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REMEMBERING EMOTIONAL EVENTS: A SOCIAL COGNITIVE NEUROSCIENCE APPROACH

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How we respond emotionally to the peaks and valleys of life reveals much about who we are now, who we have been, and has implications for who we could be in the future. The question of how we remember these emotional events is thus of central importance to understanding human experience, and is the subject of this chapter. In addressing this question, our goals are to understand the specific neurocognitive mechanisms that preserve records of significant experiences, the motivational and contextual factors that influence their operation, and what their interaction tells us about the relationship between memory and emotion more generally.

We begin with a brief historical sketch of previous approaches to emotion and memory and then move to our own multileveled social cognitive neuroscience approach. We then apply this approach to understanding how the emotional nature of an event influences the encoding, storage, and retrieval of information about it. We conclude with suggestions for ways in which a social cognitive neuroscience approach can guide future research.

Perspectives on the Emotional Past

Most investigations of emotion and memory have begun with the same question: How do we remember emotionally evocative events? But investigators have framed this question differently and, as a result, have reached different conclusions. Three approaches have dominated past research, and the strengths and weaknesses of each are rooted in the ways in which their questions have been posed.

Indelible or Reconstructed?

Debate over whether emotional memories, and especially traumatic ones, are remembered poorly or well has a long history and is central to current discussion about the recovery of supposedly repressed memories of sexual and physical abuse during childhood (for discussion, see Conway, 1997; Loftus & Ketcham, 1994; Schacter, 1996). The question of whether emotion improves or impairs memory often is framed in terms of the question of whether emotional memories are indelible or reconstructed. Debate concerning this issue has played out in three different arenas.

Repression: Fact or Fiction?

First, some have argued that memories of especially aversive experiences may be temporarily lost—driven out of consciousness by repressive mechanisms that seek to protect the psyche from the harmful consequences of thinking about them. Yet if recovered at some later time, such memories are held to be highly accurate (e.g., van der Kolk & Fisler, 1995). This account seems to turn on the truth of a traditional metaphor for memory as a library in which are stored volumes of experience that contain verbatim records of events that can be retrieved later (Conway, 1997). On this account, repressed memories of emotional experiences are simply volumes that have been lost due to operation of a repressive process but that can later be found and reread in their entirety. As argued by various investigators (cf. Lindsay & Read, 1994; Loftus, 1993; Schacter, 1996; Schacter, Koutstaal, & Norman, 1996), this account is problematic because (1) traumatic memories are typically difficult to forget, even when one wants to do so (e.g., Wenzlaff et al., 1993; for review, see Schacter, 1996), and (2) false memories for various kinds of information, including personal life events, can be generated, sometimes with relative ease (e.g., Hyman, Husband, & Billings, 1995; Loftus & Pickrell, 1995; Roediger & McDermott, 1995; Schacter, Verfaellie, & Pradere, 1996).

Fading Flashbulbs

Second, investigators studying "flashbulb" memories also have argued that special mechanisms may promote the indelible recording of traces of emotional events (e.g., Brown & Kulik, 1977). However, this view has been abandoned in light of a growing body of evidence demonstrating that so-called flashbulb memories are far from photographic recordings and in fact are subject to some of the same kinds of distortions as is recall of more generic personal experiences (Brewer, 1992; Neisser & Harsch, 1992).

It is worth noting that conclusions about the putative indelibility of flashbulb memories may depend on the kind of mnemonic information that is assessed. On the one hand, people do not often forget *that* an emotional event has occurred, and they tend to recall accurately the themes and action sequences central to an event's emotional significance (Heuer & Reisberg, 1992). On the other hand, emotional experiences involve substantial evaluation of, and inferences about, one's own and others' motivations and intentions (Lazarus, 1991; Stein, Wade, & Liwag, 1997); current goals and desires can distort perception and memory for these aspects of emotional situations during both encoding and retrieval. Thus memories for the broad "objective facts" of an event may be less subject to distortion than are one's subjective interpretations of its personal and emotional significance (Johnson & Sherman, 1990).

Focus on Fear

The third arena in which the indelibility issue has emerged involves fear conditioning in rats. Fear responses to conditioned stimuli appear to remain indefinitely intact when brain areas responsible for extinguishing them are damaged (LeDoux, 1995). Recent accounts of the forgetting of conditioned responses have suggested that past conditioned associations are not lost but that their expression is inhibited by the learning of new responses that preempt expression of old behavioral patterns (Bouton, 1994).

Although it may be true that some traces of fearful events are relatively long-lasting and enduring, it is important to note that the findings that support this conclusion come primarily from indirect tests of behavior in animals. In contrast, reconstruction and distortion is common when memory for emotional experiences is examined using explicit tests in humans (e.g., Eich, Reeves-Jaeger, & Graff-Radford, 1985; Levine, 1997; Ochsner & Schacter, 2000). It appears that whether one reaches the conclusion that emotional memories are indelible or reconstructed may depend on the kinds of data under consideration. Although these traces are reflexively expressible on indirect tests of behavior, they may be of a different type than those used when we consciously reflect on emotional experiences.

Emotion Is in the Details

A closely related debate concerns whether memory for emotional events accurately preserves records of only central details or of both central and peripheral details (e.g., Christianson & Loftus, 1991). The majority of studies indicate that central details are most accurately recalled because emotional events activate goals that favor evaluation of the personal meaning of potentially significant stimuli during both encoding and retrieval. During the initial appraisal and encoding of an emotional event, it is important to understand which characteristics of external stimuli are related to internal feeling states. For example, when walking alone at night along a deserted street, it would be more important to draw inferences about the possible intentions of the person walking toward you and to determine whether the object in his hands is a weapon than it would be to notice the color of his hat, shoes, or coat (Lazarus, 1991; Stein et al., 1997). Similar goals at memory retrieval may further focus attention on central information and can lead to biases in the way in which events are recalled. The key point is that the kind of information that is recalled most accurately depends on where attention is directed and which emotion appraisal scripts are activated (Levine, 1997).

A methodological shortcoming of some of the foregoing research involves a failure to independently verify the affective qualities of experimental stimuli. Because the extent to which to-be-remembered stimuli elicit affect is not known, when a given type of detail is remembered poorly, we cannot be sure why this has occurred: It could be because that kind of detail is not remembered well, or it could be that the stimuli were not arousing enough to lead participants to more deeply encode them.

Quantity Versus Quality

A third long-running debate in the emotion and memory literature concerns what aspect of emotion—arousal (quantity of emotion) or valence (the positive or negative quality of emotion)—most critically determines how emotion influences memory. Early theorists postulated that people preferentially encode and recall positive experiences because reflecting on negative ones is too painful (see Bradley, 1994, and Matlin & Stang, 1978, for review). More recently, the focus has shifted toward comparing memory for negative, often highly aversive, events with memory for more mundane experiences. Some of this research has found aversive memories to be less accurate, as when encoding is disrupted by extremes of emotion produced by highly traumatic experiences (Kihlstrom, 1998; Schacter, 1996), whereas other research has concluded that these memories are more accurate, as in the case of flashbulb memories or studies of fear conditioning (Brewer, 1992; Brown & Kulik, 1977; LeDoux et al., 1989). We considered some of the problems with interpreting this research in the preceding sections.

The relationship of arousal to memory has been thought to depend on exactly how arousing an experience is, with moderate amounts of arousal producing the most accurate memory, and either too little or too much arousal causing memory impairments (see Revelle & Loftus, 1992, for review). Support for this proposal in human studies has been somewhat shaky (Christianson, 1992) but is strongly supported by studies in animals showing a dose-dependent relationship between memory for stressful events and release of arousal-related neurotransmitters (e.g., McGaugh, 1995).

In most studies aversive or positive events have also been highly arousing, and it is natural to ask how each factor influences memory independently. Unfortunately, however, it has been difficult to tease apart the independent effects of arousal and valence because the two variables seldom have been manipulated systematically within a single experiment. This is partly attributable to the fact that, in recent years, the memory and emotion literature has been concerned primarily with understanding memory for traumatic events such as abuse that are both highly arousing and extremely negative. It also may be due to the fact that negative affect can be more easily and reliably elicited than positive affect.

Nevertheless, two studies have compared memory for positive and negative information that varied in degree of associated arousal. Both found that it is the quantity of arousal, not the quality of valence, that predicts memory performance. In a study of autobiographical memory, Reisberg, Heuer, McLean, and O'Shaughnessy (1988) found that retrospective reports of arousal predicted ratings of vividness, independent of the valence ascribed to an event. In a study of recognition and recall for carefully validated emotionally evocative pictures, Bradley, Greenwald, Petry, and Lang (1992) found that participants' ratings of arousal predicted memory accuracy in the same way for both positive and negative images.

It is possible that these studies did not find that valence influenced memory because they used quantitative dependent measures that are insensitive to qualitative variations in the experience of recollection. The conscious experience of emotion differs as a function of which emotion is being aroused, and thus we would expect recollection of emotional events to reflect this qualitative difference in experiential awareness. In a series of studies, we (Ochsner, 2000) used the *remember/know* procedure (Tulving, 1983) to measure conscious recollective experience of positive, neutral, and negative photos (Lang et al., 1993) that varied in degree of arousal and complexity of visual detail. In this method participants are asked to classify items presented on a recognition memory test as either new (the item was not seen during a prior study phase), as "known" (the item evokes a sense of familiarity and the participant is sure it was seen previously, but no specific details come to mind about its prior occurrence), or as "remembered" (the item evokes a detailed sense of recollective re-experiencing of the prior study episode replete with sensory, affective, or semantic details). Previous research has shown that *remember* responses are sensitive to how distinctively an item has been encoded, whereas *know* responses are sensitive to the factors that influence general familiarity (Rajaram & Roediger, 1997). Highly distinctive items possess a greater number of unique attributes, may be more deeply encoded, and may elicit a greater number of cognitive and affective appraisals than less distinctive items (Hunt & McDaniel, 1993; Ochsner, 2000). As discussed later, affective stimuli possess more attributes than neutral ones and tend to capture and hold our attention. On this basis we reasoned that affective stimuli will be encoded more distinctively than neutral stimuli and hence should be "remembered" more often. In addition, we reasoned that because encoding biases may operate more strongly, or even preferentially, for negative information (e.g., Pratto & John, 1991), negative photos would be encoded more distinctively and should tend to elicit more "remember" responses than positive photos. Under a variety of encoding conditions, we found clear and consistent support for both hypotheses (Ochsner 2000): Independent of the effects of arousal, both negative and positive stimuli were remembered more often than neutral ones, which is consistent with the idea that affective events are encoded distinctively. In addition, negative photographs tended to be remembered more often than positive photos, whereas positive photographs tended to be known more often than negative ones. This is consistent with the idea that negative events are encoded distinctively. In addition, negative photographs tended to be *remembered* more often than positive photos, whereas positive photographs tended to known more often than negative ones. This is consistent with the idea that negative events are encoded more distinctively than positive ones and so are re-experienced differently during recollection.

