional information after brief delays (Hamann et al., 1999; Ochsner, 2000). Over time, consolidation and the presence of retrieval cues augment these memory advantages, resulting in lasting and accessible memories for central features of emotional events (Finkenauer et al., 1998; LaBar & Cabeza, 2006; Sharot & Phelps, 2004). Poor memory for peripheral features is due in part to the limited capacities of attention and working memory. To the extent that central features dominate processing, fewer resources are directed toward peripheral features (e.g., Compton, 2003; Öhman et al., 2001). When neutral or background information does receive attention, this information is less likely to be elaborated on and stored in long-term memory (e.g., Finkenauer et al., 1998) and less likely to be associated with amygdala activation that promotes memory consolidation and retrieval (Cahill et al., 1994; LaBar & Phelps, 1998). Thus emotional information benefits from privileged processing in several memory systems,

but these benefits accrue at the expense of information less central to the source of emotional arousal.

The arousing nature of emotional experience is commonly viewed as the key mechanism underlying emotional memory narrowing. In support of this view, both positive and negative stimuli that elicit arousal serve to capture attention, dominate working memory, and activate the amygdala, promoting memory encoding and consolidation (Compton, 2003; McGaugh, 2004). Moreover, the more arousing people find stimuli at encoding, the greater the amygdala activation, and the more likely it is that the stimuli will later be remembered (e.g., Canli, Zhao, Brewer, Gabrielli, & Cahill, 2000; Hamann et al., 1999, 2002; Hurlemann et al., 2007). Because processing arousing information leaves fewer resources for encoding peripheral details, arousal (elicited by negative stimuli in most studies) is also associated with poorer memory for peripheral details (e.g., Adolphs et al., 2005; Cahill et al., 1994; Kensinger et al., 2007a; Mather et al., 2006; also see Easterbrook, 1959). Thus, arousal clearly contributes to both enhanced memory for emotional information and poor memory for peripheral detail.

To understand how emotion affects memory, however, aspects of emotion other than arousal must also be considered. Arousal is commonly viewed as indicating the degree of urgency or importance of a situation to an individual (e.g., Compton, 2003; McGaugh, 2004). But emotions incorporate both a sense of urgency and a direction. That is, emotions consist of urges toward attaining desired states, avoiding aversive states, or adapting to changes in the status of goals that have already occurred (e.g., Brehm, 1999). Memory is affected not only by the strength of these urges but also by their direction. For example, Hurlemann et al. (2005) assessed people's memory for several series of neutral pictures with an arousing picture embedded in each series. Memory for the neutral pictures was affected by the valence of the emotional pictures. Retrograde amnesia was observed for neutral pictures that were followed by a negative picture, but retrograde hypermnesia was observed for neutral pictures that were followed by a positive picture. Importantly, increasing or decreasing participants' arousal through pretraining administration of drugs affected the magnitude of these retrograde effects but their quality (i.e., amnesia vs. hypermnesia) depended on valence. These findings are consistent with a growing body of evidence that positive and negative emotion of equivalent intensity can nonetheless have different effects on attention (e.g., Gable & Harmon-Jones, 2008, Study 1) and memory, with negative emotion leading to memory narrowing and positive emotion to broadening (e.g., Kensinger & Schacter, 2006b; Levine & Bluck, 2004; but see Corson & Verrier, 2007). Thus arousal plays a critical role in emotional memory narrowing but does not provide a complete explanation.

Further, memory narrowing as a result of emotion is not ubiquitous. Seemingly peripheral features of emotional events are sometimes preserved

(e.g., Hulse et al., 2007; Laney et al., 2004) and critically important emotional information is sometimes forgotten (e.g., Deffenbacher et al., 2004; Morgan et al., 2004). Christianson (1992) suggested that studies showing general memory enhancement as a result of emotion may have focused on the accuracy of memory for central features of emotional events whereas studies showing general memory impairment may have focused on errors in memory for peripheral details. To understand emotional memory narrowing, then, it is important to address not only *how* the emotional spotlight works but also the types of information it illuminates and excludes. Thus, the second goal of this review was to address the critical question of what constitutes the central features of emotional events.

