

Emotional Valence, Discrete Emotions, and Memory

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Abstract

Over the last couple of decades, considerable progress has been made toward understanding whether and how emotion enhances memory. Much of this research has been limited, however, by its treatment of emotion as merely “arousal.” Drawing on appraisal theories of emotion, we argue that a more complete understanding of the effects of emotion on memory will depend on taking into account the differing motivations and problem-solving strategies associated with discrete emotions. Research on social judgment has shown that positive and negative emotion are associated with different information processing strategies. Recent findings show that these information-processing strategies affect memory as well. Moving to a greater level of specificity, we argue that, given their differing functions, the types of information that are of central importance, and hence well-remembered, are likely to differ depending on the specific emotion being experienced. We review findings suggesting that people process and remember information differently depending on whether they are feeling happy, fearful, angry, or sad.

Emotional Valence, Discrete Emotions, and Memory

In scientific explanation, parsimony is a good thing. But the appeal to simplicity that is at the heart of the principle of parsimony can at times lead to oversimplification. Scientists must sometimes ask themselves, how simple is too simple? Take, for instance, the case of emotion and memory. Memory researchers have often conceptualized emotion as “arousal” -- a variable that can be measured on a single scale ranging from relaxed to very excited or agitated. While research on memory stemming from an arousal-based model of emotion has led to fundamental advances, we will argue that this account nevertheless errs on the side of simplicity, leaving us with an incomplete picture of the effects of emotion on memory (see Reisberg, this volume, for a similar perspective). Recent findings suggest that a more complete understanding of the effects of emotion on memory will depend on taking into account the differing motivations and problem-solving strategies associated with discrete emotions such as happiness, fear, anger, and sadness.

Our claim that these specific emotions should have unique effects on memory is based on three sources of evidence. First, it is becoming clear that arousal-based models of emotion are unable to explain some recent findings within the emotion and memory literature. Recent research has shown, for instance, that positive and negative emotions that are similar in terms of the intensity of arousal have very different effects on how information is processed and remembered. Second, there is a strong theoretical and empirical tradition on emotion, appraisal theory, that distinguishes the causes and consequences of discrete emotions. According to this view, emotions such as happiness, fear, anger, and sadness serve important functions because of the different influences they have on thought and behavior. Finally there is now substantial

research demonstrating that these specific emotions have differential effects on judgment, and a growing body of research showing that the same may be true for memory.

Accordingly, we first review research on emotion and memory stemming from an arousal-based approach and demonstrate why it may be incomplete. We then describe evidence that positive and negative emotion are associated with different information processing strategies which, in turn, affect memory. This is followed by a discussion of theory and research concerning the functions of discrete emotions and the appraisal processes that elicit them. Finally we review the effects of these discrete emotions on judgment and memory.

Emotional Arousal and Memory

It is clear that emotional arousal has a powerful effect on memory. Converging evidence from autobiographical memory studies, animal and human laboratory studies, and brain imaging studies shows that emotionally arousing events are, by and large, remembered better than non-emotional events. For example, when people are asked to recall autobiographical events that they had previously recorded in diaries, greater emotional intensity is associated with greater memory vividness -- even after controlling for event novelty, importance, and the amount of rehearsal (e.g., Conway, 1995; Thompson, Skowronski, Larsen, & Betz, 1996).

Laboratory studies with animals and humans have provided a compelling neurobiological explanation for this finding. Researchers have shown that stress hormones, such as epinephrine, are released when events evoke strong emotions. These peripheral stress hormones in turn activate noradrenergic systems in the amygdala, and amygdala activation mediates consolidation of long-term memory in other brain regions (e.g., Cahill, Prins, Weber, & McGaugh, 1994; for a review see McGaugh & Cahill, 2003). The causal role of the amygdala in strengthening emotional memories is well-documented. For instance, infusing stress hormones directly into the

amygdala enhances memory for emotional information, while inactivating this region through the use of lesions or drugs attenuates the enhancing effects of stress hormones on memory (McGaugh, 2000).

Brain imaging studies provide further evidence that the amygdala plays an important role in the consolidation or strengthening of memory for emotionally arousing events (Ochsner & Schacter, 2003). For example, Canli, Zhao, Brewer, Gabrieli, and Cahill (2000) conducted an fMRI study in which participants saw negative and neutral pictures. A separate fMRI response was recorded in the amygdala as participants rated each picture for emotional intensity. Participants were later given a surprise recognition test for the pictures they had rated. The results showed that the more emotionally intense participants found the pictures, the more bilateral activation was found in the amygdala. Pictures that had been rated as the most emotionally intense were remembered better, on average, than pictures rated as less intense. Moreover, the greater the left amygdala activation, the more likely participants were to remember emotionally intense pictures (also see Cahill et al., 1996).