The Social Cognitive Neuroscience Approach

Past research on memory and emotion has failed to develop an overarching theoretical approach that specifies what emotion is, how emotional information is processed, and how we would expect it to influence memory mechanisms. Studies have been concerned more with providing an explanation for a particular phenomenon than with developing an integrated theoretical approach.

In contrast, the present approach combines theories of memory and emotion drawn from social psychology and cognitive neuroscience to provide an account of how we remember affecting experiences (Ochsner & Lieberman, 2001). Our account cuts across many levels, ranging from the social level of experience and behavior, to the cognitive level of information processing, down to the neural level of brain systems and mechanisms. We call this type of analysis the social cognitive neuroscience (SCN) approach to denote its emphasis on integrating data and theory across these three broadly defined levels of analysis (Lieberman, 2000; Lieberman, Ochsner, Gilbert, & Schacter, 2001; Ochsner & Feldman Barrett, 2001; Ochsner & Lieberman, 2001; Ochsner & Schacter, 2000; cf. Ochsner & Kosslyn, 1999). Owing somewhat to the relative novelty of our approach, the account of emotion and memory we derive is less than a comprehensive theory that explains all emotion and memory phenomena, but more than a distillation of recent research. It is an attempt to draw principled conclusions about the way in which emotional events are remembered that draw on and make sense of data at the social, cognitive, and neural levels (Ochsner & Lieberman, 2001).

From an SCN perspective, the answer to the question of how emotional events are remembered is that it depends on the goals one has in encoding, storing, and retrieving information. It should be noted that the term *goal* is shorthand for a variety of motivational processes that may influence memory. Goals may be conscious or unconscious, and may range from relatively basic biological needs (such as eating food or avoiding pain) and impulses (such as sexual desire) to more complex strivings that drive us to protect our self-esteem or attain professional success. The relationship of events to goals in turn determines both the nature of our initial emotional response to the event and how cognitive processes will be deployed in the service of remembering it. This means that memory is inherently constructive and that questions about the absolute strength or quality of one type of remembered information are ill posed. Answering a question about the absolute accuracy of memory depends on specifying exactly what it means to say that a memory is more or less accurate, and it may be difficult to agree on criteria that apply to all conditions equally well. Furthermore, Tulving (1983) has suggested that the absolute strength of a memory can never be determined because expression of stored information is strongly determined by situational and strategic factors. Instead of asking whether memory is good or bad, research should focus on elucidating the factors that determine which aspects of emotional episodes will be remembered accurately, when this will occur, and what mechanisms mediate these effects. Our analyses are motivated by exactly this kind of approach, and we begin with a brief overview of current theories of memory and emotion to serve as the backdrop against which we discuss studies of their relationship in later sections.

Systems for the Construction of Memory

Memory is not a copy or reproduction of past experiences but instead involves a complex construction that draws on various kinds of information. Schacter, Norman, and Koutstaal (1998) have recently proposed a "constructive memory framework" that summarizes some of the main encoding and retrieval processes that underlie such constructions. In this framework, representations of new experiences are viewed as patterns of features. Constituent features of a memory representation are distributed widely across different parts of the brain; no single location contains a complete record of the trace or engram of a specific experience (Damasio, 1989; Squire, 1992). Retrieval of past experience involves a process of "pattern completion" (McClelland, McNaughton, & O'Reilly, 1995). Subsets of the features that comprise a particular past experience are reactivated by a retrieval cue, and activation spreads to the remaining features.

To produce mainly accurate representations of past experience, a memory system that operates in such a manner must solve a number of problems. At the encoding stage, features must be linked together to form a bound or "coherent" representation (Moscovitch, 1994). A closely related encoding process, sometimes referred to as pattern separation (McClelland et al., 1995), is required to keep bound episodes separate from one another in memory. If episodes overlap extensively with one another, individuals may recall what is common to many episodes but fail to remember distinctive particulars that distinguish one episode from another (e.g., Schacter, Israel, & Racine, 1999).

Similar kinds of problems arise when retrieving information from memory. Because retrieval cues can potentially match stored experiences other than the sought-after episode, the rememberer may form a more refined description of the characteristics of the episode to be retrieved (Burgess & Shallice, 1996), referred to as a process of "focusing" (Norman & Schacter, 1996). When the pattern completion process produces a match, the rememberer must decide whether the retrieved information constitutes a specific memory of a particular experience or a generic image. The rememberer now needs to consider the diagnostic value of perceptual vividness, semantic detail, and other kinds of information that can help to specify the origin of the retrieved pattern (Johnson, Hashtroudi, & Lindsay, 1993: Schacter & Wagner, 1999).

Controlling Encoding and Retrieval

A variety of brain regions have been linked to these and related aspects of constructive memory functions (see Schacter et al., 1998). However, two regions are particularly relevant to memory construction: the medial temporal region and the prefrontal cortex. The medial temporal region has long been associated with memory functions, because damage to this region produces a severe impairment of memory for recent experiences (Squire, 1992). Recent neuroimaging data indicate that the medial temporal area is involved in encoding novel events into memory (e.g., Stern et al., 1996; for review, see Schacter & Wagner, 1999). Indeed, a consensus account has begun to emerge regarding how exactly the medial temporal region implements feature binding and pattern separation (e.g., McClelland et al., 1995; see Schacter et al., 1998, for a summary).

The medial temporal region also contributes to pattern completion at retrieval (cf. McClelland et al., 1995; Moscovitch, 1994). Although the neuroimaging data on medial temporal contributions to such retrieval are not entirely clear-cut—many studies have failed to observe medial temporal activity during retrieval—several brain imaging studies have implicated the medial temporal area in the successful recollection of recently acquired information (Nyberg, Cabeza, & Tulving, 1996; Schacter, Alpert, Savage, Rauch, & Albert, 1996; Squire et al., 1992; for review, see Schacter & Wagner, 1999).

The prefrontal cortex has also been implicated in both encoding and retrieval processes. On the encoding side, specific regions within the prefrontal cortex play an important role in elaborative encoding activities that relate incoming information to previous experiences (for recent studies, see Brewer, Zhao, Glover, & Gabrieli, 1998; Wagner et al., 1998). Numerous neuroimaging studies have also documented prefrontal activity during episodic retrieval, especially in the right hemisphere (for reviews, see Buckner, 1996; Nyberg, Cabeza, & Tulving, 1996). Although the exact nature of the functions indexed by these activations remains to be determined, they appear to tap effortful aspects of retrieval (Schacter, Alpert et al., 1996) related to focusing or entering the "retrieval mode" (Nyberg et al., 1995) and also to postretrieval monitoring and criterion setting (Rugg et al., 1997; Schacter, Buckner, Koutstaal, Dale, & Rosen, 1997).

Automatic or Implicit Processes

Whereas the constructive memory framework focuses on conscious, explicit, or episodic memory for specific past experiences, other memory systems are involved in nonconscious or implicit forms of memory (for reviews, see Schacter, Chiu, & Ochsner, 1993; Schacter, Wagner, & Buckner, 2001; Squire, 1992). Consider briefly two such systems: the perceptual representation system (PRS) and procedural memory.

According to Schacter (1994) and Tulving and Schacter (1990), the PRS plays an important role in the identification of words and objects on the basis of their form and structure. PRS operates at a "presemantic" level and is not involved in representing associative or conceptual information (which is the province of yet another system, semantic memory; see Tulving, 1983). Schacter (1994) has distinguished among three major PRS subsystems: a visual word form subsystem that handles information concerning physical and orthographic features; an auditory word form system that handles phonological and acoustic information; and a structural description subsystem that handles information about the relations between parts of an object that specify its global form and structure.

The PRS appears to play a prominent role in the phenomenon known as priming, which has been studied intensively during the past decade. Priming refers to changes in one's ability to identify a word or an object from reduced perceptual cues as a consequence of a recent exposure to it (Tulving & Schacter, 1990). Priming appears to operate nonconsciously, in the sense that people can exhibit effects of priming under conditions in which they lack explicit memory for having studied a word or object (for reviews, see Roediger & McDermott, 1993; Schacter et al., 1993). Further, patients with amnesic syndromes that result from damage to the medial temporal lobes—patients who have great difficulties explicitly remembering recent experiences—exhibit intact priming across a wide variety of tasks, materials, and situations (for review, see Schacter & Buckner, 1998; Squire, 1992). These findings indicate that priming does not depend on the medial temporal structures that mediate explicit remembering. Recent neuroimaging studies of priming suggest that regions of extrastriate visual cortex play a key role (see Schacter & Buckner, 1998, for review). Changes in the PRS that arise as a consequence of analyzing perceptual features, words, or objects likely constitute the basis of many kinds of priming.

Procedural memory refers to the acquisition of skills and habits: "knowing how" rather than "knowing that." Procedural memories are acquired gradually over time through repetitive practice. Studies of amnesic patients have revealed that even patients with a profound inability to explicitly remember past experiences can gradually acquire new perceptual, motor, and cognitive skills (e.g., Cohen & Squire, 1980), habits that are involved in classification and categorization (e.g., Knowlton & Squire, 1993), and implicit knowledge of sequences (Nissen & Bullemer, 1987) or grammatical rules (Knowlton, Ramus, & Squire, 1992). These results show clearly that the acquisition of procedural knowledge does not depend on the medial temporal lobe structures that are damaged in amnesic patients. In contrast, patients with Huntington's disease, who are characterized by damage to the basal ganglia, have difficulties acquiring new motor and cognitive skills despite relatively intact explicit memory—the exact opposite of the pattern exhibited by amnesic patients (e.g., Salmon & Butters, 1995; see Lieberman, 2000, for review). Recent neuroimaging evidence also implicates the basal ganglia, as well as motor cortex, in procedural learning (e.g., Karni et al., 1995; Petersen, van Mier, Fiez, & Raichle, 1998).

Ultimately, the construction of memories depends on interactions among networks that involve multiple brain regions. The exact nature of the operations performed by the constituent regions remains to be specified, and we are just beginning to explore interactions among them.

Systems for the Construction of Emotion

As was the case for memory, emotion depends on multiple systems, each dedicated to processing a specific type of information. In general, emotion systems are concerned with determining whether stimuli are significant to current or long-term goals and guiding action and thought accordingly. An emotional response is generated by the pattern of activity across these systems and may include physiological, behavioral, experiential, and cognitive components (Lazarus, 1991). The process of determining the significance of a stimulus often is called *appraisal*, and may involve separate processes that organize perception of and responses to emotional stimuli (van Reekum & Scherer, 1997). Various theorists have argued that appraisals involve the interaction of two kinds of processes: those that quickly and automatically evaluate the valence of a stimulus and can promote appropriate behavior without need of conscious processing and those that operate consciously and deliberately to control, modify, or initiate ongoing emotional responses (Damasio, 1994; LeDoux, 1995; Leventhal & Scherer, 1987; Ochsner & Feldman Barrett, 2001; Ohman, 1988). Although our understanding of emotion systems is still in its infancy, at present it is useful to broadly organize them along the continuum between automatic and controlled processing to better understand their contributions to the appraisal process (Ochsner & Feldmann Barrett, 2001; Ohman, 1988; van Reekum & Scherer, 1997; see also Dalgliesh, chap. 33, this volume).