Investigators have variously defined central information as information that captures an emotionally aroused person's attention; information that constitutes an integral part of an emotional stimulus; and information relevant to goals. The first approach accounts for the fact that memory narrowing is reliably found when laboratory stimuli include shocking sensory images, such as a bloody face, weapon, or accident scene, which serve as magnets for an emotionally aroused person's attention (Laney et al., 2003, 2004; Reisberg & Heuer, 2004, 2007). An important question for future research is whether real-world emotional events that lack such stimuli also lead to memory narrowing. The second approach accounts for findings that even neutral features of simple emotional stimuli (e.g., the colour or location of an emotional word) are well remembered, as long as those features constitute an integral part of the emotional stimulus. This approach raises the question of what constitutes an integral feature as one moves from simple laboratory stimuli to real-world emotional events.

We have argued for the third approach: that memory narrowing as a result of emotion, and violations of the memory-narrowing pattern, can best be explained by the view that emotion enhances memory for information relevant to currently active goals. People experience emotions when they perceive changes in the status of their goals. Once evoked, emotions are thought to direct cognition in a manner that is likely to be useful for responding such changes (Arnold, 1960; Frijda, 1987; Lazarus, 1991; Lerner & Keltner, 2000; Oatley & Johnson-Laird, 1987; Scherer, 1998; Stein & Levine, 1987). The more relevant information is to the goals activated by an emotional event, then, the better it should be remembered. According to this view, emotional stimuli that serve as a magnet for attention and reliably lead to memory narrowing (e.g., a bloody face, weapon, or accident scene) may do so because they increase the salience of the universal goal of survival. This implies though that emotional stimuli that increase the salience of other important goals (e.g., a threat to a relationship, self-esteem, financial stability) should also lead to memory narrowing. Thus, the importance of the goal activated by an emotional event, and the relevance of information

to that goal, rather than the presence of gruesome sensory details per se, should predict the features of emotional events that are remembered.

Examining the relevance of information to current goals helps to explain why people sometimes have excellent memory for details of emotional events that might be considered peripheral (e.g., Hulse et al., 2007; Laney et al., 2004), and sometimes forget information that might be considered central (e.g., Deffenbacher et al., 2004; Morgan et al., 2004). With respect to general memory enhancement, event sequences that evoke emotion tend to be more cohesive than event sequences that do not (Fivush et al., 2008; Goldman & Varnhagen, 1986; Graesser et al., 1994). Empathising with emotions leads people to draw additional causal links among events, further enhancing comprehension and memory (Bourg, 1996). The greater cohesiveness of emotional than neutral events can endow details that are peripheral in neutral event sequences with significance in the emotional event sequences. Thus, good memory for emotional event sequences may result because details that investigators have classified as peripheral have more relevance to people's goals in emotional than in neutral event sequences. In future research, it will be important to classify details a priori based on whether or not they are relevant to the goals made salient by emotional events, and to compare events with and without shocking sensory stimuli. This will clarify whether emotion improves memory generally when shocking sensory stimuli are not present or improves memory specifically for goal-relevant information.

Emotion can also impair memory for information that might be considered central. It is well documented that chronic stress impairs memory (e.g., Belanoff et al., 2001; McEwen & Sapolsky, 1995). In addition, efforts to regulate acute emotional reactions by suppressing emotion, or by engaging in distraction or avoidance strategies, are associated with poor memory for emotional events (e.g., Bonanno et al., 2004; Edelstein, 2006; Richards & Gross, 2000, 2006). Attempts to regulate emotion and "get through" the experience may have contributed to Morgan et al.'s (2004) finding that soldiers who underwent an extremely stressful interrogation were less likely to recognise their interrogator than soldiers who underwent a less-stressful interrogation. When people appraise emotional events as overwhelming and out of their control, their goals may shift from understanding the implications of those events to managing their emotional response (Deffenbacher et al., 2004). Emotion-regulation strategies that focus attention away from emotional events lead to generally poor memory for those events.