Relative to affectively neutral events, then, emotionally arousing events tend to produce memories that are vivid, detailed, and lasting (LeDoux, 2000). Indeed, some have argued that highly emotional memories are retained with close to photographic accuracy (Brown & Kulik, 1977), or (in the case of conditioned fear) are indelible (Fanselow & Gale, 2003; LeDoux, 1996). It is increasingly evident, though, that emotional memories are far from perfectly accurate or permanent. Recent research shows that, like memory for neutral information, emotional memories are subject to fading over time and to biases in the direction of current goals and experiences (for reviews see Levine & Pizarro, 2004; Levine, Safer & Lench, in press). Thus, characterizing emotional memory as akin to flashbulb photography or indelible ink may be too

strong. A more appropriate characterization may be that emotion acts as a mental highlighter, increasing the salience of information from the environment and from memory much as a hand-held highlighter increases the salience of text.

Over the last couple of decades, we have also learned a great deal about the type of information that emotion highlights. Information that is central to the event that elicited emotion is typically well-retained, but peripheral details can get short-shrift (e.g., Christianson & Loftus, 1991). For instance, in one study, participants were presented with one of two matched slide sequences depicting either an emotional event (a boy hit by a car) or a neutral event (a boy walking beside a car). All participants wrote down the central feature of each slide. Participants who viewed the emotional slide sequence were better able to recall the central features than participants who viewed the neutral sequence, but they were less able to recognize the particular slides they had seen (Christianson & Loftus, 1987). Following Easterbrook (1959), researchers have hypothesized that as arousal increases, the focus of attention narrows to highlight the most relevant aspects of an emotional event; since attention is a limited resource, peripheral details are less likely to be remembered.

Overall, the finding of enhanced memory for central aspects of emotional events has been well-supported (e.g., Adolphs, Denburg, & Tranel, 2001; Berntsen, 2002; Burke, Heuer, & Reisberg, 1992; Safer, Christianson, Autry, & Osterlund, 1998; for a review see Reisberg & Heuer, 2004). Moreover, some studies have shown better memory for emotionally-arousing stimuli, independent of their emotional valence (e.g., Bradley, Greenwald, Petry, & Lang, 1992; Hamann, Ely, Grafton, & Kilts, 1999). So why look beyond general arousal? A growing body of findings concerning the effects of emotion on judgment and memory cannot be explained in terms of a simple arousal-based model of emotion. We turn first to evidence that positive and

negative emotion, even at similar levels of arousal, have very different effects on cognitive processes.

Effects of Emotional Valence on Judgment and Memory

Emotional Valence and Judgment

At least since Aristotle, it has been observed that emotions color the way we think about the world (*Rhetoric*, 4th Century B.C.E.). Advertisers, salespeople, and politicians have long relied on this fact in crafting emotionally-based appeals to sell their products and programs. But recently, psychologists have made further strides toward understanding *how* emotions change the way we think. Research on emotion and judgment has demonstrated differences between judgments made while people are experiencing positively- and negatively-valenced emotions (usually mild happiness or sadness). Across a wide variety of studies, it has been shown that positive and negative emotion are associated with different information processing strategies which affect judgment.

When happy people evaluate arguments or make social judgments, they tend to rely more on prior knowledge, stereotypes, or heuristics than do people in a neutral or negative mood (e.g., Fiedler, 2000; Forgas, 1998, 2003; Higgins, 2001). They also tend to be creative and flexible when solving reasoning problems or generating semantic associates of words (Fredrickson, 2001; Isen, Daubman & Nowicki, 1987). This may be because people experiencing positive and negative emotions have different motivations. According to Schwarz and Clore (1983), people experience happiness when goals have been attained and no immediate problem demands to be solved. Having appraised circumstances as favorable or benign, happiness appears to promote a schema-based, top-down information processing strategy in which people draw freely and flexibly on prior knowledge (i.e., pre-existing ideas, attitudes, and expectations); often referred

to as “heuristic processing.” In contrast, people experience negative emotions when goals have failed and there is a problem to solve. When people are feeling negative emotions, they tend to process information in an analytic, data-driven manner, and are more conservative in their judgments; often referred to as “systematic processing.” For instance, researchers have demonstrated that experiencing sadness leads people to rely less on stereotypes and to perform better on certain deductive reasoning tasks (for a review see Bless & Schwarz, 1999).