Systems for Automatic Emotion Processing

At least two different systems for encoding emotional information can be activated automatically. The information stored in these systems is the knowledge base that guides emotional responses. The most well-studied system involves the amygdala, which receives both coarse sensory input from the thalamus and highly processed information about the identity and appearance of objects from higher cortical centers (Aggleton et al., 2000). Lesion studies in rats and primates, as well as neuroimaging and neuropsychological studies in humans, indicate that the fast subcortical route enables the amygdala to code the potential threat value of stimuli (such as shocks, aversive noises, or fear faces) without conscious awareness (Anderson & Phelps, 2001; Davis, 1997; LeDoux, 1995; Morris, Ohman, & Dolan, 1999; Ochsner & Feldman Barrett, 2001; Whalen, 1998; Whalen et al., 1998). The registration of potential threats promotes the fast linkage of orienting, arousal, and fear responses to coarse representations of these eliciting stimuli (Davis, 1998). The cortical route may supplement this first-pass analysis with information about the precise characteristics of threatening stimuli that differentiate them from nonthreatening ones (Davis, 1997; LeDoux, 2000).

A second system involves the basal ganglia and is important for coding behavioral and cognitive sequences that have become habitual over time. The basal ganglia can be activated automatically by positive or rewarding stimuli, including subliminally presented positive faces (Morris et al., 1996) and cocaine (London et al., 1990). Stimuli that consistently have been reinforced over time promote release of the neurotransmitter dopamine, which stamps in learning of responses to those stimuli (Lieberman, 2000; Schulz, Apicella, Romo, & Scarnati, 1995).

Systems for Controlled Emotion Processing

Three systems are essential for the regulation and monitoring of affective reactions to internal and external stimuli. The first depends upon areas of the ventral medial and orbital frontal cortices and is used to represent the current motivational value of an external stimulus and use it to guide behavior. Neuroimaging studies show activation of these areas by perceived or imagined positive and negative stimuli (e.g., Rauch et al., 1997; Rolls, 1999; Shin et al., 1997) and damage to these areas impairs ability to use affect to guide decision making (Bechara et al., 1995, 1996; Damasio, 1994), the ability to change behavior toward stimuli with learned affective value (Rolls, 1999), and may cause general disinhibition and socially inappropriate affect and behavior (Rolls, 1999). A second system depends upon the anterior cingulate cortex and is used to monitor the extent to which the current motivational state deviates from one that is desired (Ochsner & Feldman-Barrett, 2001; Ochsner, Kosslyn et al., 2001; cf. Botvinick et al., 1999; Posner & DiGirolamo, 1998). This function is important for many behaviors, and activation of regions of cingulate cortex has been associated with many phenomena including mental imagery (Kosslyn, Alpert et al., 1993), working memory (Petit et al., 1998), divided attention (Corbetta et al, 1991) and attention to emotion (Lane, Fink et al., 1997), hypothesis generation (Elliott & Dolan, 1998), the experience of pain (e.g. Talbot, Marrett et al., 1991), and the detection and correction of errors (Botvinick, 1999; Carter et al., 1998). The third structure is the lateral prefrontal cortex. In general, this brain region is important for working memory and implementing cognitive control (Knight et al., 1999; Miller & Cohen, 2001). Recent work suggests lateral prefrontal cortex may play a special role in emotion regulation: Ochsner, Bunge et al. (2001) used functional neuroimaging to compare brain activation when participants either let themselves respond naturally to aversive images or interpreted (or reappraised) these images in unemotional terms. They found that reappraisal activated regions of lateral prefrontal cortex and deactivated regions of the ventromedial prefrontal cortex and amygdala. These results are important because they suggest that exerting cognitive control over emotion can influence both automatic (amygdala) and controlled (ventromedial prefrontal cortex) emotion processing systems (cf. Hariri, Bookheimer, & Mazziotta, 2000).

Emotion Guides the Encoding and Storage of Information

Our emotional responses signal the occurrence of events and stimuli of particular significance to both short- and long-term goals (Lazarus, 1991). In general, these responses serve to protect the self from harm and help us to regulate current mood and behavior (Lazarus, 1991). Emotions thus motivate us to attend to, appraise, reappraise, and organize our understanding of the personally significant stimuli that aroused our feelings (cf. Dalgleish, this volume). The consequence of this added attention and consideration is that we tend to remember affectively charged events differently than we remember mundane ones. This interaction between emotion and encoding has been studied primarily in four domains: the way in which threatening stimuli automatically grab attention, how emotion regulation strategies influence attention and impact on memory, how existing emotion knowledge (in the form of schemas) guides encoding of information, and post-event rehearsal of affective events.

Detecting Threats, Attention, and Weapon Focus

Quite often, the activation of an emotional response is automatic, as strongly valenced stimuli are classified as positive or negative. In the emotional Stroop task, for example, it takes more time to name the color in which words with strong personal significance are printed than it takes to name the print color of neutral words (MacLeod, 1992; Mineka & Nugent, 1995; Williams et al., 1990). This effect seems most pronounced for aversive words (e.g., Pratto & John, 1991), and so long as these words have immediate affective significance, they can capture our attention and interfere with our ability to do other things (Matthews, Mogg, Kentish, & Eysenck, 1995).

The attention-grabbing power of affective and especially threatening stimuli on memory has been demonstrated in studies of a phenomenon known as "weapon focus." This term refers to the tendency of threatening stimuli to dominate initial perception and subsequent memory of stressful events. A classic demonstration of this effect was provided by Loftus and Burns (1982), who asked participants to watch a videotape of a staged bank robbery in which the escaping robbers either did or did not shoot a small boy in the face. Viewing the gunshot impaired memory for immediately preceding events while preserving vivid recall of the shot itself (see also Loftus, Loftus, & Messo, 1987). The apparent automaticity of this effect is underscored in a study by Christianson, Loftus, Hoffmann, and Loftus (1991). Using very brief stimulus presentations or eye-tracking records, they equated viewing time for emotional and neutral slides and found that memory for the emotional stimuli was consistently more accurate.

In some cases, unexpected and incongruent, but nonthreatening, stimuli (such as a banana held by bank robber) also may grab attention and be better remembered (Pickel, 1998). Such stimuli are not directly threatening, however, and it is likely that incongruent and affective stimuli are remembered well for different reasons. This was demonstrated by a recent functional neuroimaging study that related memory to patterns of neural activation during encoding of bizarre and affective stimuli matched for their degree of interest (Hamann et al., 1999). Although both affective and bizarre stimuli were recalled better than neutral stimuli, only for affective stimuli was amygdala activity at encoding correlated with subsequent memory (see also Cahill et al., 1996).

Attention and Emotion Regulation

Although the emotional content of stimuli may automatically grab hold of our attention, we can consciously redirect it to change our response to an event before, during, or after it has occurred. Such attempts at active emotion regulation can change the way in which we encode events and, therefore, how we remember them later on (Gross, 1998). One commonly used regulatory strategy entails suppressing the expression of emotional behavior (e.g., keeping a neutral facial expression or tone of voice so that others do not know that one is unhappy). Although expression suppression may be successful, it takes a physiological toll (Gross & Levenson, 1993) and impairs memory accuracy, possibly by diverting attention from external events to the internal regulatory process (Richards & Gross, 1999). Suppressing one's experience also may impair memory, but by reducing the detail with which events are recollected (Ochsner, 2000). Another commonly used regulatory strategy is to try to forget negative events after they have ended. Studies of intentional or directed forgetting using emotionally evocative words suggest that this strategy can be successful for normal individuals (depending on how and how much one tries to forget; for discussion, see Koutstaal & Schacter, 1997) but may be more difficult for some patients with emotional disorders (McNally, Metzger, Lasko, Clancy, & Pitman, 1998; Wilhelm, McNally, Baer & Florin, 1996). Suppression of visual images may be more difficult, however. Ochsner and Sanchez (2001) found that, whereas neutral photos could be intentionally forgotten, both negative and positive photos resisted attempts to forget them. Although the mechanisms which underlie intentional forgetting are not yet completely understood, they seem to involve restricting attention during exposure to information in anticipation that one may want to forget it, as well as diminishing postevent attention to and rehearsal of target events (Koutstaal & Schacter, 1997).

Schemas and Thematic Detail

The affective significance of a stimulus is not always immediately apparent, and in these cases we rely on knowledge of similar situations to guide a search for disambiguating cues. The emotion knowledge we draw upon may be organized in the form of schemas or scripts that specify the origins, sequelae, and meaning of our emotional responses (Lazarus, 1991). For example, when you return home after a long day at work, your spouse's furrowed brow and sharply inflected voice could indicate either unhappiness with you or the experience of a frustrating day. As is the case for understanding most emotions, it is relevant to find out whether your spouse intended to express himself or herself in this way and what might be motivating his or her actions (Lazarus, 1991; Stein, Wade, & Liwag, 1997). To determine which scenario is correct, one can search for relevant emotion knowledge in associative or episodic memory (e.g., whenever I am late, my spouse is upset) or in the environment (e.g., my spouse had a big presentation today and it might have gone badly).

The use of schematic emotion knowledge during encoding suggests that we will remember information central to and congruent with the schema for a particular kind of emotional experience. Numerous studies have demonstrated better recall for so-called central than peripheral details, including enhanced memory for the actions and weapons, rather than appearance, of attackers (Burke, Heuer, & Reisberg, 1992; Christianson & Loftus, 1987; Clifford & Scott, 1978; Yuille & Cutshall, 1986). The particular kind of information central to the schema depends on the emotion (Levine & Burgess, 1997; Stein et al., 1997), and there is good evidence that schemas help us draw inferences pertaining to causality and intention during the encoding of an emotional event and cause us to misremember these inferences as facts later on (Heuer & Reisberg, 1990).

Self-schemas represent the positive or negative views we have of ourselves, and also may direct us to attend t and encode different aspects of positive or negative events. Which aspects we encode depends upon the nature of our self-schema. The majority of individuals have a positive self-schema, which means that positive information may be elaborated more fully with respect to their existing self-views. As a consequence they may recall and recognize positive self-descriptive words more accurately than neutral and negative words (e.g., Denny & Hun 1992; Mogg et al., 1987). By contrast, individuals with negative self-concepts and self-schemas might be more likely to encode and elaborate negative as opposed to positive self-relevant information. This has been shown depressed patients, who tend to recall or recognize negative depression-related words more accurately than other word types (e.g., Watkins, Mathews, Williamson, & Ful 1992). Because their self-schemas focus attention on elaborating internal sensations and thoughts that are consistent with their negative self-view, depressives tend to m the details of their life experiences and recall episodes an overly general way (Williams & Dritschel, 1988). Attention to schema-congruent information does not always lead to better memory, however, and in some cases goal may be *not* to remember what we have experienc This is the pattern shown by patients with generaliz anxiety disorder who sometimes exhibit impaired rec of anxiety-relevant words (Mineka & Nugent, 1995).