Defining central information in terms of goal relevance also elucidates the effects of emotional valence and discrete emotions on memory narrowing. Having an active goal enhances the accessibility of relevant information only

so long as that goal has not been attained (e.g., Förster et al., 2005; Zeigarnik, 1967). Consistent with this effect of goals on memory, negative emotion and desire have been shown to promote narrowing of attention and memory (e.g., Brosch et al., 2008; Gable & Harmon-Jones, 2008; Storbeck & Clore, 2005). Positive emotion following goal attainment has been shown to promote broadening of attention and memory (e.g., Fredrickson, 2001; Gable & Harmon-Jones, 2008; Isen et al., 1987) and vulnerability to reconstructive memory errors (e.g., Kensigner & Schacter, 2006b; Levine & Bluck, 2004). Preliminary findings also suggest that the types of information that are central, and hence well remembered, differ depending on a person's discrete emotional state (Levine & Burgess, 1997; Levine & Pizarro, 2004). Fearful people show enhanced memory for information about risks (e.g., Lench & Levine 2005; MacLeod & Mathews, 2004; Mathews & Klug, 1993; Wessel & Merckelbach, 1998), sad people for information about losses (e.g., Lyubomirsky et al., 1998; Reynolds & Brewin, 1999; Watkins & Teasdale, 2001), and angry people for information about the agents or causes of goal obstruction (Lerner & Tiedens, 2006). In short, people look for, notice, and remember information relevant to currently active goals. Because people's goals differ depending on their discrete emotion, the kinds of information that are most salient and memorable should also differ in systematic ways.

Limitations of this approach should also be noted. The claim that emotion enhances memory for goal-relevant information at the expense of irrelevant details is circular if investigators decide whether or not a particular detail was goal relevant based on whether or not it was remembered. Thus, defining central information in terms of goal relevance raises the thorny issue of how to determine a priori the goals that will be salient for a particular individual in a particular situation. When emotions are evoked by events that impact universal goals (e.g., survival, access to food, sex, nurturance, avoiding injury), it is often possible to predict the features of events that are relevant and likely to be remembered. For example, when a person is angry, the agent responsible for obstructing his or her goal is central. In the context of a laboratory study, the word "murder" embedded in a list of neutral words such as "shop", "towel", and "mountain" is almost certain to be remembered. When emotions pertain to personal, idiosyncratic goals, however, the features of events that are of central importance may be hard to determine a priori. A person with the goal of avoiding heights may remember the word "mountain" whereas others may not. So, it will be necessary to test this model by assessing memory after varying the relevance of details to universal goals associated with emotions.

It must also be acknowledged that some findings are inconsistent with this goal-based perspective. Enhanced memory has been found for information that is neither part of an emotional stimulus, nor goal relevant, but

simply spatially or temporally proximal to an emotional stimulus. For example, memory for neutral pictures was found to be enhanced if those pictures alternated with emotional pictures rather than with other neutral pictures (Anderson, Wais, & Gabrieli, 2006; also see McGaugh, 2006). Such findings suggest that the effects of emotion on memory may differ depending on the stage of information processing. When people are emotionally aroused, attentional and encoding processes should privilege goal-relevant information. Once information has been encoded, however, emotional or not, it may benefit from consolidation in long-term memory, ensuring rich and detailed memories for significant life events (Anderson et al., 2006).

We have reviewed three approaches to defining the features of emotional events that will be preserved in memory. Each of these approaches explains some findings in the emotion and memory literature and conflicts with others. We have laid them out side by side to facilitate research that directly contrasts the predictions made by different models. An important avenue for future research will be to assess memory accuracy for emotional events with and without shocking sensory details, for information that varies in terms of whether or not it is an integral part of the emotional event, and for information that varies with respect to whether or not it is relevant to the goal activated by the emotion. Further research is also needed to clarify the mechanisms underlying the differing effects of positive and negative emotions, and of discrete emotions, on memory.

The potential benefits of such work are profound. Emotion affects memory on a daily basis and in situations in which detailed and accurate memory really matters. The importance of understanding the effects of emotion on memory for evaluating the accuracy of eyewitness testimony concerning crimes is often noted. But people are also faced daily with the need to accurately remember information while experiencing a range of emotional states. An attorney angered by the acts of opposing counsel, a patient saddened by a diagnosis, a rescue worker frightened by a disaster, must nonetheless encode and retrieve detailed information accurately if they are to make good decisions. Further research on emotion-induced memory narrowing may help people guard against the tendency to forget information that appears unimportant under emotion's sway, and harness the capacity of emotion to enhance memory. The essential link between emotions and goals may provide the key to understanding the selective nature of memory for emotional events.

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