Emotional Valence and Memory

The differing information processing strategies associated with positive and negative emotion affect not only judgment, but memory as well. For instance, Bless et al. (1996) induced a happy or sad mood in participants, and then presented them with information about common activities (e.g., eating at a restaurant). Some of the information was consistent with general knowledge or schemas (e.g., "the hostess placed the menus on the table") and some was not consistent (e.g., "he put away his tennis racket"). Later, participants were given a surprise recognition test with both old and new information. The results showed that happy people were more likely than sad people to "recognize" information consistent with general knowledge -- independent of whether or not that information had actually been presented. In contrast, sad people tended to be more conservative and more accurate in their recognition judgments. Similarly, Park and Banaji (2000) found that happy participants showed a bias toward greater leniency in recognizing ethnic names as members of stereotypical categories, leading to many instances of false recognition. In contrast, participants in a negative mood used a more stringent criterion when making recognition judgments. Thus laboratory studies have shown that positive emotion leads to greater reliance on general knowledge or stereotypes, and to intrusion errors in memory, whereas negative emotion leads to more conservative recognition judgments.

Distinguishing between the information processing strategies associated with positive and negative emotion helps explain otherwise puzzling findings in the literature on autobiographical memory. For example, Berntsen (2002) had independent judges code the content of people's most negative and positive autobiographical memories for central and peripheral information. Negative memories focused primarily on central information, as would be predicted by arousal-based models, but positive memories did not. Instead, positive memories tended to include a wide range of information. In addition, positive and negative autobiographical memories often differ in both subjective clarity and objective accuracy. When asked about the subjective clarity or vividness of autobiographical memories that they have previously recorded in diaries, people tend to rate positive life events as better remembered than negative life events (e.g., Matlin & Stang, 1978; Rubin & Berntsen, 2003; Thompson et al., 1996; Walker, Vogl, & Thompson, 1997). Paradoxically, though, when researchers look at the objective accuracy of people's accounts, they typically find no valence effect (e.g., Holmes, 1970) or superior memory for negative events (e.g., Banaji & Hardin, 1994; Bluck & Li, 2000; Kreitler & Kreitler, 1968). Thus people seem to believe that they remember happy events better than they actually do.

One explanation for these findings is that people experiencing positive and negative emotions (that are similar in terms of level of arousal) process information differently. Levine and Bluck (2004) hypothesized that, when recalling events that made them happy, people may "paint with broad strokes," drawing on information encoded when events first occurred but also drawing freely on their general knowledge about what is plausible to fill in gaps in their representations. If so, happy memories should be associated with greater subjective memory clarity, but also with more intrusion errors, than negative memories. To test this hypothesis, they assessed participants' emotions and memories concerning the televised announcement of the

verdict in the murder trial of O. J. Simpson. In the memory assessment, half of the events presented had actually occurred, for example, "O. J. Simpson mouthed the words 'thank you' to the jury." Half were plausible but hadn't occurred, for example, "O. J. Simpson gave the 'thumb's up' sign to his lawyer, Robert Shapiro." (These events were pre-tested with a separate group of participants who had not seen the verdict announcement on TV. The pretest showed that the true and false events did not differ significantly in plausibility.) After two months, participants rated how clearly they recalled the events. After 14 months, they completed a surprise recognition test.

The results showed that, after two months, participants whose initial emotional reaction to the verdict announcement was positive recalled events with greater clarity than participants whose initial reaction was negative or neutral. Similarly, after more than a year, participants whose initial reaction was positive recognized more events than participants whose initial reaction was negative. This does not mean that participants who felt happy about the verdict were more accurate, however -- they were not. Happy participants recalled events with greater clarity, and recognized more events, independent of whether or not the events had actually occurred. Participants whose reaction to the verdict was negative were more likely to err in a conservative fashion by rejecting events. Signal detection analyses confirmed that the threshold for judging events as having occurred was lower for people who were happy about the verdict than for people whose reaction was negative.

