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AGING AND EMOTIONAL MEMORY

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Most studies investigating the relationship between emotion and memory in adults have used college students as participants. However, the impact of emotion on memory may change across the adult life span. Compared with younger adults, older adults exhibit deficits in many types of memory tasks (for reviews, see Light, 1996; Prull, Gabrieli, & Bunge, 2000; Zacks, Hasher, & Li, 2000). In contrast, older adults actually improve rather than decline in emotional well-being and regulation (e.g., Carstensen & Charles, 1998). Emotions gain centrality in everyday information processing with age (Blanchard-Fields, 1998; Labouvie-Vief, 1998), and there is evidence that brain regions associated with emotional processes deteriorate less with age than many other regions. As outlined in the first part of this chapter, this research on emotion and aging predicts that the relationship between emotion and memory should change as people age. In the second part of the chapter, I review studies examining age differences in memory for emotional information. These studies reveal that emotion becomes more salient in memory and that emotional goals have more of an influence as one grows older.

Age-Related Changes in Emotional Processes and Their Implications for Memory

Emotional Well-Being Improves Across the Adult Life Span

Emotional well-being remains stable or even is enhanced with age. Younger adults are at higher risk for depression than older adults (Lawton, Kleban, & Dean, 1993; Weissman, Leaf, Bruce, & Florio, 1988). Even among patients diagnosed with dysthymia (a milder, chronic form of depression), older adults have higher ratings for emotional well-being and seem to be in better mental health (Oxman, Barrett, Sengupta, & Williams, 2000). Almost all mental disorders are more prevalent among younger than older adults (Regier et al., 1988). A longitudinal study found that clinician-rated psychological health shows a steady improvement from age 30 to 62 (Jones & Meredith, 2000), indicating that these mental health differences do not simply reflect a cohort effect.

Many studies have also found that normal everyday subjective emotional experience either remains steady or actually improves across the life span—a quite remarkable finding considering that physical health tends to decline and social networks tend to contract in old age. On questionnaires, older adults respond that they experience fewer negative emotions than younger adults (Gross et al., 1997). Life satisfaction remains constant (Diener & Suh, 1998) or increases (Lawton et al., 1993) with age. When asked to look back and rate how satisfied they were at different points in their lives, people tend to report that they are most satisfied at the current moment (Field, 1997), suggesting that people also have a subjective sense that their own satisfaction increases across the life span. In one experience sampling study including participants from 18 to 94 years old, the frequency and duration of negative emotions experienced in daily life decreased with age (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). Positive affect appears to remain mostly constant (Carstensen et al., 2000) or increase (Mroczek, 2001) across the life span. In very old age (after the age of 85), cross-sectional data indicate that positive affect may decrease again (Smith, Fleeson, Geiselmann, Settersten, & Kunzmann, 1999), although a longitudinal study found that positive outlook increased from ages 85 to 92 (Agren, 1998). Another longitudinal study spanning 23 years revealed that negative affect decreased over time in multiple age cohorts, whereas positive affect remained stable until about age 60, when it decreased slightly (Charles, Reynolds, & Gatz, 2001).

Among younger adults, negative mood increases the likelihood of remembering negative information (Blaney, 1986; Bower, 1981). Depression also increases the likelihood of remembering negative information (Bradley, Mogg, & Williams, 1995; Gilboa, Roberts, & Gotlib, 1997; Johnson & Magaro, 1987; Mineka & Nugent, 1995; Watkins, Mathews, Williamson, & Fuller, 1992). [Also see chapter 6—Eds.] Older adults' lower levels of negative affect suggest that they may be less likely to recall negative information than younger adults. Thus, across the life span, the likelihood of remembering negative information may decrease relative to the likelihood of remembering positive or neutral information, as a result of decreasing negative mood.

Emotion Regulation Effectiveness Increases

Emotions often seem to be beyond our control, coming and going whether we choose to experience them or not. Nevertheless, we actually have considerable control over our emotions (e.g., Gross, 2001). Furthermore, there is evidence that the ability to regulate emotions improves with age. Older adults are more likely than younger adults to maintain positive emotional states and to maintain the absence of negative states (Carstensen et al., 2000). They are more likely than younger or middle-aged adults to endorse statements suggesting increased emotional control, such as "I try hard to stay in a neutral state and to avoid emotional situations" and "Detachment or cool judgment is my best way to meet life situations" (Lawton, Kleban, Rajagopal, & Dean, 1992). They are also less likely to ruminate about emotionally upsetting events (McConatha & Huba, 1999). In addition, their coping and defense strategies tend to reflect more impulse control (Diehl, Coyle, & Labouvie-Vief, 1996). Across an ethnically and culturally diverse set of samples, older adults consistently reported being better able to control their emotions than younger adults (Gross et al., 1997). Ratings of emotional control and emotional experience were correlated; higher ratings of emotional control were associated with higher frequencies of happiness and lower frequencies of sadness and fear. This pattern suggests that changes in emotion regulation processes contribute to the improvement in emotional experience across the life span.

People use a variety of strategies to regulate emotion. For example, reappraisal and suppression are both effective ways to regulate emotion, but they have quite distinct mechanisms and side effects (e.g., Gross, 2001). In general, these strategies can be classified as either response-focused or antecedent-focused (Gross, 2001, 2002). Response-focused strategies attempt to manage emotion after it is already under way, whereas antecedent-focused strategies attempt to influence emotion before it occurs. Initial research suggests that older adults' increased ability to regulate emotion relies more on antecedent-focused strategies, such as reappraising an event to alter its emotional impact, than on response-focused strategies, such as suppressing the expression of an emotion (Carstensen, Gross, & Fung, 1998). For example, compared with younger adults, older adults report using less confrontative coping, greater distancing, and more positive reappraisal (Folkman, Lazarus, Pimley, & Novacek, 1987). In general, older adults seem to be better able to reappraise events cognitively (Diehl et al., 1996; Labouvie-Vief, DeVoe, & Bulka, 1989).

Laura Carstensen's socioemotional selectivity theory posits that the increasing effectiveness of emotion regulation results from the increasing salience of emotional goals as people approach the end of life (Carstensen, 1992, 1995; Carstensen, Isaacowitz, & Charles, 1999). According to her theory, perceived limitations on time direct attention toward emotional goals. Thus, older adults prefer to spend time with emotionally meaningful social partners (Fredrickson & Carstensen, 1990; Fung, Carstensen, & Lutz, 1999; Fung, Lai, & Ng, 2001), and younger people mimic this preference under experimental conditions where time is limited (Fung et al., 1999). Older adults emphasize emotional dimensions more than other personal dimensions in their mental representations of social

partners (Fredrickson & Carstensen, 1990), a pattern also evident in younger adults facing the end of their lives because of terminal illness (Carstensen & Fredrickson, 1998). Older adults are also more likely to adopt emotion-focused strategies when attempting to solve interpersonal problems (Blanchard-Fields & Camp, 1990; Blanchard-Fields, Camp, & Casper Jahnke, 1995). Thus, it appears that aging, because it brings people continually closer to the ultimate end, shifts goal priorities so that emotional goals gain importance and have more of an impact on behavior.