Postevent Rehearsal, Consolidation, and Reminiscence

The emotions we experience in response to signific events may reveal to us what we consider important, wh we want, and why we want it (Ross & Conway, 19 Singer & Salovey, 1996). Whether personal or public, em tional events tend to retain their significance for long periods of time and are recounted and rehearsed more oft than neutral ones (Neisser & Harsch, 1992; Schac 1996), and the amount of rehearsal is generally associat with increased subsequent memory (Cohen, Conway, Maylor, 1994; Conway & Bekerian, 1988; Rubin & Koz 1984; see, however, Christianson & Loftus, 1990; Pillem 1984). Negative events are hard to ignore and may be more important to revisit because they may signal threats th could continue in the future (Skowronski & Carlsto

1989); diary studies have shown that people tend to rehearse unpleasant experiences more than pleasant ones and, as a result, may tend to overestimate the frequency with which they occurred (Thomas & Diener, 1995).

Although memory for arousing events ultimately surpasses memory for neutral events, initially it may actually be worse (Revelle & Loftus, 1992). The initial decline and subsequent improvement in memory for arousing events is called the "reminiscence effect," and it has been demonstrated with both words (Bradley & Baddeley, 1990; Kleinsmith & Kaplan, 1963) and pictures (Kaplan & Kaplan, 1969). The effect is somewhat small and variable (Burke et al., 1992; Corteen, 1969) but is reliable (Park & Banaji, 1996) and may depend on as yet unclear particulars of the paired-associate paradigm most commonly used to study it.

Theoretical accounts of the reminiscence effect have appealed to various kinds of consolidation mechanisms that take more time to integrate emotional events into existing knowledge structures. Revelle and Loftus (1992) suggested that because we extract more information per unit time from emotional than from neutral experiences (Christianson et al., 1991), it may be difficult to access that information initially. The amygdala, which is essential for detecting preattentive threats, seems to be the essential mediator of this consolidation. LaBar and Phelps (1998) found that reminiscence is eliminated by damage to the temporal lobe that includes the amygdala.

Neural Mechanisms for Encoding and Storing Emotional Information

The systems responsible for encoding and storing specifically affective information include the systems for automatic emotion processing reviewed herein. The system involving the amygdala is best understood. Lesion research in rats (e.g., LeDoux et al., 1989) and lesion (e.g., LaBar, LeDoux, Spencer, & Phelps, 1995) and neuroimaging studies with humans (e.g., LaBar et al., 1998) indicate that the amygdala is essential for coding conditioned associations between stimuli and visceral responses. Encoding of emotional information depends on the release of norepinephrine (NE), and drugs that block NE release in animals and humans eliminate the memory advantage for arousing stimuli (Cahill, Prins, Weber, & McGaugh, 1994; McGaugh & Cahill, 1997). The amygdala also modulates consolidation of episodic and semantic information by the hippocampus and related structures: Enhanced recall of the aversive portions of a story is associated with amygdala activity during encoding (Cahill et al., 1996) and is eliminated by amygdala lesions (Markowitsch, Calabrese et al., 1994). Although the majority of studies in humans suggest that the amygdala plays a special role in the detection of threat and memory for aversive stimuli (Ochsner & Feldman-Barrett, 2001), this may be because only a single study has examined memory for positive, as well as negative, information. Hamann et al. (1999) found that recall of both positive and negative photos was correlated with amygdala activity at encoding, which fits with animal studies that show that amygdala lesions block learning of associations between stimuli and appetitive, as well as aversive, visceral states (Holland & Gallagher, 1999).

It is possible that the amygdala's role in emotional memory is to help consolidate the storage of events to the extent that they are arousing, irrespective of their valence, and that the effects of valence on memory are mediated by schematic knowledge stored in associative memory. In keeping with this notion, amygdala lesions eliminate the memory advantage for emotional stimuli only on episodic memory tasks in which the valence or emotional theme of stimuli could not be used to help organize encoding of them (Phelps & Anderson, 1997).

Processing and storing information about appetitive states that involve moving closer to a goal state or stimulus, regardless of whether that stimulus is exclusively positive, seems to be the job of the basal ganglia. In some studies, basal ganglia activation has been observed during the recall of positive, but not negative, personal experiences (Lane, Reiman, Bradley, et al., 1997) and in others during recall of sad, but not happy, ones (Lane, Reiman, Ahern, & Schwartz, 1997). Animal work has indicated that the basal ganglia are important for potentiating and reinforcing conditioned associations between stimuli and appetitive reinforcers, such as food and sex; future neuroimaging research may explicate a similar role for the basal ganglia in humans.

Emotion Influences and Guides Retrieval

Although the product of the encoding process forms the foundation for our recollections, why and how we pull up a record of a past emotional experience is as important a determinant of what we remember as is why and how we initially encoded certain aspects of it. Indeed, retrieval of emotional information does not take place in a vacuum, and it can be influenced strongly by the context in which we recall, and the goals that motivate the search for, remembered information.

Cues That Confound

The first step of the retrieval process involves the activation of stored memory traces by cues that either are self-generated (in the case of recall) or are provided in the retrieval environment (in the case of recognition). Following the classic work of Semon (1909/1923; Schacter, 2001), Tulving (1983) theorized that the conscious product of this process is not a pure representation of activated memory traces but a synergistic combination of cue and trace together. Thus retrieval cues themselves may be incorporated into our conscious recollections. As discussed earlier, unless we have reason to believe the information that comes to mind is incorrect, the second stage of retrieval that allows for monitoring and correction of the memory search may not proceed (Norman & Schacter, 1996).

Affective cues can powerfully bias memory in this way. In some cases, these cues may be internal states. Thus Eich et al. (1985) found that for chronic pain patients, recall of past levels of pain were systematically biased upward or downward in the direction of the level of pain currently being experienced. Interestingly, only if current pain is emotionally evocative does it distort memory for past pain, indicating that it is the emotional, not the physical, state that provides the cues that bias memory (Eich, Rachman, & Lopatka, 1990). These cues also may involve more complex patterns of emotional appraisal. During the 1992 presidential campaign, Levine (1997) studied the supporters of former presidential candidate Ross Perot after he had reentered the race in October to determine how well they could remember their feelings about his withdrawal from the race in July. In general, past feelings were recalled as being more consistent with current feelings than they actually were. For example, if an individual was excited about Perot's return in October but had been upset about his departure in July, he or she recalled having been more hopeful for his return than he or she actually was. The specific direction and kind of bias depended on the specific emotions experienced and were recalled accurately (or were overestimated) only if current feelings had remained constant. Bias also may be caused by external cues, as shown by Ochsner, Schacter, and Edwards (1997), who found that when asked to recall the pleasant or unpleasant tone of voice in which a person had spoken earlier, recall was biased in the direction of affect present in a photo of that person used as a retrieval cue.

Although numerous factors likely influence the degree of bias caused by a retrieval cue, such as the relative perceptual dominance of one type of cue over another (Ochsner et al., 1997) and the relative specificity of the cue and completeness of the memory trace (Norman & Schacter, 1996), this important topic has been little studied for emotional memories (for discussion of retrieval bias in other domains, see Schacter, 1999).

Schemas: The Goals, the Biases, and the Unknown

The second stage of the retrieval process involves evaluating the information brought to awareness by the retrieval cues. When recalling emotional events, our schematic emotion knowledge can guide this process in at least three primary ways: by setting the goals which initiate memory search, by setting the criteria against which past experiences are judged desirable or accurate, and by guiding conscious or nonconscious inferences that fill in missing or unknown information that was not encoded initially. Because of their close interdependence on a shared pool of knowledge, each of these schematic influences often occurs in combination with at least one of the others. In each of the examples that follow, although we highlight only one kind of influence for purposes of illustration, more than one kind may be present.

Self- and Mood-Regulatory Goals

Our self-knowledge may act as a chronic goal that guides retrieval of past experiences to confirm or create a compatible self-image in the present (Ochsner & Schacter, 2000; Ross, 1986). For most individuals, this means maintaining a positive self-view (Taylor, 1989) that can guide us, for example, to remember past faults and foibles, such as poor grades (Bahrick, Hall, & Berger, 1996) or unsuccessful gambling ventures (Frank & Gilovich, 1989), either as less common or as more positive than they actually were (Conway & Ross, 1984). Similarly, married men might protect themselves from feeling responsible about marital decline by misremembering early marital life in less rosy terms (Holmberg & Holmes, 1994, as cited in Levine, 1997). As discussed earlier, depressives may recall experiences as more negative than they actually were, which reinforces their negative self-view (Nolen-Hoeksema, 1991).

Higgins (Higgins & Tykocinski, 1992) has suggested that there may be two ways in which we maintain our self-views: We either focus on attaining our ideals or on avoiding the consequences of failing to fulfill our duties and responsibilities. He has found that each type of individual will tend to recall different kinds of information: An ideal focus leads one to recall more positive information, whereas a duty focus (or ought-focus, as he calls it) leads one to recall more negative information (Higgins & Tykocynski, 1992; see also Singer, 1990).

Retrieval of emotional experiences also may be used to regulate our present mood. Just as we want to maintain a positive self-concept, most of the time we want to feel good and will recall positive life events when feeling bad. Thus Josephson, Singer, and Salovey (1994, as cited in Singer & Salovey, 1996) found that, although negative memories were initially brought to mind by a sad film, participants tended to then recall positive experiences and most were consciously attempting to change their mood by doing so. The tendency to recall positive memories in response to negative moods may be more pronounced in individuals with high self-esteem (Smith & Petty, 1995) or who exhibit a repressive coping style (Boden & Baumeister, 1997), although they may have different reasons for exhibiting this tendency. Individuals with high self-esteem may acknowledge that they felt bad, whereas repressors may not. As a consequence, individuals with high self-esteem may learn that they can successfully cope with negative affect, whereas repressors fail to learn that they can adapt and may continue to avoid situations in which negative affect may be evoked (McFarland & Buehler, 1997). It is important to note that in some cases recall of negative experiences may be desirable, such as when we want to dampen a playful mood to focus on work or other tasks (Parrot & Sabini, 1990).

Criterion Setting and Reevaluation

When deciding what to search for in memory and deciding whether what we have recalled is accurate, our judgments may be informed by cultural and personal theories about how feelings and attitudes rise or fall over time (Ross, 1989). In some cases, these theories are implicit and guide the assumptions we make without our being aware that our recollections are being biased. For example, women tend to recall past menstrual cycles as being more painful then they actually were, which fits with popular notions that anxiety increases just before menstruation begins but contrasts with empirical research that indicates that this increase in anxiety may not occur (McFarland, Ross, & DeCourville, 1989; Ross & Buehler, 1994).