These findings demonstrated that the association between happiness and reconstructive memory errors, previously found in brief laboratory studies, extends to memory for real world events and over prolonged retention intervals. Memories become sketchy over time. When remembering events that made them happy (i.e., events that are consistent with their goals), people seem to draw flexibly on general knowledge, sometimes confusing plausible and actual

events. Incorporating plausible or schema-congruent information from general knowledge when remembering events that evoked happiness would result in representations that are *experienced* as more complete. This may explain why people often rate positive events as better remembered than negative events (e.g., Thompson et al., 1996), even though studies with objective measures tend to show no differences or even superior memory for negative events (e.g., Banaji & Hardin, 1994; Bluck & Li, 2000). When remembering events that evoked negative emotion (i.e., events that conflict with their goals), people were more conservative in their memory judgments. People may adopt a more conservative, data-driven strategy when remembering negative events in the service of repairing past negative outcomes or avoiding future ones.

The broader point is that these findings cannot be explained in terms of general emotional arousal. People experiencing positive and negative emotions have different motivations. They process information differently as a result, and these differences affect memory. The emotional life of an individual consists of more than positive and negative moods, however. People make judgments, and store, retrieve, and act on information when they are experiencing a variety of specific emotions such as fear, anger, and sadness. These emotions may each have their own influences on what people think and remember. Thus, we turn next to theory and research on discrete emotions.

Appraisal Theories of Emotion

Appraisal theories of emotion grew out of a long tradition in emotion research that recognized that emotions come in a variety of basic types—each with its own causes, consequences, and functions. The evolutionary approach characterizes specific emotions as solutions to the general problem of survival (e.g., Darwin, 1872). For example, fear motivates animals to avoid danger, allowing them to live long enough to pass along their genes. Like fear,

other discrete emotions are thought to have evolved to solve particular types of problems.

Appraisal theories extended this broad evolutionary approach to address the cognitive elicitors of emotion. That is, if a rapidly approaching figure engenders fear in an individual, it is because it is recognized as a threat to an important goal. The process of appraisal that leads to fear would instead lead to happiness if the approaching figure were recognized, not as a predator, but as a loved one. Although appraisal theories developed independently from research on emotion and memory, we believe that they provide a useful framework for addressing some of the limitations of arousal-based models. Thus, we first take a closer look at the assumptions underlying appraisal theories and then discuss how they may elucidate the effects of emotions on judgment and memory.

Beginning with the work of Magda Arnold (1960) and Richard Lazarus (1968), and influenced by the approach of Herbert Simon (1967), appraisal theories have focused on identifying the functions that specific emotions fulfill within the cognitive system. In his 1967 paper, "Motivational and Emotional Controls of Cognition," Simon noted that models of human information processing typically neglect the interaction of cognition with emotion. He argued that the cognitive system simply could not function without processes that do what emotions do. Unlike computers, human beings are constrained in a number of ways—we have multiple and ever-shifting goals, limited cognitive resources, and an environment that is in constant flux. Given these constraints, people need a way to keep track of information that is important. Thus, to ensure survival, a certain amount of continuous background processing (not necessarily conscious) is necessary to monitor the environment for information that an important goal has been threatened, especially given that the goal in question may not be within current attentional focus. When information relevant to the status of a goal is detected, it must be possible to

interrupt ongoing processing and behavior, reprioritize goals, and direct cognitive resources to the affected goal. Simon argued that emotion fulfills this function by acting as an “interrupt mechanism” that signals the presence of information relevant to a goal.

To illustrate how emotions might serve this interrupting function, consider another set of subjective feeling states that are critical for survival: hunger, thirst, and fatigue. In the absence of such feelings, people would have to actively monitor how long it had been since they had last eaten, drunk, or slept—a task that would require considerable cognitive resources.

Undifferentiated arousal alone (i.e., signaling that “some essential goal” is affected) would not provide enough information about the type of behavior needed to respond to the situation.

Because people have discrete subjective states associated with the needs for food, liquid, and rest, though, no one is in danger of lying down to take a nap when the body needs food. Given their importance for survival, it is not surprising that these feelings influence subsequent cognitions in a goal-consistent manner. For example, hungry people rate high calorie snacks as more desirable than people who have just eaten (Gilbert et al., 2002; Read & van Leeuwen, 1998). Thirsty people rate water as more important to hikers in the wilderness than those who are not thirsty (Van Bowen & Loewenstein, 2003). Thus, for a small set of physiological goals that must be maintained to ensure survival, each goal is associated with a unique subjective feeling state that interrupts ongoing thought and behavior, reprioritizes goals, and directs cognitive resources toward information relevant to fulfilling those goals.