The research demonstrating improved emotion regulation and increasing importance of emotional goals with age suggests several age differences in memory for emotional information. First, the increased importance of emotional goals may increase the salience of all emotionally relevant information relative to neutral information for older adults. Second, because one way to regulate emotion is to avoid attending to or remembering negative information—focusing instead on positive information—older adults may have a bias against negative information in their memories. Thus, older adults' memories may be more emotionally gratifying. Third, insofar as older adults are more likely to use reappraisal strategies, they may remember originally negative events in a more positive light. I review studies addressing these possibilities later in the chapter.

Decreasing Physiological Arousal Associated With Emotion

Physiological reactions to emotion-eliciting events rely on the cardiovascular system, which changes with age (Cacioppo, Berntsen, Klein, & Poehlmann, 1998). The muscle mass of the heart decreases, leading to a decline in the heart's stroke volume. In addition, both blood flow resistance and resting blood pressure increase. Thus, it is perhaps not surprising that cardiovascular reactivity (heart rate and pulse transmission time) associated with emotional responding decreases with age (Levenson, Carstensen, & Gottman, 1994; Levenson, Friesen, Ekman, & Carstensen, 1991; Tsai, Levenson, & Carstensen, 2000). This age difference in physiological reactivity appears when participants are asked to generate and relive past emotional episodes from their own lives (Levenson et al., 1991), discuss marital problems with their spouses (Levenson et al., 1994), or watch emotional film clips (Tsai et al., 2000). These physiological differences occur despite similar subjective emotional experience and expressive behavior among younger and adult participants.

According to the Easterbrook hypothesis (1959), physiological arousal leads to a narrowing of attention. Many studies have examined this claim in the context of the relationship between emotional arousal and memory in younger adults, but the results are mixed. Typically, these studies find a positive effect of arousal when the level of arousal is moderate and a negative effect when the it is relatively high (Baddeley, 1998). [Also see chapter 1—Eds.] Using these studies to make predictions about the implications of age-related changes in physiological arousal is further complicated because older adults' lower levels of physiological reactivity are not associated with lower levels of emotional experience relative to younger adults. Thus, the age differences in physiological reactivity do not lead to any clear predictions about how the relationship of emotion and memory might change across the life span.

Relatively Well-Maintained Neural Mechanisms of Emotion

Amygdala The emotional systems in the brain consist of interacting circuits involving the prefrontal cortex, amygdala, and anterior cingulate. The amygdala seems to play the most critical role in terms of the interaction between emotion and memory—at least for younger adults. [For a general review of emotion, memory, and the brain, also see chapter 2—Eds.] Neural and hormonal mechanisms mediated by the amygdala enhance memory for emotional stimuli (Hamann, 2001). It is highly interconnected with both cortical and subcortical regions (Young, Scannell, Burns, & Blakemore, 1994) and so is in a position to integrate disparate sources of information and affect a wide range of functions. In particular, with its numerous connections to the hippocampus and other medial temporal regions, the amygdala is ideally situated to influence memory processes.

Nevertheless, an intact amygdala is not needed to remember emotionally neutral material (e.g., Bechara, Tranel, Damasio, & Adolphs, 1995; Scoville & Milner, 1957). Instead, the amygdala plays a modulatory role, enhancing memory associated with emotionally arousing material, especially during the consolidation period after the emotional event (McGaugh, 2000). Animal studies indicate that adrenal stress hormones and the amygdala interact to modulate consolidation of recently acquired information (McGaugh, Ferry, & Vazdarjanova, 2000). Case studies of patients with bilateral lesions in the amygdala have found that they do not show the normal enhancement in memory for emotional material, although they remember nonemotional information as well as normal controls (Adolphs, Cahill, Schul, & Babinsky, 1997; Cahill, Babinsky, Markowitsch, & McGaugh, 1995). Conversely, amnesic patients with intact amygdalae show an enhancement in memory for emotional material despite their overall memory impairment (Hamann, Cahill, McGaugh, & Squire, 1997).

Brain imaging studies also provide evidence that the amygdala plays a critical role in enhanced long-term memory for emotionally arousing events (Cahill et al., 1996; Canli, Zhao, Brewer, Gabrieli, & Cahill, 2000; Canli, Zhao, Desmond, Glover, & Gabrieli, 1999). For example, in one study, participants received a PET

scan while watching either emotionally negative or emotionally neutral films. Greater amygdala activity while watching the negative films predicted better memory for these films later, whereas there was no such correlation for neutral films (Cahill et al., 1996). Recent findings indicate that the amygdala is also associated with enhanced memory for emotionally positive information (Hamann, Ely, Grafton, & Kilts, 1999).

With age, brain volume decreases (for reviews, see Kemper, 1994; Raz, 2000). This decrease, however, does not occur at an equal rate across all regions of the brain. Aging has relatively little impact on the amygdala volume, especially when compared with the atrophy in other regions such as the prefrontal cortex. Although MRI studies focusing on the hippocampus or amygdala often find decreases in volume with age (e.g., Bigler, Anderson, & Blatter, 2002; Jack, Petersen, O'Brien, & Tangalos, 1992; Jack et al., 1997; cf. Lim, Zipursky, Murphy, & Pfefferbaum, 1990; Mu, Xie, Wen, Weng, & Shuyun, 1999; Smith, Malcein, et al., 1999), studies that include a broader selection of brain regions find that the amygdala-hippocampus complex shows little or no change relative to other regions of the brain (e.g., Coffey et al., 1992; Good et al., 2001; Ohnishi, Matsuda, Tabira, Asada, & Uno, 2001; Raz et al., 1997; Sullivan, Marsh, Mathalon, Lim, & Pfefferbaum, 1995) or decreases at a rate no greater than that of the volume of the whole brain (Tisserand, Visser, van Boxtel, & Jolles, 2000). Furthermore, postmortem studies using stereologically based cell-counting techniques find almost no changes with normal aging in the hippocampus (Raz, 2000; West, Coleman, Flood, & Troncoso, 1994) or in the entorhinal cortex (Gomez-Isla et al., 1996), which is closely connected to the hippocampus and limbic system. This pattern suggests that the enhancement in memory for emotional material due to the interaction of the amygdala and hippocampus should remain relatively intact in older adults.

Prefrontal Cortex Researchers investigating memory and aging have become interested in the role of the prefrontal cortex (PFC). The PFC shows a disproportionately large decrease in volume with age, compared with other regions involved in memory processes, such as medial temporal regions (Coffey et al., 1992; Cowell et al., 1994; DeCarli et al., 1994; Raz, 2000; Raz et al., 1997; West, 1996). Patients with lesions in the frontal lobes show deficits in strategic memory tasks that are striking in contrast with their intact performance on nonstrategic memory tasks (Shimamura, 1995). Older adults show a similar, although less pronounced, disproportionate deficit for strategic memory tasks (for reviews, see Johnson & Raye, 2000; Light, 2000; Moscovitch & Winocur, 1995; Prull et al., 2000). Furthermore, older adults' performance on such tasks is correlated with their performance on neuropsychological tests usually associated with frontal lobe damage (Craik, Morris, Morris, & Loewen, 1990; Fabiani & Friedman, 1997; Glisky, Polster, & Routhieaux, 1995; Henkel, Johnson, & De Leonardis, 1998; Mather, Johnson, & De Leonardis, 1999; McDaniel, Glisky, Rubin, Guynn, & Routhieaux, 1999; Schacter, Kazniak, Kihlstrom, & Valdiserri, 1991).