In other cases, our theories may be more explicit and can be used to control the impact that past events have on us in the present. Of particular importance are theories one holds about the need to revisit past experiences, because the nature of these theories determines whether or not we learn from them. For example, one could believe that reliving past pain begets more pain in the present, and research does suggest that recollecting unpleasant experiences can depress mood and may bring other, like experiences to mind, especially if the experiences are traumatic (Bower & Forgas, 2000; Strack, Schwarz, & Schneidinger, 1985). One might hold this belief because a particularly extreme past experience has changed the way in which one evaluates the quality of present experiences. Lottery winners, for example, take less pleasure in normal everyday activities, presumably because they fail to match the pleasure of their win (Brickman, Coates, & Janoff-Bulman, 1978). Similarly, paraplegics also may enjoy the present less than they did before their life-changing event because they remember life before the accident as having been better than it is now. Belief that the past produces pain that cannot be controlled or diminished may foster avoidance and fear of new painful experiences, as well as a repressive coping style that has adverse health consequences.

However, if one believes that the causes of past tragedies or joys can be understood and controlled, then past events can be recollected much more positively (Janoff-Bulman, 1992). For individuals with this belief, recollection serves to restructure beliefs about the past and the ability to cope in the future, thereby fostering a sense of learning and growth by allowing people to feel that they have gained control over the factors that influence their happiness (Janoff-Bulman, 1992; Folkman & Lazarus, 1984).

For example, when recounting traumatic experiences, understanding and expressing one's feelings and their sources can have salutary effects on mental and physical health (Pennebaker, 1997). Studies of the way in which we recall pain also illustrate this point nicely: Sometimes recalling pain as less severe than it was can make people feel more hopeful and in control, as is the case for mothers recollecting the pain of childbirth (Norvell, Gaston-Johansson, & Fridh, 1987); but sometimes recollecting pain as more severe can serve the same end, as shown by people with high dental anxiety who recall more pain than they actually reported experiencing following a trip to the dentist (Kent, 1985). In the long term, our tendencies to construe and re-recollect events positively or negatively can determine our overall level of happiness (Seidlitz & Diener, 1993; Suh, Diener, & Fujita, 1996).

Our goals in remembering past events and our ability to learn from them may be different depending on how long ago they occurred. Strack et al. (1985) suggested that recent events may indicate how able we are to cope with stresses and enjoy successes and can shift mood in a direction congruent with the emotion recalled. In contrast, we may recall long-distant events when we want to make inferences about how we have developed over time. Thus remembering an argument with one's father could make us nostalgic and wistful if the argument took place during childhood but upset and angry if it took place only a few days ago (Strack et al., 1985).

Filling in for What Is Unknown

Another reason that schematic emotion knowledge can influence memory for past events is that our initial affective responses to them may not have been well encoded in the first place. If our initial feelings are not easily recoverable because they were not well stored, then schematic knowledge may be used to fill in what is missing.

For example, information about the duration of events is one attribute that seems to be poorly encoded, and we use memory of the intensity of the experience to draw inferences about it. Thus, when asked to rate the likability of a film, our judgments are based on its content and not its duration (Fredrickson & Kahneman, 1993), and estimates of the duration of violent scenes increase as a function of the intensity of our emotional reactions to them (Loftus et al., 1987). We may focus on intensity and neglect duration to such an extent that we prefer a longer lasting, but less painful, experience to a shorter but more painful one (Varey & Kahneman, 1992).

Altered States of Awareness

A final way in which emotion may influence retrieval is by influencing the subjective state of awareness accompanying recollection of past events. In general, as compared to neutral events, emotional events tend to be subjectively re-experienced in a way that seems to more closely approximate our original experience of them. The effects of emotion on awareness may stem from the fact that affecting stimuli activate physiological responses that can add heat and color to our initial experiences and our memories of them. The sense of subjective re-experiencing has been studied in at least three different ways.

The first involves simply asking people to rate the vividness with which they recall past personal experiences. Numerous studies have shown that recollections of significant, affecting, or consequential events are rated as more vivid than neutral events (e.g., Conway & Bekerian, 1988; Christianson & Loftus, 1990). Vividness ratings are ambiguous, however, with respect to the basis on which they are made (see Ochsner & Schacter, 2000, for discussion), and a second—more direct—method for assessing states of awareness employs the *remember/know* method of Tulving (1983), Gardiner, and others (e.g., Gardiner & Java, 1993). As discussed earlier, this method asks participants to indicate whether their recall or recognition of an event is accompanied by a detailed sense of re-experiencing an event (in which case, a *remember* response would be made), or whether it simply seems familiar (in which case, a *know* response is made). Ochsner (in press) found that emotionally arousing and especially negative photos were more likely to be remembered than neutral ones, and also found that this effect did not require one to explicitly appraise the emotionality of the images when they first were seen. The final way in which awareness has been assessed has to do with our subjective point of view when visualizing past experiences. Events can be re-viewed in the mind's eye either from one's original first-person, or *field*, perspective or from a detached, third-person *observer* perspective in which the rememberer sees herself as part of the memory. Focusing on recovering past feelings makes us more likely to see events unfold from a *field* perspective (Robinson & Swanson, 1993).

Neural Systems for Retrieving Emotional Information

Retrieval of emotional memories seems to involve most of the systems used for retrieval in general (reviewed in the section titled "Systems for the Construction of Memory"), in combination with the systems used for controlled, and to a lesser extent automatic, emotion processing. In this section we focus on the contributions of those structures involved in emotion.

The two automatic emotion systems that encode and store information about the link between conditioned stimuli or behaviors and visceral states are involved in retrieval of those links. For example, studies of fear conditioning have shown that expression of conditioned fear responses is eliminated if the amygdala is lesioned after training has been completed (LeDoux, 1995). Similarly, posttraining lesions of the basal ganglia can disrupt expression of well-learned sequences of rewarded behavior, including grooming (Berridge & Whishaw, 1992). Although amygdala activity at encoding may be correlated with memory for episodic and associative information (e.g., Cahill et al., 1996; Hamann et al., 1999), presumably because it is helping to consolidate storage of it, the amygdala does not seem to be so important for the retrieval of declarative emotion knowledge. The dissociability of conditioned and episodic emotional knowledge also has been shown in studies that compare amnesiacs who cannot remember a fear-conditioning procedure even though they show conditioned fear responses and patients with amygdala lesions who remember the procedure but acquired no conditioned associations (e.g., Bechara, Tranel, Damasio, & Adolphs, 1995).

Although it is likely that the basal ganglia also do not participate in the retrieval of associative or episodic emotion knowledge, the requisite studies have not yet been performed. One study did show basal ganglia activation during retrieval of positive memories (Lane, Reiman, Bradley, et al., 1997), but it is not clear whether the activation was due to retrieval of information or to the experience of positive affect per se. This interpretive problem is quite general and affects other studies of the retrieval of emotional memories: It is seldom clear whether activation or the failure to find activation of a putative emotion area means that it is or is not involved in retrieval or experience (e.g., George, Ketter, Parekh, & Horwitz, 1995).

Areas involved in controlled emotion processing are important for mediating retrieval of emotional information. For example, the orbital and ventral medial prefrontal regions seem to be essential for gating the expression of learned conditioned behaviors. Lesions to these areas in rats, monkeys, or humans will cause perseverative responding to stimuli that are no longer being reinforced (Bechara, Damasio, Tranel, & Damasio, 1996, 1997; Rolls, 1999; Stuss, Eskes, & Foster, 1994). An inability to inhibit previously learned responses following medial prefrontal damage also can slow extinction of conditioned fear responses (Morgan & LeDoux, 1995).

Retrieval of emotional memories also may activate more strongly systems that are used to retrieve information more generally. Shin et al. (1997) asked normals and patients with posttraumatic stress disorder to generate from memory mental images of either combat-related or neutral scenes that they had studied earlier. Areas of visual cortex thought to be the "mental screen" on which images are viewed were activated more strongly by the combat scenes. It is possible that this pattern of heightened activity is the neural signature of the vividness and experiential detail that characterizes emotional recollection.

Summary

It is a truism in science that all else being equal, theories that can account for the largest body of data possible are most robust, generalizable, and desirable. For the past century, researchers in cognitive neuroscience and social psychology have conducted studies of phenomena related to emotion and memory. Social psychological theories have emphasized the individualized nature of the emotion process and how goals influence what we recollect and how accurately we do so. Cognitive neuroscientists, following in the footsteps of the cognitive psychologists who preceded them, have related the accuracy of emotional memory to the functional specialization of neural systems. Current theories account only for the data obtained within the confines of one discipline or the other, but not both.

We believe that the time is right to put the methods, data, and theories of these two disciplines together to construct theories of emotion and memory that make contact with data at many levels of analysis. This is the essence of the social cognitive neuroscience approach that has guided this chapter, and it has led to some general conclusions that integrate insights from social psychological and cognitive neuroscientific research. The first is that emotion and memory are inherently constructive, goal-directed, and individual; the second is that each depends on a set of separate but interacting neural systems, each dedicated to processing a specific type of information; the third and last is that many emotion and memory phenomena can be seen as arising from the interaction of those systems that operate automatically and those that operate under conscious control. This means that the content of recollection depends on the goals that guide encoding and recollection, the nature of the emotion involved, and the neural systems that are activated.

Although it is clear that what we recollect depends on why we are trying to remember, at present our knowledge of how neural systems mediate this process is much murkier. In general, future research should continue to apply a social cognitive neuroscience approach to explore how and why the activity of different neural systems is influenced by different encoding and retrieval goals and how these systems are involved in either the encoding, storage, or retrieval and reexperiencing of episodes past.

REFERENCES

Aggleton, J. (Ed.). (2000). *The amygdala: A functional analysis.* New York: Guilford Press.

Anderson, A. K., & Phelps, E. A. (2001). Lesions of the human amygdala impair enhanced perception of emotionally salient events. *Nature, 411,* 305–309.

Bahrick, H. P., Hall, L. K., & Berger, S. A. (1996). Accuracy and distortion in memory for high-school grades. *Psychological Science, 7,* 265–271.

Bechara, A., Damasio, H., Damasio, A. R., & Lee, G. P. (1999). Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. *Journal of Neuroscience, 19,* 5473–5481.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1996). Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. *Cerebral Cortex, 6,* 215–225.

Bechara, A., Tranel, D., Damasio, H., & Adolphs, R. (1995). Double dissociation of conditioning and declarative knowledge relative to the amygdala and hippocampus in humans. *Science, 269,* 1115–1118.

Berridge, K. C., & Whishaw, I. Q. (1992). Cortex, striatum and cerebellum: Control of serial order in a grooming sequence. *Experimental Brain Research, 90,* 275–290.

Boden, J. M., & Baumeister, R. F. (1997). Repressive coping: Distraction using pleasant thoughts and memories. *Journal of Personality and Social Psychology, 73,* 45–62.

Botvinick, M. M., Braver, T. S., Carter, C. S., Barch, D. M., & Cohen, J. D. (1999). Evaluating the demand for control: Anterior cingulate cortex and cross-talk monitoring. (Tech. Rep.). Pittsburgh, PA: Carnegie-Mellon University.

Bouton, M. E. (1994). Context, ambiguity, and classical conditioning. *Current Directions in Psychological Science, 3*(2), 49–53.