Human beings have thousands of goals, however, ranging from keeping family relations intact, to finishing an article, to stopping at the market to buy milk before it runs out. Indeed, human beings have far too many goals for it to be feasible to have a distinct subjective feeling that monitors the status of each one, especially since these goals are constantly changing. This is

where discrete emotions enter the picture. Discrete emotions provide an elegant general-purpose solution to the problem of monitoring information relevant to an individual's many current goals. This is because, unlike drive states such as hunger and thirst, each of which are tied to the status of one specific goal, discrete emotions such as happiness, fear, anger, and sadness are sensitive to a wide variety of goals. According to cognitive appraisal theories, people experience emotions when events are appraised as relevant to the status of *some* goal, and a response is required -- typically revising goals and beliefs and constructing new plans. Specific emotions are thought to have evolved so that organisms could respond adaptively to different types of changes in the status of their goals. Once evoked, specific emotions direct attention to information that is functional -- that is, useful for responding to the type of situation that typically evokes the emotion (e.g., Frijda, 1987; Oatley & Johnson-Laird, 1987; Ortony, Clore, & Collins, 1988; Scherer, 2003; Stein & Levine, 1987, 1990).

Several models have been proposed describing the different goal-related appraisals, motivations, and problem-solving strategies associated with discrete emotions. Researchers have provided evidence for these models using a variety of methods, including analyses of accounts of autobiographical events, responses to vignettes in which appraisal dimensions have been varied, and experimental manipulations of emotions (e.g., Ellsworth & Scherer, 2003; Frijda, 1987; Levine, 1995, 1996; Oatley & Johnson-Laird, 1987; Ortony, Clore & Collins, 1988; Roseman, 1991; Roseman, Weist, & Swartz, 1994; Scherer, 1984, 1998; Smith & Lazarus, 1993; Stein & Levine, 1987; Stein, Trabasso, & Liwag, 2000; Weiner, 1985). We have chosen to focus on the emotions happiness, fear, anger, and sadness because, even among researchers who question the notion that certain emotions are basic and universal (e.g. Ortony & Turner, 1990), there is significant agreement that these four states are associated with unique and coherent patterns of

eliciting appraisals, facial expressions, subjective feeling states, motivations, and action tendencies.

While appraisal theories differ in details, the results support the following general rules concerning the patterns of appraisal that elicit basic emotions. *Happiness* is evoked when people perceive events as conducive to goal attainment. That is, people feel happy when they attain something they value or avoid something they find unpleasant. Conversely, people feel negative emotions such as fear, anger, and sadness when they fail to attain or maintain something they value or fail to avoid something unpleasant. *Fear* is evoked when goal failure is threatened but has not yet occurred. *Anger* is evoked when goals are obstructed and people believe that something can be done to reinstate the goal (Levine, 1995; Stein & Levine 1989) or that they have power or control over the situation (Roseman, 1991; Scherer, 1984). In contrast, *sadness* is evoked when people believe that a goal has failed irrevocably and cannot be reinstated, leaving them with little power or control over the loss (Izard, 1977; Levine 1995; Roseman, 1991; Scherer, 1984; Smith & Lazarus, 1993; Stein & Levine, 1989).

Because these emotions depend on people's appraisals of a situation, the same events can elicit anger or sadness, depending on people's beliefs about their ability to cope with goal failure, and their beliefs about whether the failure was caused by an intentional agent or by an uncontrollable force. Intentional harm may come to evoke anger because people realize that events that are under a person's control can often be changed or prevented from recurring. When harm is caused accidentally or by forces outside human control, there are fewer options for reversing the situation, leading more often to the experience of sadness (Levine, 1995).

The appraisals associated with discrete emotions are not a sophisticated adult overlay on more primitive emotional processes. Developmental psychologists have shown that, in the first

year of life, infants display facial expressions of happiness in response to success at instrumental attempts to attain a goal, anger when goals are obstructed, fear when danger is threatened (e.g., fear of heights), and sadness at losses (Alessandri, Sullivan, & Lewis, 1990; Campos, Bertenthal, & Kermoian, 1992; Lewis, Sullivan, Ramsay, & Alessandri, 1992; Sroufe & Waters, 1976; Stenberg, Campos, & Emde, 1983; for reviews see Lewis, 2000; Witherington, Campos, & Hertenstein, 2001). Children as young as three explain emotions in terms of whether goals have been attained or obstructed (Stein & Levine, 1989), and by the age of five, distinguish anger from sadness based, in part, on whether they believe that goal reinstatement is possible or impossible (Levine, 1995).