The PFC also plays an important role in affective processing (for a review, see Davidson & Irwin, 1999). Brain imaging studies reveal activity in the PFC during the normal experience of positive and negative emotions (George et al., 1995; Kimbrell et al., 1999; Lane, Reiman, Ahern, Schwartz, & Davidson, 1997; Lane, Reiman, Bradley, et al., 1997). Patient data going back to the famous case of Phineas Gage indicate that dysfunction of the prefrontal cortex disrupts the regulation of emotion and social conduct (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994; Dimitrov, Phipps, Zahn, & Grafman, 1999). An extreme example of a failure of social and emotional regulation is the act of killing someone—in particular, when this murder is not an act of self-defense. A positron emission tomography (PET) study of 41 murderers who had pleaded not guilty by reason of insanity found that, compared with normal controls, the murderers showed reduced glucose metabolism in the PFC (Raine, Buschbaum, & LaCasse, 1997).

On the face of it, this pattern seems paradoxical. Normal aging leads to disproportionate declines in the PFC yet is not associated with the types of problems regulating emotions and social behavior that are the hallmark of many patients with frontal lobe damage. In fact, in addition to being better able to regulate their own emotional experience, older adults are also better able to control their expressions of negative emotions. For example, they are less likely than younger adults to report having a tendency to lose their temper quickly (McConatha & Huba, 1999). This pattern suggests that some prefrontal regions are more critical for the regulation of emotion and that prefrontal regions specialized for emotional processing are less subject to age-related decline than other regions of the PFC.

Considering that the frontal lobes occupy about a third of the human cortex, it is not surprising that thinking about the PFC as a monolithic unit can be misleading. In terms of the role of the PFC in aging, emotion, and memory, it seems especially important to consider the dorsolateral PFC and the orbital PFC as discrete regions (Phillips & Della Sala, 1998). These two regions have separate anatomical pathways to communicate with subcortical regions and seem to mediate very different processes (Masterman & Cummings, 1997). The orbital PFC seems to be essential for regulating emotion (see Davidson, Putnam, & Larson, 2000, for a review). Patients with lesions in orbitofrontal regions have difficulty reversing responses previously rewarded but no longer rewarded (Rolls, 2000) and show disinhibited behavior (Bechara, Damasio, Tranel, & Anderson, 1998). They also show emotion regulation deficits in gambling tasks, as they are driven by short-term emotional payoffs, ignoring more significant future emotional consequences (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, & Damasio, 2000). On the other hand, the dorsolateral PFC seems particularly important for strategic memory processes. Declines in the volume and activity of the dorsolateral PFC in it have been associated with older adults' deficit in strategic memory tasks (for a review, see Raz, 2000).

Unfortunately, there is little information about which areas of the PFC are most affected by normal aging. Most studies examining age-related changes in the frontal lobes have not considered subdivisions within the frontal lobes. Recent evidence, however, indicates that the orbital PFC may be selectively spared in comparison to other areas of the PFC (Salat, Kaye, & Janowsky, 2001). In contrast, the study by Salat et al. (2001) suggests that regions in the medial and lateral PFC and anterior cingulate are more likely to be affected by aging. Thus, preliminary evidence suggests that at least one region in the PFC that is important for regulating emotion is comparatively spared by aging.

Hemispheric Asymmetry Indirect techniques for examining laterality and emotion suggest that the right hemisphere plays a larger role than the left hemisphere in processing emotions (for a review, see Kolb & Whishaw, 1990). For example, people tend to make eye movements toward the left during emotional tasks and to the right during nonemotional tasks (Schwartz, Davidson, & Maer, 1975), and the emotional aspect of facial expressions tend to be more pronounced on the left side of the face (Moscovitch & Olds, 1982). There is also evidence of laterality effects for emotional valence, as people have a more negative response to films shown to the right than left hemisphere (Dimond, Farrington, & Johnson, 1976). Data from case studies of patients with lesions suggest that this laterality effect occurs in the frontal lobes, with the left frontal lobe normally mediating positive emotions and the right frontal cortex mediating negative emotions (Grafman, Vance, Weingartner, Salazar, & Amin, 1986). Furthermore, neuroimaging and electrophysiological studies with normal younger adults reveal right PFC activation during negative emotional states (Davidson & Irwin, 1999).

Some researchers have proposed that certain age-related cognitive deficits occur because in aging the right hemisphere deteriorates faster than the left hemisphere (Ellis & Oscar-Berman, 1989; Evert & Oscar-Berman, 2001; Goldstein & Shelly, 1981; Johnson et al., 1979; Nebes, 1990; Schaie & Schaie, 1977). Researchers suspect that the right hemisphere is more affected by aging because older adults score as well as younger adults on verbal subtests of intelligence tests but are impaired on subtests measuring visuospatial skills. This dissociation is consistent with the lateralization of verbal and spatial functions to the left and right hemispheres, respectively. Furthermore, the performance of normal elderly persons on intelligence tests is similar to that of patients with damage restricted to the right hemisphere (Schaie & Schaie, 1977).

A major problem with this hypothesis, however, is that the tests sensitive to right-hemisphere damage tend to require more complex problem solving than those sensitive to left-hemisphere damage. It may be the complexity of the tests that leads to older adults' pattern of performance, rather than their reliance on the right hemisphere. Thus, a number of investigators have attempted direct tests of the right-hemisphere hypothesis by comparing younger and older adults' performance on tasks in which the stimuli are tachistoscopically presented to either the right or left visual field. Most visual half-field experiments have not found age differences in hemispheric asymmetry (e.g., Hutner & Oscar-Berman, 1996; Mittenberg, Seidenberg, Oleary, & Digiulio, 1989; Nebes, 1990; Nebes, Madden, & Berg, 1983; Obler, Woodward, & Albert, 1984). In addition, studies specifically examining hemispheric asymmetry for the perception of emotional stimuli have not found age differences in how dominant the right hemisphere is for processing emotions (Cherry, Hellige, & McDowd, 1995; Hutner & Oscar-Berman, 1996; Moreno, Borod, Welkowitz, & Alpert, 1990; Reminger, Kaszniak, & Dalby, 2000). Finally, measurements of the volume of the right and left hemispheres have failed to find evidence for greater age-related decreases in the right hemisphere (e.g., Good et al., 2001). Thus, there is little evidence to show that older adults have a selective decline in the right hemisphere that affects emotional processing.