Bower, G. H., & Forgas, J. P. (2000). Affect, memory, and social cognition. In E. E. Eich (Ed.), *Cognition and emotion.* New York: Oxford University Press.

Bradley, B. P., & Baddeley, A. D. (1990). Emotional factors in forgetting. *Psychological Medicine, 20,* 351–355.

Bradley, M. M. (1994). Emotional memory: A dimensional analysis. In S. H. M. v. Goozen, N. E. V. d. Poll, & J. A. Sergeant (Eds.), *Emotions: Essays on emotion theory* (pp. 97–134). Hillsdale, NJ: Erlbaum.

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 379–390.

Brewer, J. B., Zhao, Z., Glover, G. H., & Gabrieli, J. D. E. (1998). Making memories: Brain activity that predicts whether visual experiences will be remembered or forgotten. *Science, 281,* 1185–1187.

Brewer, W. F. (1992). The theoretical and empirical status of flashbulb memory hypothesis. In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb" memories* (pp. 274–305). New York: Cambridge University Press.

Brickman, P., Coates, D., & Janoff-Bulman, R. (1978). Lottery winners and accident victims: Is happiness relative? *Journal of Personality and Social Psychology, 36*(8), 917–927.

Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition, 5*, 73–99.

Buckner, R. L. (1996). Beyond HERA: Contributions of specific prefrontal brain areas to long-term memory retrieval. *Psychonomic Bulletin and Review, 3*, 149–158.

Bunge, S. A., Ochsner, K. N., Desmond, J. E., Glover, G. H., & Gabrieli, J. D. E. (2001). Prefrontal regions involved in keeping information in and out of mind. *Brain, 124*, 2074–2086.

Burgess, P. W., & Shallice, T. (1996). Confabulation and the control of recollection. *Memory, 4*, 359–411.

Burke, A., Heuer, F., & Reisberg, D. (1992). Remembering emotional events. *Memory and Cognition, 20*, 277–290.

Cahill, L., Haier, R. J., Fallon, J., Alkire, M., Tang, C., Keator, D., Wu, J., & McGaugh, J. L. (1996). Amygdala activity at encoding correlated with long-term, free recall of emotional information. *Proceedings of the National Academy of Sciences, 93*, 8016–8021.

Cahill, L., Prins, B., Weber, M., & McGaugh, J. L. (1994). b-Adrenergic activation and memory for emotional events. *Nature, 371*, 702–704.

Carter, C. S., Braver, T. S., Barch, D. M., Botvinick, M. M., Noll, D., & Cohen, J. D. (1998). Anterior cingulate cortex, error detection, and the online monitoring of performance. *Science, 280*, 747–749.

Christianson, S.-Å. (1992). Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin, 112*, 284–309.

Christianson, S.-Å., & Loftus, E. F. (1987). Memory for traumatic events. *Applied Cognitive Psychology, 1*, 225–239.

Christianson, S.-Å., & Loftus, E. F. (1990). Some characteristics of people's traumatic memories. *Bulletin of the Psychonomic Society, 28*, 195–198.

Christianson, S.-Å., & Loftus, E. (1991). Remembering emotional events: The fate of detailed information. *Cognition and Emotion, 5*, 81–108.

Christianson, S.-Å., Loftus, E. F., Hoffmann, H., & Loftus, G. R. (1991). Eye fixations and memory for emotional events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17*, 693–701.

Clifford, B. R., & Scott, J. (1978). Individual and situational factors in eyewitness testimony. *Journal of Applied Psychology, 63*, 352–359.

Cohen, G., Conway, M. A., & Maylor, E. A. (1994). Flashbulb memories in older adults. *Psychology and Aging, 9*, 454–463.

Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern analyzing skill in amnesics: Dissociation of knowing how and knowing that. *Science, 210*, 207–210.

Conway, M., & Ross, M. (1984). Getting what you want by revising what you had. *Journal of Personality and Social Psychology, 47*, 738–748.

Conway, M. A. (1997). *Recovered and false memories*. Oxford, England: Oxford University Press.

Conway, M. A., & Bekerian, D. A. (1988). Characteristics of vivid memories. In M. M. Grunebeg, P. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (Vol. 1, pp. 519–524). Chichester, England: Wiley.

Corbetta, M., Miezin, F. M., Dobmeyer, S., Shulman, G. L., & Petersen, S. E. (1991). Selective and divided attention during visual discriminations of shape, color, and speed: Functional anatomy by positron emission tomography. *Journal of Neuroscience, 11* (8), 2383–2402.

Corteen, R. S. (1969). Skin conductance changes and word recall. *British Journal of Psychology, 60*, 81–84.

Damasio, A. R. (1989). Time-locked multiregional retroactivation: A systems-level proposal for the neural substrates of recall and recognition. *Cognition, 33*, 25–62.

Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Putnam.

Davis, M. (1997). Neurobiology of fear responses: The role of the amygdala. *Journal of Neuropsychiatry and Clinical Neurosciences, 9*, 382–402.

Davis, M. (1998). Are different parts of the extended amygdala involved in fear versus anxiety? *Biological Psychiatry, 44*, 1239–1247.

Denny, E. B., & Hunt, R. R. (1992). Affective valence and memory in depression. *Journal of Abnormal Psychology, 101*, 575–580.

Eich, E., Rachman, S., & Lopatka, C. (1990). Affect, pain and autobiographical memory. *Journal of Abnormal Psychology, 99*, 174–178.

Eich, E., Reeves, J. L., Jaeger, B., & Graff-Radford, S. B (1985). Memory for pain: Relation between past and present pain intensity. *Pain, 23*, 375–380.

Elliott, R., & Dolan, R. J. (1998). Activation of different anterior cingulate foci in association with hypothesis testing and response selection. *Neuroimage, 8*, 17–29.

Folkman, S., & Lazarus, R. (1984). Personal control and stress and coping processes: A theoretical analysis. *Journal of Personality and Social Psychology, 46*, 839–852.

Frank, M. G., & Gilovich, T. (1989). Effect of memory perspective on retrospective causal attributions. *Journal Personality and Social Psychology, 57*, 399–403.

Fredrickson, B. L., & Kahneman, D. (1993). Duration neglect in retrospective evaluations of affective episodes. *Journal of Personality and Social Psychology, 65* (1 45–55.

Gardiner, J. M., & Java, R. I. (1993). Recognising and remembering. In A. F. Collins, S. E. Gathercole, M. A Conway, & P. E. Morris (Eds.), *Theories of memory* (pp. 163–188). Hove, England: Erlbaum.

George, M. S., Ketter, T. A., Parekh, P. I., & Horwitz, B (1995). Brain activity during transient sadness and happiness in healthy women. *American Journal of Psychiatry, 152*, 341–351.

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*, 224–237.

Gross, J. J., & Levenson, R. W. (1993). Emotional suppression: Physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology, 106*, 970–986.

Hariri, A. R., Bookheimer, S. Y., & Mazziotta, J. C. (2000 Modulating emotional responses: Effects of a neocortical network on the limbic system. *Neuroreport, 11*, 43–48.

Hamann, S. B., Ely, T. D., Grafton, S. T., & Kilts, C. D (1999). Amygdala activity related to enhanced memory for pleasant and aversive stimuli. *Nature Neuroscience, 2*, 289–293.

Heuer, F., & Reisberg, D. (1992). Vivid memories of emotional events: The accuracy of remembered minutiae. *Memory and Cognition, 18*, 496–506.

Higgins, E. T., & Tykocinski, O. (1992). Self-discrepancies and biographical memory: Personality and cognition at the level of psychological situation. *Personality and Social Psychology Bulletin, 18*, 527–535.

Holland, P. C., & Gallagher, M. (1999). Amygdala circuitry in attentional and representational processes. *Trends in Cognitive Sciences, 3*(2), 65–73.

Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language, 32*, 421–445.

Hyman, I. E., Husband, T. H., & Billings, F. J. (1995). False memories of childhood experiences. *Applied Cognitive Psychology, 9*, 181–197.

Janoff-Bulman, R. (1992). *Shattered assumptions: Towards a new psychology of trauma.* New York: Free Press.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114*, 3–28.

Johnson, M. K., & Sherman, S. J. (1990). Constructing and reconstructing the past and future in the present. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Volume 2. Foundations of social behavior.* New York: Guilford Press.

Kaplan, R., & Kaplan, S. (1969). The arousal-retention interval revisited: The effects of some procedural changes. *Psychonomic Science, 15*, 84–85.

Karni, A., Meyer, G., Jezzard, P., Adams, M. M., Turner, R., & Ungerleider, L. G. (1995). Functional MRI evidence for adult motor cortex plasticity during motor skill learning. *Nature, 377*, 155–158.

Kent, G. (1985). Memory of dental pain. *Pain, 21*, 187–194.

Kleinsmith, L. J., & Kaplan, S. (1963). Paired-associate learning as a function of arousal and interpolated interval. *Journal of Experimental Psychology, 65*, 190–193.

Knight, R. T., Staines, W. R., Swick, D., & Chao, L. L. (1999). Prefrontal cortex regulates inhibition and excitation in distributed neural networks. *Acta Psychologica, 101*, 159–178.

Knowlton, B. J., Ramus, S. J., & Squire, L. R. (1992). Intact artificial grammar learning in amnesia: Dissociation of classification learning and explicit memory for specific instances. *Psychological Science, 3*, 172–179.

Knowlton, B. J., & Squire, L. R. (1993). The learning of categories: Parallel brain systems for item memory and category level knowledge. *Science, 262*, 1747–1749.

Koutstaal, W., & Schacter, D. L. (1997). Intentional forgetting and voluntary thought suppression: Two potential methods for coping with childhood trauma. In L. H. Dickstein, M. B. Riba, & J. M. Oldham (Eds.), *Annual Review of Psychiatry* (Vol. 16). Washington, DC: American Psychiatric Press.

LaBar, K. S., Gatenby, J. C., Gore, J. C., LeDoux, J. E., & Phelps, E. A. (1998). Human amygdala activation during conditioned fear acquisition and extinction: A mixed-trial fMRI study. *Neuron, 20*, 937–945.

LaBar, K. S., LeDoux, J. E., Spencer, D. D., & Phelps, E. A. (1995). Impaired fear conditioning following unilateral temporal lobectomy in humans. *Journal of Neuroscience, 15*, 6846–6855.

LaBar, K. S., & Phelps, E. A. (1998). Arousal-mediated memory consolidation. *Psychological Science, 9*, 490–493.

Lane, R. D., Fink, G. R., Chau, P. M.-L., & Dolan, R. J. (1997). Neural activation during selective attention to subjective emotional responses. *Neuroreport, 8*, 3969–3972.

Lane, R. D., Reiman, E. M., Ahern, G. L., & Schwartz, G. E. (1997). Neuroanatomical correlates of happiness, sadness, and disgust. *American Journal of Psychiatry, 154*, 926–933.

Lane, R. D., Reiman, E. M., Bradley, M. M., Lang, P. J., Ahern, G. L., Davidson, R. J., & Schwartz, G. E. (1997). Neuroanatomical correlates of pleasant and unpleasant emotion. *Neuropsychologia, 35*, 1437–1444.