Once elicited, how might discrete emotions affect subsequent cognitive processes?

According to appraisal theories, by reprioritizing goals, emotions serve as a powerful organizing force, not just for behavior, but for perception, judgment, and memory as well (Dalglish, 2004; Frijda, 1987; Lerner & Keltner, 2000; Oatley & Johnson-Laird, 1987; Roseman, Wiest & Swartz, 1994; Stein & Levine, 1987). In the service of responding to the types of circumstances that lead to their elicitation, discrete emotions should cause people to become attuned to, and to search for, information that is relevant to their emotional state. Thus, the types of information that are of central importance, as opposed to being peripheral details, would be expected to differ depending upon a person's specific emotional state (Levine & Pizarro, 2004). Because the activation of one goal can automatically inhibit the accessibility of alternative goals (Shah, Friedman, and Kruglanski, 2002), information peripheral to the motivational state of the emotion being experienced may become less accessible.

Appraisal theories allow one to make predictions about the types of information that should be most relevant or central in specific emotional states. Happiness has been found to exert

a variety of cognitive and behavioral effects that Frederickson (1998) has characterized as “broaden-and-build” tendencies. It promotes expansive thoughts and actions such as affiliation, play, exploration, creative thinking, and the use of broader sources of information when making decisions. Fear is elicited by the perception of a threat of goal failure and motivates thoughts and behaviors directed toward avoiding the threat. When frightened, then, people would be expected to selectively attend to, encode, and retrieve information concerning threats and means of avoiding them. Anger is elicited when goals are obstructed; it motivates thoughts and behaviors directed toward removing the obstruction. Thus, angry people should selectively encode and retrieve information concerning goals and the agents or causes responsible for obstructing the goal. This focus on goals and the causes of failure would serve an important function. People are most likely to construct effective plans to reinstate their goals if they understand who or what caused the situation that they are trying to change.

In contrast, sadness is elicited when people appraise goal failure as irrevocable. For the sad person, information concerning the risks and causes of failure (central information for the frightened or angry person, respectively) would be irrelevant or peripheral. When a goal fails and cannot be reinstated, its failure affects all of the goals, beliefs, and plans that are associated with it. Thus, when sad, understanding the outcomes and consequences of failure becomes centrally important. Sadness may ultimately be followed by plans to substitute more attainable goals. In the midst of the emotional episode, however, the withdrawal and passivity commonly associated with sadness may reflect the difficult mental work of coming to terms with the need to revise prior goals and expectations (Levine, 1996).

Based on appraisal theories, then, emotions should differ in their effects on subsequent cognition. A growing body of research supports this view, but much of it has focused on the

effects of specific emotions on judgment. We review these findings below and then turn to the sparse but intriguing findings suggesting that discrete emotions also affect the content of memories.

Effects of Discrete Emotions on Judgment and Memory

Discrete Emotions and Judgment

Researchers have shown differing effects of discrete emotions on judgment in domains as disparate as risk and probability, stereotyping, economic decision-making, public policy, and moral judgment. These effects have been demonstrated even when the emotions were elicited by events unrelated to the judgment at hand. So while anger may certainly affect the way you think about the neighbor who just crashed into your car, that same anger also affects the way you think about your spouse when you later walk in the door. In a series of studies, Lerner and her colleagues assessed the effects of anger and fear on judgments concerning risk. They found that inducing fear caused people to be very sensitive to the possibility of risk, and to inflate the probability that something bad might happen. Inducing anger, on the other hand, caused people to minimize the risk associated with acting (Lerner & Keltner, 2001; Small, Lerner, Gonzalez, & Fischhoff, 2003). Lench and Levine (2004) found that inducing fear reduced people's unrealistic optimism that negative outcomes were more likely to happen to others than to themselves.

Researchers have also contrasted the effects of anger and sadness on judgments in a variety of domains. The results are consistent with the view that anger increases the salience of the causes or agents responsible for goal obstruction, whereas sadness increases the salience of irrevocable losses. For example, DeSteno, Petty, Wegner, and Rucker (2000) found that inducing anger in participants led to greater estimates of the likelihood of events in which others intentionally caused harm (e.g., being knowingly sold a 'lemon' by a dishonest car dealer),

whereas inducing sadness led to greater estimates of the likelihood of losses (e.g., a best friend moving away). Bodenhausen, Shepard, and Kramer (1994) found that participants made to feel angry relied more on stereotypes when making judgments concerning blame than participants made to feel sad; for example, judging a person with an ethnic (i.e., Latino) name as more legally culpable for an alleged incident of misconduct than a person with a traditional English name. In another study, inducing anger led to more spontaneous judgments of causality and blame about the September 11 terrorist attacks than inducing sadness (Small, Lerner, Gonzalez & Fischhoff, 2005).