In contrast, there is substantial evidence showing that prefrontal activity associated with memory and other cognitive processes becomes less lateralized with age (Cabeza, 2002). For example, brain activity associated with episodic retrieval is right-lateralized among younger adults (Nyberg, Cabeza, & Tulving, 1996) but becomes more bilateral with age. This decreased lateralization may reflect dedifferentiation of brain regions, changes in strategy, or compensatory mechanisms (in which analogous regions on the contralateral side are recruited to assist processing). In any case, this reduction in lateralization for memory processes does not lead to any strong predictions about changes in the impact of emotion on memory. One possibility, however, is that it interacts with the lateralization of positive and negative affect also seen in the PFC (Davidson & Irwin, 1999). The decrease seen with age in the right lateralization of memory processes may lead to decreases in the degree to which memories are negative. Because we do not know whether laterality effects for valence also decrease with age, this possibility is only speculative.

Overview of Emotion and the Aging Brain In summary, studies investigating age-related changes in the brain suggest that brain regions typically associated with emotional processes are relatively well preserved in older adults. The amygdala shows little deterioration, and there does not appear to be greater right than left hemisphere decline with aging. There is also some indication that orbitofrontal regions associated with emotional control in the PFC are less affected by aging than other parts of the PFC. Altogether, these findings suggest that the impact of emotion on memory will still occur among older adults. In fact, the impact of emotion might even be amplified, as emotional processes may gain more influence than other processes supported by brain regions that deteriorate faster.

Summary of Predictions for Memory Based on Research on Emotion and Aging

The behavioral studies reviewed in the preceding sections indicate that emotional processes gain centrality and effectiveness with age. In addition, the neurological studies indicate that the brain regions supporting emotional processing are relatively spared the effects of age. The one major exception to this pattern of maintenance is that physiological intensity of emotion in the peripheral nervous system, as measured by heart rate, declines with age. Nevertheless, the reduced physiological responsiveness in older adults does not seem to affect their subjective emotional reactions or experience (Levenson et al., 1991, 1994; Tsai et al., 2000).

The findings regarding emotional functioning in these different domains lead to two major hypotheses about how the impact of emotion may differ for older and younger adults. First is the *emotional compensation hypothesis*: well-maintained emotional processes can help older adults remember information they otherwise would have forgotten. Second is the *goal-directed emotional memory hypothesis*: in general, memory should become more emotionally gratifying, as older adults focus on regulating emotion more than younger adults. In the following section, I review findings from studies examining age differences in the effects of emotion on memory to see if either or both of these predictions hold.

Evidence for Changes in the Role of Emotion in Remembering as We Age

Memory for Emotional Versus Neutral Information

Our most vivid and powerful memories involve emotional events (e.g., Brown & Kulik, 1977; Reisberg, Heuer, McLean, & Oshaughnessy, 1988; Rubin & Kozin, 1984). Several studies that look at memory for emotional information (but do not distinguish positive from negative information) suggest that memory accuracy for emotional information does not decrease with age as much as memory for neutral information. In one study, older and younger participants participated in scripted situations (such as packing a picnic basket) and imagined participating in others (Hashtroudi, Johnson, & Chrosniak, 1990). After intervening tasks, they rated their memories for half the situations they had experienced, using a memory characteristics questionnaire that assessed the amount of perceptual and contextual detail and thoughts and feelings associated with their memories. The following day, they rated their memories of each situation and then recalled as much as they could about them. After this 1-day delay, older adults rated thoughts and feelings as more memorable than younger adults did. In contrast, this age difference did not appear when participants rated situations immediately after they experienced them. This pattern suggests that, for older adults, the salience of thoughts and feelings increases over time. In addition, in their actual recall of the situations, older adults reported more thoughts and feelings and evaluative statements than did younger adults, whereas younger adults reported more colors, objects, actions, spatial references, and nonvisual sensory references than did older adults.

Days later, Hashtroudi et al. (1990) asked the older and younger adults to make source attributions for each situation, indicating whether they participated in it or just imagined participating in it. Older adults seemed to emphasize their thoughts and feelings when making these source judgments, as their confidence in their recollections correlated more highly with their ratings of associated thoughts and feelings for each event than those of younger adults (Johnson & Multhaup, 1992).

Externally generated emotional information also seems to gain advantage in memory as one ages. One study suggesting that emotional information gains salience examined memory for a narrative that contained equivalent numbers of neutral (e.g., "Celia sipped some more sherry") and emotional (e.g., "and looked very searchingly at Mrs. Oliver") phrases (Carstensen & Turk-Charles, 1994). Four age groups from 20 to 83 years old were tested. Each successive age group recalled a greater portion of emotional information, so that a significant linear trend across the life span emerged. Older adults also recalled a larger proportion of emotional information than younger adults in a study that examined memory for advertisements (Fung & Carstensen, in press). Participants saw a series of advertisements (such as a picture of a camera identified with a brand name and accompanied by a slogan). Some participants saw a particular advertisement picture and brand name with a slogan that appealed to emotional goals (e.g., "Capture those special moments"), whereas others saw it with a slogan that suggested expanding horizons or achieving success in the future (e.g., "Capture the unexplored world"). Younger adults remembered these different types of slogans equally well, but older adults remembered the emotional slogans better than the expanding horizons slogans.

One of the challenges of doing research on emotion and memory is counterbalancing emotional and neutral material. Differences between memory for the two types of stimuli can sometimes result from something other than the difference in emotionality. The age differences in Fung and Carstensen's (in press) study, however, occurred not only for the slogans but also for the brand names—even though the brand names themselves were not emotional, and each brand name appeared equally often with each type of slogan.

In addition, another recent study suggests that older adults remember the same information better if it is presented in an emotionally evaluative frame

(Rahhal, May, & Hasher, 2002). Older and younger participants listened to a tape of a male and a female speaker reading trivia. They were told that all of the statements read by the female speaker were true and all of the statements read by the male speaker were false (or vice versa). After a short delay, they completed a source memory test in which they were given a list of the statements that had been read and were asked either who said the statements (a perceptual source task) or whether they were true or false (a conceptual, emotionally valenced source task). As many studies have shown, older adults were less able than younger adults to indicate who said each statement. Nevertheless, they were just as accurate as the younger adults at indicating whether the statements were true or false, even though this information had been conveyed by the gender of the speaker. This pattern was replicated when the conceptual, emotionally valenced task changed to one of evaluating the character of a person (good or evil) (Rahhal et al., 2002) or the safety of an item (May, Rahhal, Leighton, & Berry, 2002). Thus, for example, participants would be told that everyone the female speaker described was good and everyone the male speaker described was evil. If they heard the female speaker describe someone named Sally and were later asked if Sally was good or evil, they were as good as younger adults at making this judgment—but if asked whether Sally was described by the male or female, they were less accurate than younger adults.

Each of the studies reviewed in this section suggests that older adults remember emotional aspects of events better than neutral events and thus confirm a prediction generated from both the research on emotional goals and on brain regions associated with emotional processes. None of these studies distinguished positive from negative information, however, so the predictions regarding emotionally gratifying information were not addressed. I address studies that examine age differences in memory by valence in a subsequent section.