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30(3)*, 261–273.

Lazarus, R. S. (1991). *Emotion and adaptation.* New York: Oxford University Press.

LeDoux, J. E. (1995). Emotion: Clues from the brain. *Annual Review of Psychology, 46*, 209–235.

LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, 23, 155–184.

LeDoux, J. E., Romanski, L., & Xagoraris, A. (1989). Indelibility of subcortical emotional memories. *Journal of Cognitive Neuroscience, 1*, 238–243.

Leventhal, H., & Scherer, K. (1987). The relationship of emotion to cognition: A functional approach to a semantic controversy. *Cognition and Emotion, 1*, 3–28.

Levine, L. J. (1997). Reconstructing memory for emotions. *Journal of Experimental Psychology: General, 126*, 165–177.

Levine, L. J., & Burgess, S. L. (1997). Beyond general arousal: Effects of specific emotions on memory. *Social Cognition, 15*, 157–181.

Lieberman, M. D. (in press). Intuition: A social cognitive neuroscience approach. *Psychological Bulletin.*

Lieberman, M. D., Ochsner, K. N., Gilbert, D. T., & Schacter, D. L. (2001). Do amnesics exhibit cognitive dissonance reduction? The role of explicit memory and attention in attitude change. *Psychological Science, 12*, 135–140.

Lindsay, D. S., & Read, J. D. (1994). Psychotherapy and memories of childhood sexual abuse: A cognitive perspective. *Applied Cognitive Psychology, 8*, 281–338.

Loftus, E. F. (1993). The reality of repressed memories. *American Psychologist, 48*, 518–537.

Loftus, E. F., & Burns, T. (1982). Mental shock can produce retrograde amnesia. *Memory and Cognition, 10*, 318–323.

Loftus, E. F., & Ketcham, K. (1994). *The myth of repressed memory: False memories and allegations of sexual abuse.* New York: St. Martin's Press.

Loftus, E. F., Loftus, G., & Messo, J. (1987). Some facts about "weapon focus." *Law and Human Behavior, 11*, 55–62.

Loftus, E. F., & Pickrell, J. E. (1995). The formation of false memories. *Psychiatric Annals, 25*, 720–725.

London, E. D., Broussolle, E. P., Links, J. M., Wong, D. F., Cascella, N. G., Dannals, R. F., Sano, M., Herning, R., Snyder, F. R., Rippetoe, L. R., Toung, T. J., Jaffe, J. H., & Wagner, H. N. (1990). Morphine-induced metabolism changes in human brain: Studies with positron emission tomography and [fluorine 18] fluorodeoxyglucose. *Archives of General Psychiatry, 47*, 73–81.

Markowitsch, H. J., Calabrese, P., Würker, M., Durwen, H. F., Kessler, J., Babinsky, R., Brechtelsbauer, D., Heuser, L., & Gehlen, W. (1994). The amygdala's contribution to memory—a study on two patients with Urbach-Wiethe disease. *Neuroreport. 5*, 1349–1352.

Mathews, A., Mogg, K., Kentish, J., & Eysenck, M. (1995). Effect of psychological treatment on cognitive bias in generalized anxiety disorder. *Behaviour Research and Therapy, 33*, 293–303.

Matlin, M. W., & Stang, D. J. (1978). *The Pollyanna principle.* Cambridge, MA: Schenkman.

McClelland, J. L., McNaughton, B. L., & O'Reilly, R. C. (1995). Why there are complementary learning systems in the hippocampus and neocortex: Insights from the successes and failures of connectionist models of learning and memory. *Psychological Review, 102*, 419–457.

McFarland, C., & Buehler, R. (1997). Negative affective states and the motivated retrieval of positive life events: The role of affect acknowledgement. *Journal of Personality and Social Psychology, 73*, 200–214.

McFarland, C., Ross, M., & DeCourville, N. (1989). Women's theories of menstruation and biases in recall of menstrual symptoms. *Journal of Personality and Social Psychology, 57*, 522–531.

McGaugh, J. L. (1995). Emotional activation, neuromodulatory systems and memory. In D. L. Schacter (Ed.), *Memory distortion: How minds, brains, and societies reconstruct the past* (pp. 255–273). Cambridge, MA: Harvard University Press.

McGaugh, J. L., & Cahill, L. (1997). Interaction of neuromodulatory systems in modulating memory storage. *Behavioural Brain Research, 83*, 31–38.

McNally, R. J., Metzger, L. J., Lasko, N. B., Clancy, S. A., & Pitman, R. K. (1998). Directed forgetting of trauma cues in adult survivors of childhood sexual abuse with and without posttraumatic stress disorder. *Journal of Abnormal Psychology, 107*, 596–601.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24*, 67–202.

Mineka, S., & Nugent, K. (1995). Mood-congruent memory biases in anxiety and depression. In D. L. Schacter, J. T. Coyle, G. D. Fischbach, M.-M. Mesulam, & L. E. Sullivan (Eds.), *Memory distortion: How minds, brains, and societies reconstruct the past* (pp. 173–196). Cambridge, MA: Harvard University Press.

Mogg, K., Mathews, A., & Weinman, J. (1987). Memory bias in clinical anxiety. *Journal of Abnormal Psychology, 96*, 94–98.

Morgan, M. A., & LeDoux, J. E. (1995). Differential contribution of dorsal and ventral medial prefrontal cortex to the acquisition and extinction of conditioned fear in rats. *Behavioral Neuroscience, 109*(4), 681–688.

Morris, J. S., Frith, C. D., Perrett, D. I., Rowland, D., Young, A. W., Calder, A. J., & Dolan, R. J. (1996). A differential neural response in the human amygdala to fearful and happy facial expressions. *Nature, 383*, 812–815.

Morris, J. S., Ohman, A., & Dolan, R. J. (1999). A subcortical pathway to the right amygdala mediating "unseen" fear. *Proceedings of the National Academy of Sciences, 96*, 1680–1685.

Moscovitch, M. (1994). Memory and working-with-memory: Evaluation of a component process model and comparisons with other models. In D. L. Schacter & E. Tulving (Eds.), *Memory systems 1994* (pp. 269–310). Cambridge, MA: MIT Press.

Neisser, U., & Harsch, N. (1992). Phantom flashbulbs: False recollections of hearing the news about Challenger In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb memories* (pp. 9–31). Cambridge, England: Cambridge University Press.

Nissen, M. J., & Bullemer, P. (1987). Attentional requirements of learning: Evidence from performance measures. *Cognitive Psychology, 19*, 1–32.

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*, 569–582.

Norman, K. A., & Schacter, D. L. (1996). Implicit memory explicit memory, and false recognition: A cognitive neuroscience perspective. In L. M. Reder (Ed.), *Implicit memory and metacognition.* (pp. 00–00). Hillsdale, NJ Erlbaum.

Norvell, K. T., Gaston-Johansson, F., & Fridh, G. (1987 Remembrance of labor pain: How valid are retrospective pain measurements? *Pain, 31*, 77–86.

Nyberg, L., Cabeza, R., & Tulving, E. (1996). PET studies of encoding and retrieval: The HERA model. *Psychonomic Bulletin and Review, 3*, 135–148.

Nyberg, L., Tulving, E., Habib, R., Nilsson, L.-G., Kapur S., Houle, S., Cabeza, R., & McIntosh, A. R. (1995 Functional brain maps of retrieval mode and recovery of episodic information. *Neuroreport, 6*, 249–252.

Ochsner, K. N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General, 129*, 242–261.

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E (2001, April). *Rethinking feelings: Exploring the neurocognitive bases of emotion control.* Paper presented at UCLA conference on social cognitive neuroscience Los Angeles, CA.

Ochsner, K. N., & Feldman-Barrett, L. (2001). In T. Mayne & G. Bonnano (Eds.), *Emotion: Current issues and future directions.* New York: Guilford Press.

Ochsner, K. N., & Kosslyn, S. M. (1999). The cognitive neuroscience approach. In D. E. Rumelhart & B. Martin-Bly (Eds.), *Handbook of cognition and perception* (Vol. 10). San Diego: Academic Press.

Ochsner, K. N., Kosslyn, S. M., Cosgrove, G. R., Price B., Cassem, N., Nierenberg, A., & Rauch, S. (2001 Deficits in visual cognition and attention following bilateral anterior cingulotomy. *Neuropsychologia, 3* 219–230.

Ochsner, K. N., & Lieberman, M. D. (2001). The emergence of social cognitive neuroscience. *American Psychologist, 56*, 717–734.

Ochsner, K. N., & Sanchez, H. (2001). *The relation between the regulation and recollection of affective experience.* Unpublished manuscript.

Ochsner, K. N., & Schacter, D. L. (2000). A social cognitive neuroscience approach to emotion and memory. In J. C Borod (Ed.), *The neuropsychology of emotion* (pp. 163–193). New York: Oxford University Press.

Ochsner, K. N., Schacter, D. L., & Edwards, K. (1997). Illusory recall of vocal affect. *Memory, 5*, 433–455.

Ohman, A. (1988). Preattention processes in the generation of emotions. In V. Hamilton, G. H. Bower, & N. H Frijda (Eds.), *Cognitive perspectives on emotion and motivation* (Vol. 44, pp. 127–143).

Park, J., & Banaji, M. (1996, May). *The effect of arousal and retention delay on memory: A meta-analysis.* Paper presented at the annual convention of the American Psychological Society, San Francisco.

Parrott, W. G., & Sabini, J. (1990). Mood and memory under natural conditions: Evidence for mood incongruent recall. *Journal of Personality and Social Psychology, 59*, 321–336.

Pennebaker, J. W. (1997). Writing about emotional experiences as a therapeutic process. *Psychological Science, 8*, 162–166.

Petersen, S. E., van Mier, H., Fiez, J. A., & Raichle, M. E. (1998). The effects of practice on the functional anatomy of task performance. *Proceedings of the National Academy of Science, 95*, 853–860.

Petit, L., Courtney, S. M., Ungerleider, L. G., & Haxby, J. V. (1998). Sustained activity in the medial wall during working memory delays. *Journal of Neuroscience, 1822*, 9429–9437.

Phelps, E. A., & Anderson, A. K. (1997). Emotional memory: What does the amygdala do? *Current Biology, 7*(5), R311–314.

Pickel, K. L. (1998). Unusualness and threat as possible causes of "weapon focus." *Memory, 6*, 277–295.

Pillemer, D. B. (1984). Flashbulb memories of the assassination attempt on President Reagan. *Cognition, 16*, 63–80.

Posner, M. I., & DiGirolamo, G. J. (1998). Executive attention: Conflict, target detection, and cognitive control. In R. Parasuraman (Ed)., *The attentive brain* (pp. 401–423). Cambridge, MA: MIT Press.

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61*, 380–391.

Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory and Cognition, 21*, 89–102.