Thus, a growing body of evidence indicates that discrete emotions differ in their effects on judgment. Researchers studying social judgment initially assumed that emotions act by influencing the processing of information in one of two ways—by encouraging slow and careful “systematic” processing or by encouraging quick-and-dirty “heuristic” processing. For instance, Tiedens and Linton (2001) elegantly demonstrated that discrete emotions associated with appraisals of *certainty* (such as happiness, anger, and disgust) encourage more heuristic processing, such as relying on the expertise of a source of communication when evaluating arguments. Emotions associated with *uncertainty* (such as sadness and fear), on the other hand, promoted more careful, systematic styles of thinking. The findings above, however, point to a more complex picture of how emotions affect judgment. Rather than simply affecting the *type* of processing, discrete emotions appear to influence the *content* of information processing. Thus, while anger and fear might both lead to the use heuristics, the information that an angry person draws on from prior knowledge may be very different from the information accessed while afraid. Further research is needed to examine whether anger leads to heuristic processing about blame, sadness to heuristic processing about loss, and fear to heuristic processing about risk. The

conditions under which discrete emotions promote heuristic versus systematic processing also remain to be specified.

Discrete Emotions and Memory

Research on memory and discrete emotions, albeit limited, reveals a pattern of findings similar to the literature on discrete emotions and judgment. Fearful people display enhanced memory for threat-related information and poorer memory for threat-irrelevant details. For example, Wessel and Merckelbach (1998) investigated the effects of fear on memory in a sample of spider phobics. Phobic and low-fear control participants were shown a bulletin board to which central (pictures of spiders) and peripheral (pictures of babies and pens) stimuli were attached. As expected, spider phobics displayed an increase in physiological markers of fear when viewing the display. Later, when asked to recall the display, spider phobics showed enhanced memory for the central, threatening information and impaired memory for peripheral, non-threatening information. The association between fear and enhanced memory for threatening stimuli also has been noted by investigators assessing the accuracy and completeness of eyewitness testimony. For instance, “weapon focus” refers to witnesses’ tendency to focus on and remember the weapon used to commit a crime, often at the expense of memory for other information such as the perpetrator’s face (e.g., Kramer, Buckhout, & Eugenio, 1990; Loftus, Loftus, & Messo, 1987; Steblay, 1992).

Clinically anxious people also exhibit attentional and memory biases characterized by hypersensitivity to threat. These biases are found most reliably when researchers assess attention to, and encoding of, threat-related information rather than retrieval (MacLeod & Mathews, 2004). For example, Mathews and Klug (1993) used an emotional Stroop paradigm to assess color-naming latencies (a sign of greater attention) for positive and negative threat-related words,

positive and negative non-threat-related words, and neutral words. Participants were patients with a variety of anxiety disorders and controls. They found that anxious patients took longer to name the colors of both positive and negative threat-related words (but not positive or negative words unrelated to threat) than to name to the colors of neutral words. Selective retrieval of threatening information has also been found (though less consistently) in studies using implicit memory measures (for a reviews see MacLeod & Mathews, 2004; Minetka et al., 2003). For example, Mathews, Richards, and Eyesenk (1989) had clinically anxious people and controls listen to and write down homophones (words that sound alike but have two meanings and spellings). Each of the homophones had a threatening meaning and a neutral meaning (e.g., *die* and *dye*). They found that anxious participants were more likely than controls to write down the threatening meaning when they heard the sound of the word, suggesting that threatening information may be more accessible in memory for these people.