A Different Story: Alzheimer's Disease and Emotional Memory

Unlike normal aging, Alzheimer's disease has a dramatic impact on the amygdala. Compared with age-matched controls, Alzheimer's patients show a significant reduction in volume of their amygdalae, with estimates ranging from 20% to 35% (Callen, Black, Gao, Caldwell, & Szalai, 2001; Cuenod et al., 1993; Herzog & Kemper, 1980; Smith, Malcein, et al., 1999) to as much as 55% (Scott, DeKosky, & Scheff, 1991). In addition, Alzheimer's disease reduces amygdalar volume more dramatically than it reduces brain volume overall (Scott et al., 1991) or other individual structures (Cuenod et al., 1993; Kemper, 1994).

Not surprisingly, this degeneration of the amygdala has an impact on emotional memory. A study examining memory for the Kobe earthquake (which measured 7.2 on the Richter scale and caused more than 6,000 deaths) found that among Japanese Alzheimer's patients, the accuracy of autobiographical memory for the earthquake was positively correlated with the volume of their amygdala as measured by an MRI (Mori et al., 1999). Furthermore, compared with other older adults, patients with Alzheimer's disease do not show the enhancement in memory for emotional rather than neutral pictures (Abrisqueta-Gomez, Bueno, Oliveira, & Bertolucci, 2002; Hamann, Monarch, & Goldstein, 2000; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002) or the enhancement in memory for emotional words (Kensinger et al., 2002). Alzheimer's patients are also impaired when learning to associate a neutral stimuli with an aversive outcome (Hamann, Monarch, & Goldstein, 2002).[1]

Thus, older adults with Alzheimer's disease show a very different memory pattern than that seen with normal aging. Whereas emotion enhances memory as much as or more for older adults than it does for younger adults, this emotional enhancement decreases or disappears altogether for Alzheimer's patients.

Impact of an Affective Focus on Nonaffective Information

Many researchers have noted that older adults' memories are more influenced by the gist or schematic information about an event than are younger adults' memories. Older adults are more likely to falsely recognize new words that are semantically associated with studied words (Balota et al., 1999; Isingrini, Fontaine, Taconnat, & Duportal, 1995; Kensinger & Schacter, 1999; Norman & Schacter, 1997; Rankin & Kausler, 1979; Smith, 1975; Tun, Wingfield, Rosen, & Blanchard, 1998), to falsely recognize new pictures that are categorically related to studied pictures (Koutstaal, Schacter, & Brenner, 2001; Koutstaal, Schacter, Galluccio, & Stofer, 1999), to falsely recognize schema-consistent objects as having been in a scene (Hess & Slaughter, 1990), and to incorrectly attribute schematically related statements to a speaker associated with that schema (Mather et al., 1999).

Perhaps older adults' greater schema reliance occurs because they engage more often in emotion-focused memory processes. For two reasons, we may assume that being more emotion focused will increase reliance on schematic knowledge. First, an emotional self-focus seems to shift people's focus away from the event itself, instead emphasizing connections between the event and oneself. That is, asking people to rate how they feel when hearing statements enhances memory for the semantic content but impairs memory for associated contextual details, such as who made the statement (Johnson, Nolde, & De Leonardis, 1996; Mather et al., 1999; Suengas & Johnson, 1988). Lacking memory of specific perceptual and contextual details associated with the event in memory, people may rely more on their schematic knowledge about the event to help reconstruct it later. In addition, the thoughts and inferences generated while thinking about one's reactions to an event may draw on schematic knowledge about the event and may then later become confused with the event itself. In summary, an emotional self-focus may increase how schematically an event is remembered, as a result of how attention is allocated and how related information becomes associated with the event.

One study that supports the hypothesis that an emotional focus can lead related thoughts and inferences to be confused in memory with the event itself asked older and younger adults to participate in a play and then review it (Hashtroudi, Johnson, Vnek, & Ferguson, 1994). In the first part of the experiment, two participants were prompted to repeat or think about lines of a play. The experimenter read each line of the play to the pair of participants and then indicated which one should say or think the line. There were three review conditions. In the factual focus condition, participants were asked to talk and then think about what had been said by both participants in each scene. In the affective focus condition, participants were asked to talk and then think about how they felt during each scene. Finally, in the control condition, participants were asked to talk and then think about anything regarding the play. After rehearsing the scenes, half of the participants in each review condition were given a source-monitoring test, in which individual statements from the play were presented, as well as semantically related distractors. These participants were asked to indicate whether the statement had been said or thought and which person had said or thought it—or whether the statement had not been in the play. Examining participants' source-monitoring accuracy revealed a significant interaction between age and type of focus. Whereas the type of focus did not affect younger adults' source-monitoring accuracy, older adults were significantly less accurate in the affective and control conditions than in the factual focus condition. The other half of the participants recalled the play. Both older and younger participants in the affective focus condition remembered less of the play. In addition, participants in the affective focus condition recalled more inferences about and elaborations on the play. In fact, 51% of what the older adults recalled and 38% of what the younger adults recalled in the affective focus condition included elaborative information (compared to less than 30% in both other conditions). Thus, an emotional focus can lead one's inferences and related thoughts about an event to become confused with the event itself when one is remembering.

This combination of greater recall of inferences and reduced recall of perceptual information after focusing on the emotional aspects of events may lead to more schema-reliant memories after focusing on one's feelings. A study examining memory for choices is consistent with this possibility (Mather & Johnson, 2000). In this study, older and younger adults made a series of two-option choices (e.g., a choice between two job candidates). Each option had positive and negative features (e.g., "Seemed quite motivated," "Has little professional experience"). After making the choices, one group of participants reviewed how they felt about each choice, another group reviewed the details of the choice options, and a third did an unrelated task. After a delay, participants were given memory tests for each decision that included the features from each option intermixed with new features.

They were asked whether each feature had been associated with the first option, the second option, or neither option. One piece of schematic knowledge about the decisions that might have influenced memory is the belief that chosen options were better than rejected options. If this belief were to affect memory, it should do so by increasing the number of choice-supportive memory attributions. Positive features should more likely be attributed to the chosen than to the rejected options, and negative features should show the opposite pattern. In averages across conditions, older adults were more choice-supportive than younger adults. The focusing condition did not affect how choice-supportive older adults were. Younger adults, however, were significantly more choice-supportive in the emotional-review condition than in the other two conditions and were as choice-supportive as the older adults only in the emotional-review condition.

However, increased influence of general knowledge or beliefs on memory after engaging in affective focus may occur only for affectively significant situations such as choices. Remembering that the option you chose was the better option should make you feel less regret and more pleasure. Reviewing a choice may therefore activate emotional goals that would not be activated in other contexts. To investigate whether an affective review would increase the influence of schematic knowledge on memory, even when the schema should not lead to more positive emotion, Mather and Johnson (2003) conducted a similar study with different materials. They used a story that included several unstated inferences as the to-be-remembered material rather than choice options. Participants read the story and then were asked either to review how they felt about it, to review its details, or to do an unrelated task. Both older and younger adults in the affective-review condition were very likely to falsely recognize the unstated inferences from the story. The factual review, however, helped reduce younger adults' schema reliance much more than it reduced older adults' schema reliance. Thus, across two studies, older adults were more schema-reliant than younger adults, except when participants were told to focus on their feelings. This pattern suggests that emotional processing increases schema reliance.