Rauch, S. L., Savage, C. R., Alpert, N. M., Fischman, A. J., & Jenike, M. A. (1997). The functional neuroanatomy of anxiety: A study of three disorders using positron emission tomography and symptom provocation. *Biological Psychiatry, 426*, 446–452.

Reisberg, D., Heuer, F., McLean, J., & O'Shaughnessy, M. (1988). The quantity, not the quality, of affect predicts memory vividness. *Bulletin of the Psychonomic Society, 26*, 100–103.

Revelle, W., & Loftus, D. A. (1992). The implications of arousal effects for the study of affect and memory. In S.-Å. Christianson (Ed.), *The handbook of emotion and memory: Research and theory* (pp. 113–149). Hillsdale, NJ: Erlbaum.

Richards, J. M., & Gross, J. J. (1999). Composure at any cost? The cognitive consequences of emotion suppression. *Personality and Social Psychology Bulletin, 25*, 1033–1044.

Robinson, J. A., & Swanson, K. L. (1993). Field and observer modes of remembering. *Memory, 1*, 169–184.

Roediger, H. L., III & McDermott, K. B. (1993). Implicit memory in normal human subjects. In H. Spinnler & F. Boller (Eds.), *Handbook of neuropsychology* (Vol. 8, pp. 63–131). Amsterdam: Elsevier.

Roediger, H. L., III & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803–814.

Rolls, E. T. (1999). *The brain and emotion*. New York: Oxford University Press.

Ross, M. (1989). Relation of implicit theories to the construction of personal histories. *Psychological Review, 96*, 341–357.

Ross, M., & Buehler, R. (1994). Creative remembering. In U. Neisser & R. Fivush (Eds.), *The remembering self: Construction and accuracy in the self-narrative* (Vol. 6, pp. 205–235). New York: Cambridge University Press.

Ross, M., & Conway, M. (1986). Remembering one's own past: The construction of personal histories. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 122–144). New York: Guilford Press.

Rubin, D. C., & Kozin, M. (1984). Vivid memories. *Cognition, 16*, 81–95.

Rugg, M. D., Fletcher, P. C., Frith, C. D., Frackowiak, R. S. J., & Dolan, R. J. (1996). Differential activation of the prefrontal cortex in successful and unsuccessful memory retrieval. *Brain, 119*, 2073–2083.

Rugg, M. D., Fletcher, P. C., Frith, C. D., Frackowiak, R. S. J., & Dolan, R. J. (1997). Brain regions supporting intentional and incidental memory: A PET study. *NeuroReport, 8*, 1283–1287.

Salmon, D. P., & Butters, N. (1995). Neurobiology of skill and habit learning. *Current Opinion in Neurobiology, 5*, 184–190.

Schacter, D. L. (1994). Priming and multiple memory systems: Perceptual mechanisms of implicit memory. In D. L. Schacter & E. Tulving (Eds.), *Memory systems 1994* (pp. 244–256). Cambridge, MA: MIT Press.

Schacter, D. L. (1996). *Searching for memory: The brain, the mind, and the past*. New York: Basic Books.

Schacter, D. L. (1999). The seven sins of memory: Insights from psychology and cognitive neuroscience. *American Psychologist, 54*(3), 182–203.

Schacter, D. L. (2001). *Stranger behind the engram: Theories of memory and the psychology of science*. Hillsdale, NJ: Erlbaum.

Schacter, D. L., Alpert, N. M., Savage, C. R., Rauch, S. L., & Albert, M. S. (1996). Conscious recollection and the human hippocampal formation: Evidence from positron emission tomography. *Proceedings of the National Academy of Sciences, 93*, 321–325.

Schacter, D. L., & Buckner, R. L. (1998). Priming and the brain. *Neuron, 20*, 185–195.

Schacter, D. L., Buckner, R. L., Koutstaal, W., Dale, A. M., & Rosen, B. R. (1997). Late onset of anterior prefrontal activity during retrieval of veridical and illusory memories: An event-related fMRI study. *NeuroImage, 6*, 259–269.

Schacter, D. L., Chiu, C. Y. P., & Ochsner, K. N. (1993). Implicit memory: A selective review. *Annual Review of Neuroscience, 16*, 159–182.

Schacter, D. L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language, 40*, 1–24.

Schacter, D. L., Koutstaal, W., & Norman, K. A. (1996). Can cognitive neuroscience illuminate the nature of traumatic childhood memories? *Current Opinion in Neurobiology, 6*, 207–214.

Schacter, D. L., Norman, K. A., & Koutstaal, W. (1998). The cognitive neuroscience of constructive memory. *Annual Review of Psychology, 49*, 289–318.

Schacter, D. L., Verfaellie, M., & Pradere, D. (1996). The neuropsychology of memory illusions: False recall and recognition in amnesic patients. *Journal of Memory and Language, 35*, 319–334.

Schacter, D. L., & Wagner, A. D. (1999). Medial temporal lobe activations in fMRI and PET studies of episodic encoding and retrieval. *Hippocampus, 9*, 7–24.

Schacter, D. L., Wagner, A. D., & Buckner, R. L. (2001). Memory systems of 1999. In E. Tulving & F. I. M. Craik (Eds.), *Handbook of memory*. New York: Oxford University Press.

Schultz, W., Apicella, P., Romo, R., & Scarnati, E. (1995). Context-dependent activity in primate striatum reflecting past and future behavioral events. In J. C. Houk & J. L. Davis (Eds.), *Models of information processing in the basal ganglia: Computational neuroscience* (pp. 11–27). Cambridge, MA: MIT Press.

Seidlitz, L., & Diener, E. (1993). Memory for positive versus negative life events: Theories for the differences between happy and unhappy persons. *Journal of Personality and Social Psychology, 64*, 654–663.

Semon, R. (1923). *Mnemic psychology*. London: George Allen & Unwin. (Original work published 1909)

Shin, L. M., Kosslyn, S. M., McNally, R. J., Alpert, N. M., Metzger, L. J., Lasko, N. B., Orr, S. P., & Pitman, R. K. (1997). Visual imagery and perception in posttraumatic stress disorder: A positron emission tomographic investigation. *Archives of General Psychiatry, 543*, 233–241.

Singer, J. A. (1990). Affective responses to autobiographical memories and their relationship to long-term goals. *Journal of Personality, 58*, 535–563.

Singer, J. A., & Salovey, P. (1996). Motivated memory: Self-defining memories, goals, and affect regulation. In L. L. Martin & A. Tesser (Eds.), *Striving and feeling: Interactions among goals, affect, and self-regulation* (pp. 229–250). Mahwah, NJ: Erlbaum.

Skowronski, J. J., & Carlston, D. E. (1989). Negativity and extremity biases in impression formation: A review of explanations. *Psychological Bulletin, 105*, 131–142.

Smith, S. S., & Petty, S. M. (1995). Personality moderators of mood congruency effects on cognition: The role of self-esteem and negative mood regulation. *Journal of Personality and Social Psychology, 68*, 1092–1107.

Squire, L. R. (1992). Memory and the hippocampus: A synthesis from findings with rats, monkeys, and humans. *Psychological Review, 99*, 195–231.

Squire, L. R., Ojemann, J. G., Miezin, F. M., Petersen, S. E., Videen, T. O., & Raichle, M. E. (1992). Activation of the hippocampus in normal humans: A functional anatomical study of memory. *Proceedings of the National Academy of Sciences, 89*, 1837–1841.

Stein, N. L., Wade, E., & Liwag, M. D. (1997). A theoretical approach to understanding and remembering emotional events. In N. L. Stein, P. A. Ornstein, B. Tversky, & C. Brainerd (Eds.), *Memory for emotional and everyday events* (pp. 15–47). Mahwah, NJ: Erlbaum.

Stern, C. E., Corkin, S., Gonzalez, R. G., Guimaraes, A. R., Baker, J. R., Jennings, P. J., Carr, C. A., Sugiura, R. M., Vedantham, V., & Rosen, B. R. (1996). The hippocampal formation participates in novel picture encoding: Evidence from functional magnetic resonance imaging. *Proceedings of the National Academy of Sciences, 93*, 8660–8665.

Strack, F., Schwarz, N., & Gschneidinger, E. (1985). Happiness and reminiscing: The role of time perspective, affect, and mode of thinking. *Journal of Personality and Social Psychology, 49*, 1460–1469.

Stuss, D. T., Eskes, G. A., & Foster, J. K. (1994). Experimental neuropsychological studies of frontal lobe functions. In F. Boller & J. Grafman (Eds.), *Handbook of neuropsychology*. Amsterdam: Elsevier.

Suh, E., Diener, E., & Fujita, F. (1996). Events and subjective well-being: Only recent events matter. *Journal of Personality and Social Psychology, 70*, 1091–1102.

Talbot, J. D., Marrett, S., Evans, A. C., Meyer, E., Bushnell, M. C., & Duncan, G. H. (1991). Multiple representations of pain in human cerebral cortex. *Science, 251*, 1355–1358.

Taylor, S. (1989). *Positive illusions: Creative self-deception and the healthy mind*. New York: Basic Books.

Thomas, D. L., & Diener, E. (1990). Memory accuracy in the recall of emotions. *Journal of Personality and Social Psychology, 59*, 291–297.

Tulving, E. (1983). *Elements of episodic memory*. Oxford, England: Clarendon Press.

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247*, 301–306.

van der Kolk, B. A., & Fisler, R. (1995). Dissociation and the fragmentary nature of traumatic memories: Overview and exploratory study. *Journal of Traumatic Stress, 8*, 505–525.

van Reekum, C. M., & Scherer, K. R. (1997). Levels of processing in emotion antecedent appraisal. In G. Matthews (Ed.), *Cognitive science perspectives on personality and emotion* (pp. 259–300). Amsterdam: Elsevier Science.

Varey, C. A., & Kahneman, D. (1992). Experiences extended across time: Evaluation of moments and episodes. *Journal of Behavioral Decision Making, 5*, 169–185.

Wagner, A. D., Schacter, D. L., Rotte, M., Koutstaal, W Maril, A., Dale, A. M., Rosen, B. R., & Buckner, R. L (1998). Building memories: Remembering and forgetting of verbal experiences as predicted by brain activity *Science, 281*, 1188–1191.

Watkins, P. C., Matthews, A., Williamson, D. A., & Fuller R. D. (1992). Mood congruent memory in depression: Emotional priming or elaboration. *Journal of Abnormal Psychology, 101*, 581–586.

Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C Lee, M. B., & Jenike, M. A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *Journal of Neuroscience, 18*(1), 411–418.

Wilhelm, S., McNally, R. J., Baer, L., & Florin, I. (1996 Directed forgetting in obsessive-compulsive disorder *Behaviour Research and Therapy, 34*, 633–641.

Williams, J. M., & Dritschel, B. H. (1988). Emotional disturbance and the specificity of autobiographical memory. *Cognition and Emotion, 2*, 221–234.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Matthews A. (1990). *Cognitive psychology and emotional disorders*. Chichester, England: Wiley.

Yuille, J. C., & Cutshall, J. L. (1986). A case study of eyewitness memory of a crime. *Journal of Applied Psychology, 71*, 291–301.