One explanation for these findings is that they have little to do with discrete emotions, but are simply further evidence for the memory enhancing effects of emotional arousal. But appraisal theory makes very different predictions about memory across specific emotional states that may be similar in terms of levels of arousal. Preliminary support for these predictions comes from research showing that people experiencing different emotions seem to display enhanced memory for different types of information. People in a depressed mood who are asked to recall autobiographical events tend to focus, not on sources of threat, but on negative outcomes such as personal losses and defeats. For instance, Lyubomirsky, Caldwell, and Nolen-Hoeksema (1998) found that moderately sad or depressed people recalled more negative autobiographical events associated with loss (e.g., failing a test, losing a girlfriend, their parents divorce) than did non-depressed people. Moreover, although depression and post-traumatic stress disorder (PTSD) are

both characterized by the presence of intrusive memories, the content of the intrusive information for these two disorders differs. Consistent with the differing motivations associated with sadness and fear, depression is characterized by rumination on past negative outcomes and their consequences for the self, whereas PTSD is characterized by intrusive memories related to past threats to safety (e.g., Lyubomirsky, Caldwell, and Nolen-Hoeksema, 1998; Reynolds & Brewin, 1999; Watkins & Teasdale, 2001).

In an attempt at a more direct test of the predictions made by appraisal theory, Levine and Burgess (1997) conducted a study contrasting discrete emotions in the same study, to see if each emotion would lead to enhanced memory for particular kinds of information. Specifically, they assessed the effects of happiness, anger, and sadness on the encoding of information in a narrative. Emotions were evoked in undergraduates by randomly assigning grades of “A” or “D” on a surprise quiz. Immediately afterwards, students participated in what they believed to be an unrelated study. During the study they heard and later recalled a narrative about a student’s first term in college. Finally, they rated how happy, angry, and sad they had felt when they received their quiz grade. In contrast to happy participants, who demonstrated enhanced memory for the narrative as a whole, participants who reported feeling primarily sad or primarily angry tended to recall specific types of information. As predicted, sad participants recalled significantly more information concerning event outcomes than did angry participants (e.g., “They receive a bad grade on the speech”). Angry participants showed a non-significant tendency to recall more information about the protagonist’s goals than did sad participants (e.g., “Mary wants her speech to be really good”). In addition, a significant positive correlation was found between the intensity of anger reported and the amount of information that participants recalled about goals.

Further research is needed to identify the mechanisms underlying the effects of discrete emotions on memory, but the findings reported above lend support to the view that discrete emotions evoke “appraisal tendencies” (Lerner & Keltner, 2000) as well as “action tendencies” (Frijda, 1987), influencing the processing, encoding, and retrieval of information in ways consistent with their differing functions.

Conclusion

A great deal of research on emotion and memory has been based on the assumption that emotion can be characterized as general arousal. This model has been fruitful. Fundamental advances have been made toward identifying the mechanisms underlying the memory-enhancing effects of emotional arousal, including the roles played by stress hormones and by the amygdala. So, why should researchers studying emotion and memory be interested in valence and discrete emotions? Assumptions about the characteristics of emotion determine the very questions researchers ask. While illuminating certain phenomenon, favored assumptions may leave others in the dark (Campos, Campos, & Barrett, 1989). We have argued that a more complete understanding of how emotion affects memory will necessitate taking into account properties of emotion that are just as fundamental as arousal. Namely, discrete emotions such as happiness, fear, anger, and sadness are responses to very different types of changes in the status of goals, and they motivate cognitions as well as behaviors directed toward maintaining, preventing, or coping with those changes.

Full acceptance of this claim will require further research on discrete emotions and memory, but three sources of evidence provide reason to take this approach to emotion seriously. First, positive and negative memories differ in ways that cannot be explained using a solely arousal-based model of emotion. It is well-documented that positive and negative emotion can

lead to conceptually-driven and data-driven processing, respectively. A growing body of evidence shows that these information-processing strategies affect memory. Second, research based on appraisal theories has provided evidence that discrete emotions are elicited by different interpretations of events and promote dissimilar problem-solving strategies. Third, although research comparing the effects of discrete emotions on memory is sparse, a few studies have shown that information relevant to the functions of discrete emotions appears to be particularly salient in memory.

We began by comparing emotional arousal to a highlighter that enhances the salience of central information. Drawing on recent research on the effects of emotional valence and discrete emotions on memory, this illustration can now be extended. Rather than a single highlighter, emotions appear to be akin to a set of highlighters with differing properties. Whereas happiness acts as a broad, inclusive highlighter that increases the salience of a wide swath of information, negative emotions seem to work like fine-tip highlighters, increasing the salience of a narrow range of information in the service of either preventing (fear), fixing (anger), or adjusting to (sadness) goal failure. By conceptualizing emotions not as general arousal but as a group of related responses, each with its own functions, causes, and consequences, we hope to encourage further advances toward understanding the information processing strategies evoked by particular emotions and the types of information that are of central importance, and hence well-remembered, in specific emotional states.

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