Interestingly, the amygdala may help mediate this effect, as patients with amygdala damage have poorer memory for gist and superior memory for detail (Adolphs, Denburg, & Tranel, 2001). In the Adolphs et al. study, participants were shown a series of photographs accompanied by brief descriptions. Normal controls and patients with unilateral amygdala damage all showed better memory for general information associated with aversive photographs than for their visual details. In contrast, a patient with bilateral amygdala damage had better memory for the detail than for the general information. Along these same lines, studies with undergraduates have found that emotional stimuli enhance memory for central information but have a detrimental effect on peripheral details (Burke, Heuer, & Reisberg, 1992; Christianson, 1992; Reisberg & Heuer, 1992). As outlined earlier, the amygdala shows relatively little decline with age; thus, the enhancement it provides for memory for general information about emotional scenes is probably maintained.

Flashbulb Memories and Aging

People often remember the circumstances of learning about shocking events with great vividness and detail. Brown and Kulik (1977) called these "flashbulb memories" because they often seem as clear and vivid as if a flashbulb camera went off and recorded every detail of the news. To help explain their findings of extremely vivid memories for surprising and emotionally arousing events, Brown and Kulik suggested that on recognizing that an event is unexpected and important, the limbic system issues a "Now print!" order for memory (Livingston, 1967).

Subsequent research has confirmed that, although flashbulb memories are far from exact snapshots of the surprising moment, one remembers the circumstances of learning about shocking events better than those of ordinary events (e.g., Christianson, 1989). The strength of emotional reactions helps predict how accurate later recall will be (Conway et al., 1994; Pillemer, 1984), especially over a longer delay (Schmolck, Buffalo, & Squire, 2000).

Most of what we know about aging and memory predicts that older adults will be less likely to have accurate and vividly remembered flashbulb memories. According to Brown and Kulik's (1977) original formulation, a flashbulb memory includes information for contextual information associated with when the person first learned about the event, such as the source of the information, the place, the other people present at the time, and what else was happening at the time. Older adults have particular difficulty remembering this type of contextual and source information (e.g., Hashtroudi, Johnson, & Chrosniak, 1989; McIntyre & Craik, 1987; Spencer & Raz, 1995), suggesting that they will be less likely to have flashbulb memories.

Nevertheless, evidence about age differences in the vividness and accuracy of flashbulb memories is mixed. Wright, Gaskell, and O'Muircheartaigh (1998) conducted surveys that included several thousand British participants representative of the larger population. Participants were asked about their memories for Margaret Thatcher's resignation as prime minister of Great Britain and for their memories of a semi-final England Football Association Cup match in which 96 people were crushed to death in full view of a national television audience. To the surprise of the researchers, 19 months after Thatcher's resignation and 36 months after the football tragedy, self-ratings for memory clarity for these events were greater the older the respondent was, until after age 75, when they returned to the levels in the younger adult cohort. In contrast, 12 years after President Kennedy's assassination, Yarmey and Bull (1978) found less detailed accounts of the circumstances of learning of the assassination in people older than 66.

Neither the Wright et al. (1998) nor the Yarmey and Bull (1978) studies included objective measures of accuracy. Studies of younger adults' flashbulb memories show that objective measures are essential because many highly confidently recalled flashbulb memories include quite inaccurate vivid details (e.g., Neisser & Harsch, 1992; Schmolck et al., 2000). In particular, among younger adults, flashbulb memories are quite susceptible to distortion in which memory for the original circumstances becomes confused with other related memories. For example, when recalling how they learned about the space shuttle Challenger disaster 3 years after it occurred, many undergraduates remembered learning about it from a TV broadcast, even though they actually had learned about it from a friend or some other source (Neisser & Harsch, 1992). Older adults are more likely than younger adults to exhibit memory distortion as a result of misattributing information they learned from one source to another source (e.g., Henkel et al., 1998; Mather & Johnson, 2000; Mather et al., 1999; Mitchell, Johnson, & Mather, 2003). So older adults' flashbulb memories likely will be more susceptible to memory distortion caused by source monitoring errors. Thus, although the participants in the Wright et al. study remembered the shocking events more vividly the older they were, they also probably remembered them less accurately.

Two additional studies examining age differences in flashbulb memories measured recall within a few weeks of the event and again some months later (Cohen, Conway, & Maylor, 1994; Davidson & Glisky, 2002). Though participants' first memory reports were probably not exact representations of what happened, these studies could at least assess the consistency of the flashbulb memories over time—a reasonable proxy for measuring objective accuracy. These studies provide mixed evidence for the hypothesis that older adults have less accurate flashbulb memories. In the first study, groups of younger and older adults recounted how they heard the news of Thatcher's resignation (Cohen et al., 1994). They were tested within 2 weeks of the resignation and again 11 months later. Older adults' responses at the two test points were significantly less likely to be consistent than those of younger adults.

In the second study examining age differences in flashbulb memory consistency, groups of younger and older adults recounted how they learned about the deaths of Princess Diana and Mother Theresa within 3 weeks of each incident and again about 6 months later (Davidson & Glisky, 2002). In this study, there were no significant differences between the consistency of younger and older adults' memories. In addition, among the older adults, there were no significant correlations between the consistency of their memories for the deaths and scores on a battery of tests associated with medial temporal lobe function or a battery of tests associated with frontal lobe function. In contrast, memory consistency for a control event (the most interesting event in their own lives that occurred on the same weekend when Princess Diana died) was correlated with performance on these batteries (although only marginally with

the frontal battery). A number of studies examining older adults' source memory performance have found significant positive correlations between source attribution accuracy and performance on tests of frontal lobe function (Craik et al., 1990; Glisky et al., 1995; Mather et al., 1999) and sometimes also between source accuracy and performance on tests of medial temporal lobe function (Henkel et al., 1998; Mather et al., 1999). The fact that memories were as accurate for the surprising public events among older adults with low frontal function as among those with high frontal function suggests that other brain regions (such as the amygdala) may be involved in forming and consolidating memories of surprising events. Processes mediated by these regions may compensate for decline in frontal regions.

In summary, the research on older adults and flashbulb memories is somewhat surprising because older adults do not always show less accurate memories than younger adults, as one might expect from their memory performance in similar contexts. The emotional aspect of shocking events may be a critical component of this greater-than-expected accuracy. More research is needed, however, in which older and younger adults' memory for shocking events is compared with memory for interesting but nonemotional events. The emotional compensation hypothesis outlined earlier in the chapter predicts that age differences in forgetting and distortion should be greater for the control events than for the shocking events. Also of interest is whether the valence of the event interacts with age differences at all. Most flashbulb memory studies have looked at memories for negative events, but memories for positive surprising events can also have flashbulb-like qualities (Scott & Ponsoda, 1996). As outlined in the following section, valence seems to have a different impact on younger and older adults' memories.

Evidence for Increasingly Gratifying Memories With Age

For younger adults, negative information dominates positive information in many contexts (for reviews, see Baumeister, Bratslavsky, Fickenauer, & Vohs, 2001; Rozin & Royzman, 2001). Negative information is processed more thoroughly, negative impressions are more difficult to disconfirm, and negative emotions have more impact. Nevertheless, the evidence is mixed for younger adults' memory, with some studies finding a bias for negative and some for positive information. There is growing evidence, however, that with age comes a shift toward favoring positive rather than negative information in memory. As I show in this section, evidence for this shift has been seen both in longitudinal studies investigating personal autobiographical memories and in lab studies investigating memory for emotional pictures or verbal stimuli.

Among younger adults, memories for highly negative events seem to be accessible for a longer time than memories of highly positive events (Berntsen, 2001, 2002). A survey of over a thousand Danish citizens, however, revealed that this pattern in which negative memories last longer than positive memories reverses itself in the late 30s (Berntsen & Rubin, 2002). By age 60, there is dramatically reduced recall of remote negative events compared to recall of remote positive events. When asked to describe memory for an extremely happy event, older adults tended to pick events from their 20s, whereas when asked to describe a memory for an extremely sad or traumatic event, they picked more recent events. This pattern of recall for sad and traumatic events is contrary to findings indicating that, in general, people remember information encoded during adolescence and early adulthood better than information encountered earlier or later in life (Rubin, Rahhal, & Poon, 1998). Berntsen and Rubin (2002) conclude that the likely explanations of the reduced recall of remote sad and traumatic events are reduced rehearsal of negative events or repression.

The decreasing accessibility of negative long-term personal memories across the life span may help explain an intriguing finding from a longitudinal study (Field, 1981). Sixty adults were interviewed four times over a 44-year period and were asked during each interview to rate how happy their childhood had been. There was a highly significant trend over time, as participants rated their childhood as increasingly happier the older they became.

A study of political supporters of Ross Perot indicates that memory for the intensity of past sadness decreases with age (Levine & Bluck, 1997). After Perot abruptly withdrew from the presidential race in July 1992, some of his supporters were asked to rate their initial emotional reactions. After the elections that November, they were asked to recall their initial emotional reactions. There were no age differences in the initial reports of emotion intensity. Nevertheless, the follow-up questionnaire revealed that, among those participants who still wished that Perot had been elected, older adults remembered experiencing less intense sadness than younger adults did. The older the participants, the more they underestimated how sad they had been when Perot withdrew from the race. Interestingly, there were no age differences for supporters who no longer wished that Perot had been elected—these supporters all tended to underestimate how sad they had been.

A study in which older and younger adults were asked about recent memories also found that younger adults remember negative emotions more intensely than older adults. Older and younger adults carried electronic pagers for a week and filled out a questionnaire about their current emotions each time they were paged at random intervals throughout each day (Carstensen et al., 2000). At the end of the week, they were asked to recall the percentage of time they had experienced positive and negative emotions and their concomitant intensities (Kennedy, 2002). There were no age differences in the accuracy of estimates for the percentage of time emotions had been experienced, but younger adults were significantly more likely than older adults to overestimate how intense their negative affect had been.

Decreases for negative information are also seen in memory for emotional pictures (Charles, Mather, & Carstensen, 2003). Younger (18–29 years), middle-aged (41–53 years), and older (65–80 years) adults watched a slide show of negative, positive, and neutral pictures displayed in a random order. Half the pictures were of people (e.g., a couple mourning at a tombstone, a happy family, scuba divers) and half did not contain people (e.g., a slice of pizza with a cockroach on it, two bunnies, a chair). The participants included equal numbers of men and women, European Americans and African Americans, and white- and blue-collar workers within each condition. After seeing the pictures and completing a 15-minute filler task, participants were asked to recall as many of the pictures as they could. Then, they completed a recognition memory test in which they saw a series of pictures and indicated which ones they had seen before. The proportion of total recall that consisted of negative pictures decreased across the life span, whereas the proportion that consisted of positive pictures increased. Recognition accuracy for negative pictures similarly decreased. These age differences were consistent across the different genders, ethnicities, and socioeconomic statuses represented among the participants.[2]

Another study focusing on memory for emotional pictures examined whether there are age differences in brain activity at the time of encoding the pictures (Mather et al., 2001). Younger and older adults watched positive, negative, and neutral pictures while in a functional magnetic resonance imaging scanner. For each picture, they rated how emotionally arousing it was for them. After their scan, they were given a recognition memory test for the pictures in which they were asked whether they had seen each test picture while they were in the scanner. They were then asked to indicate whether they remembered it vividly or just knew it had been shown in the scanner (R/K; e.g., Gardiner & Java, 1993). Older adults rated the negative pictures as less arousing and rated the positive pictures as more arousing than the younger adults did. As in the study by Charles et al. (2003), there was a significant age by valence interaction in recognition memory performance, indicating that older adults showed a disproportionate disadvantage in recognizing the negative pictures. Furthermore, when older adults did actually recognize a negative picture from the scanner session, they were less likely to say they vividly remembered it than they were for the positive pictures they recognized.

As I said earlier, the amygdala appears to be relatively unscathed by aging. Mather et al. (2001) found that for both older and younger adults, the amygdala was more active while emotional pictures were displayed than while neutral pictures were displayed. There was an interaction, however. Older adults had greater amygdala activity while seeing positive pictures, whereas the younger adults had equivalent activation for the two types of emotional pictures. In addition, older adults showed more prefrontal activity while viewing positive pictures. These differences in brain activity at the time of encoding suggest that older adults' bias to remember less negative information is at least partially a result of processes operating at the time of encoding.

Another study suggests that biased attention at the time of encoding contributes to the increasingly emotionally gratifying memories seen with age (Mather & Carstensen, in press). On each trial, older and younger adults were shown an emotional and a neutral face side by side for 1 second. Then the faces disappeared, and a dot probe appeared behind one of the faces. Participants had to indicate the side of the screen the dot was on. In two experiments, older adults responded faster if the dot was behind a neutral face than if it was behind a negative face. They also showed a trend to respond faster if the dot was behind a positive face than if it was behind a neutral face. Younger adults did not show any attentional biases. In a later forced-choice recognition memory test, older adults were more accurate at identifying which positive faces they had seen before than which negative faces they had seen before, whereas this was not the case for younger adults.

Increasingly emotionally gratifying memory with age was also found in two studies focusing on memory for choices (Mather & Carstensen, 2003; Mather & Johnson, 2000). These studies suggest that processes operating at the time of retention and retrieval also contribute to older adults' emotionally gratifying memory biases. In the first study, as described earlier in this chapter, older adults were more choice-supportive than younger adults when attributing features to options from past choices (Mather & Johnson, 2000). They were more likely to attribute positive features to the options they had chosen than to the other options and were more likely to attribute negative features to the rejected options. The age difference in choice-supportiveness obtained even when older and younger adults were equated for overall recognition and source attribution accuracy by decreasing the delay between encoding and test for the older adults. Older adults' choice-supportive biases obtained not only for features actually associated with the options but also for new features misattributed to one of the two options. Older adults' choice-supportive biases for new features indicate that at least some of the processes supporting emotionally gratifying memories operate at the time of retrieval.

The importance of retrieval processes is further highlighted by the second study of age differences in memory for decisions (Mather & Carstensen, 2003). Half the participants were asked to recall the features from their choices before completing a recognition and source attribution test for the features, whereas the other half took the recognition test first. Overall, there were age by valence interactions for both recall and recognition. Younger adults remembered negative features from the choice options much better than positive features. Older adults showed a less extreme advantage for the negative features than the positive features. Particularly interesting, however, was the differential impact of taking a recall test on later recognition of positive and negative features for older and younger adults. Younger adults were less likely to recognize positive features if they received the recall test first, whereas the test order did not have much of an impact on older adults' recognition of positive features. Taking a recall test first had the opposite effect for

recognition accuracy of negative features. Younger adults' accuracy for negative features was not affected by having taken the test, whereas older adults were less likely to correctly recognize negative features if they had done the recall test first. This pattern suggests that for younger adults, attempting to recall information that includes both positive and negative aspects may inhibit later memory for the positive aspects, whereas for older adults, recall may inhibit later memory for the negative aspects. Repeated retrieval may make older adults' memories more positive and younger adults' memories more negative.

In addition, half of the participants in each condition completed the memory tests after 10 minutes, whereas the other half completed the tests after 2 days. Comparisons across these two delay groups revealed that older adults' recognition accuracy for negative features declined more than did that of younger adults, whereas their decline in accuracy for positive features was not much greater than that of younger adults. Thus, older adults tended to forget the negative features more quickly than the positive features. Thus, factors operating over the retention interval also play a role in making older adults' memories more gratifying.

Apparently, the salience of emotional goals also plays an important role in making memories more gratifying. Mather and Johnson (2000) found that younger adults were more choice-supportive in their memories of their recent decisions if they had been asked to review their feelings than if they had been asked to review the details or to do an unrelated task. Only the emotion-focused younger adults were as choice-supportive as the older adults were across all of the conditions, suggesting that older adults were more likely to focus on emotion even when not explicitly told to think about their feelings.

Kennedy, Mather, and Carstensen (in press) also found that making emotional goals salient increases gratification. In their study, 300 nuns between the ages of 47 and 102 completed a questionnaire in which they were asked to remember their responses to a questionnaire they had completed 14 years earlier about their health practices and medical history. Participants in the emotion-focus condition completed a retrospective questionnaire in which they were asked to rate their current feelings after each subset of questions. At the same points in the questionnaire, participants in the accuracy-focus condition were reminded to answer the questions as accurately as they could and asked to complete ratings regarding their subjective sense of remembering. There was also a control condition questionnaire without any reminders. For age comparisons, the control group was divided into middle-aged (47–65) and older (79–102) groups.

Older adults showed a positive bias when remembering their past health practices and illnesses, whereas middle-aged adults showed a negative bias. Both older and younger participants in the emotion-focused condition had a positive retrospective memory bias, whereas both older and younger participants in the accuracy-focused condition had a negative bias. Thus, older adults and emotion-focused participants showed the same pattern in their retrospective biases. These findings remained significant after controlling for current mood and current ratings of physical and mental health and emotional experience. Furthermore, making emotional goals salient not only led to a positive memory bias but also led emotion-focused participants to be in a better mood than accuracy–focused participants after completing the questionnaire.

Further evidence that older adults' positive memory biases contribute to their enhanced well-being comes from a study comparing emotion while one is reminiscing with others about past events to emotion while one is engaged in other social activities (Pasupathi & Carstensen, in press). In contexts in which participants were engaged in mutual reminiscing, older adults experienced significantly more positive emotion than younger adults. In contrast, in social contexts that did not involve reminiscing, age was not significantly correlated with positive emotion. A second study found that age was associated with improved emotional experience only during reminiscing about positive experiences. These findings suggest that, for older adults, remembering positive events can be an effective way to regulate emotion.

Summary: Aging, Emotion, and Memory

In contrast with functioning in the physical and cognitive domains, emotional functioning does not deteriorate with age. Instead, if anything, it actually grows more effective across the life span. Changing time perspective (Carstensen et al., 1999), greater experience and maturity (Labouvie-Vief, 1998), and relatively well-maintained brain regions associated with emotional processing may all contribute to this intact functioning and help older adults remember emotional information better than neutral information. Similarly, the pattern of fewer neurological changes in brain regions associated with emotion than in other regions suggests that emotional processes may be available to compensate for decline in other processes that contribute to memory formation and retention.

This emotional compensation hypothesis is supported by studies in which memory for emotional information is maintained better in old age than memory for neutral information. For example, older adults remember their own internal emotional reactions more vividly than younger adults do (Hashtroudi et al., 1990), and a larger proportion of the externally perceived information they remember consists of emotional information (Carstensen & Turk-Charles, 1994; Charles et al., 2003; Fung & Carstensen, in press). Furthermore, at the time of retrieval, older adults can remember the source of information as well as younger adults if the source is identified through its emotional rather than nonemotional aspects (May et al., 2002; Rahhal et al., 2002). In addition, older adults' errors and biases resemble those of younger adults under emotional conditions (Kennedy et al., 2002; Mather & Johnson, 2000, 2003), suggesting that, in general, older adults are more likely to engage in an emotional focus when encoding or retrieving events.

Studies that focus on memory for positive and negative information separately, however, indicate only partial support for the emotional compensation hypothesis, as aging does not lead to a relative enhancement for all types of emotional information. Instead, the enhancement in memory for emotional material among older adults seems to be driven by enhanced memory for positive information. In fact, memory for negative information declines with age (e.g., Charles et al., 2003; Mather et al., 2001).

This bias to remember positive relatively better than negative events with age is consistent with the hypothesis that older adults should remember information consistent with their emotional goals. Both in lab studies with controlled stimuli and in field studies examining memories for real-life events, older adults' memories are more emotionally gratifying than younger adults' memories. In comparison with memories of younger adults, a larger proportion of what older adults remember is positive and a smaller proportion is negative (Charles et al., 2003; Mather et al., 2001; Mather & Carstensen, 2003). Older adults' memories for specific events or time periods are also more likely than younger adults' memories to be distorted in an emotionally gratifying direction (Field, 1981; Levine & Bluck, 1997; Mather & Carstensen, 2003; Mather & Johnson, 2000). For older adults, negative memories fade faster than positive memories, whereas this is not the case for younger adults (Berntsen & Rubin, in press; Mather & Carstensen, 2003).

These gratifying memories seem to be a critical component of older adults' successful emotion regulation processes. For example, older adults experience more positive emotion than younger adults while reminiscing with other people, but there is no significant age difference in positive emotion in other social contexts (Pasupathi & Carstensen, in press). Thus, memory and emotional functioning seem to interact in mutually beneficial ways. Emotional processes can help older adults remember information they might otherwise have forgotten—and, in turn, emotionally gratifying biases in memory enhance emotional well-being.

Notes

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1. Contrasting with these findings, one study found that Alzheimer's patients showed as much of a memory benefit for emotional stories as did normal older controls (Kazui et al., 2000). However, the control participants were at ceiling in their memory accuracy for the emotional aspects of the story, and the patients had relatively mild dementia (their average Mini-Mental State Examination score was 22.6).
2. However, a study testing older and younger adults using a similar set of emotional pictures did not find an age by valence interaction (Kensinger et al., 2002). It is not clear why the results of these studies differ.

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