Emotional Memory

Mara Mather
University of Southern California, USA

Our most vivid memories tend to be emotional. This advantage for emotional events is seen both in real-life autobiographical memory and in memory for laboratory stimuli. For instance, when shown emotional scenes, both younger and older adults tend to remember an emotional foreground item at the expense of a neutral background (Kensinger, Piguet, Krendl, & Corkin, 2005; Reisberg & Hertel, 2004). What is it that makes emotional events so much more memorable than neutral events? And are happy and sad memories equally well remembered? The two fundamental dimensions of emotions—arousal and valence—play key roles in memory for emotional events. Both of these factors influence how likely events are to be remembered, and the nature of those memories.

Arousal and Memory

Many decades of research show that arousing events tend to be remembered particularly well. For instance, shocking events such as the 9/11 terrorist attack elicit vivid, high-confidence memory reports years later (Hirst et al., 2009). Even a much smaller dose of arousal can influence long-term memory; for instance, showing people an emotional stimulus can sometimes enhance memory a week later for what happened right beforehand (Knight & Mather, 2009).

How does arousal have the power to shape memory? Arousal is a physiological experience that involves an interacting set of neurochemicals that make us more alert and awake. Arousal makes our heart pound faster and our palms sweat. Noradrenaline, released by the locus coeruleus in the brainstem during arousal, is an important neurochemical that influences memory for emotional events. It influences how the rest of the brain processes information during emotionally intense events and how long traces of that processing last. Noradrenaline released in sensory regions makes neurons more selective, such that they still activate in response to stimuli they are most tuned to, but are less responsive to, other stimuli (Berridge & Waterhouse, 2003). Noradrenaline also stimulates the amygdala and hippocampus in ways that make memory traces last longer (McGaugh, 2004).

Together, these effects mean that, during emotionally arousing events, people narrow their attention and remember the target of their attention better later. But, because noradrenaline increases the selectivity of processing, it also means that information that was not as salient will be even more likely to be forgotten later. Thus, memory is not always better for emotional events—instead, it is more selective (Mather & Sutherland, 2011). Illustrating this increase in selectivity, when participants heard an emotional sound such as a baby crying and then saw an array of letters flash briefly on a white background, they were able to remember more of the salient dark gray letters and fewer of the light gray letters than when they heard a neutral sound (Sutherland & Mather, 2012). Also, because emotionally arousing stimuli, such as guns or nudes, are both salient and induce arousal, they tend to be remembered well, often at the expense of surrounding neutral information (e.g., Fawcett, Russell, Peace, & Christie, 2013; Kensinger, 2009; Schmidt, 2002).

Valence and Memory

Valence also has a major impact on memory. Studies testing younger adults tend to find that "bad is stronger than good" when remembering information (Baumeister, Bratslavsky, Fickenauer, & Vohs, 2001). But this does not

The Encyclopedia of Adulthood and Aging, First Edition. Edited by Susan Krauss Whitbourne.

DOI: 10.1002/9781118528921.wbeaa243

apply when the information is about oneself. People tend to think about themselves in a positive light and so will often have a positive bias when recalling autobiographical memories (Walker, Skowronski, & Thompson, 2003). For instance, when twins were separately given key words (such as "accident") to use to retrieve autobiographical memories, they often both recalled the same event as happening to themselves if it was an achievement but both recalled it as happening to the other twin if it was a memory of personal wrongdoing (Sheen, Kemp, & Rubin, 2006).

One exception to the positive bias about the past occurs when people want to see their current self as having improved compared with their past self. In this case, they will have a bias to recall their past selves in a negative light (Ross & Wilson, 2003). Motivation also influences how people remember positive and negative information from choice options. When remembering which features went with which option, people have a bias to attribute positive features to the option they chose and negative features to the option they rejected (Mather, Shafir, & Johnson, 2000). This bias is shaped by motivation at the time of retrieval, as deceiving people about which option they chose leads them to attribute more positive and fewer negative features to the option they *thought* they chose rather than the one they actually chose (Henkel & Mather, 2007).

Thus, current motivations interact with the valence of information to shape whether positive or negative memories will be more likely to be retrieved. Here, in contrast with arousal, the critical mechanisms are not about neurochemical changes in how information is processed and consolidated but instead revolve around how the information relates to current emotional goals.

Age Differences in Emotional Memory

Getting older shifts our perceptions of how much time is left in life. In turn, this should influence goals, because when time seems limited, present-focused emotional goals tend to be more influential than information seeking goals that will have benefits in the future (Carstensen, Isaacowitz, & Charles, 1999). Indeed, research with older adults reveals a shift in emotional memory such that they are more likely than younger adults to remember information that should enhance mood compared with mood-depressing information. When people see a picture slide show and later recall the pictures, a larger proportion of older adults' memories consists of the positive pictures whereas a smaller proportion of their memories consists of the negative pictures (Charles, Mather, & Carstensen, 2003). When asked to remember the features of choice options, older adults remember the features in an even more choice-supportive fashion (attributing positive features to the option they chose and negative features to the option they rejected) than younger adults do—unless the younger adults are asked to think about how they feel about the choices, in which case they are as choice-supportive as the older adults (Mather & Johnson, 2000). Older adults also tend to recall more positive (relative to negative) personal memories than younger adults.

This age-related positivity effect can be eliminated by manipulations that require cognitive control to be exerted for a secondary task, is stronger in older adults who score higher on tests of cognitive control, and is stronger when there are fewer other task constraints, suggesting that the shift toward more positive memories among older adults is something that involves cognitive control and is not just a happy side of age-related decline in brain processes that detect and encode negative (and potentially threatening) information (Nashiro, Sakaki, & Mather, 2012; Reed, Chan, & Mikels, 2014).

In contrast with valence, there are few obvious changes in how arousal influences memory in aging. Consistently with the lack of behavioral differences, the amygdala shows relatively little structural decline in normal aging compared with other brain regions and continues

to show clear responses to novel stimuli (Allen, Bruss, Brown, & Damasio, 2005; Wright, Wedig, Williams, Rauch, & Albert, 2006). However, comparing the effects of arousal on memory in younger and older adults is complicated by the need to account for the positivity effect, in which older adults have relatively poorer memories of negative stimuli than other stimuli, compared with younger adults. As negative stimuli are often more arousing than positive stimuli, the positivity effect can be a confounding factor for understanding age differences in the effects of arousal on memory. Thus, it is particularly interesting to examine studies where emotional arousal is elicited via different stimuli from those used to test memory, or where arousal is induced via isometric exercise rather than emotional stimuli. Like younger adults, when older adults hear an arousing sound and then see an array of letters flashed on a screen, they tend to remember even more of the most salient high-contrast letters and even fewer of the less salient letters (Sutherland & Mather, in press). Likewise, when older adults squeeze a handgrip device, they show as much benefit in memory for what they were just attending to as do younger adults (Nielson & Jensen, 1994). This type of isometric exercise increases noradrenaline, and older adults on beta blockers (which work against the effects of noradrenaline) do not show the arousal-induced memory enhancement (Nielson & Jensen, 1994). Thus, in older adults, the locus coeruleus–noradrenaline system still appears to enhance memory.

Conclusions

Emotion helps to signal important events and so it makes sense that it would be one of the most potent modulators of our memories. Emotion continues to help shape what we remember and forget throughout life. While arousal enhances memory for high-priority or salient information for older adults as well as for younger adults, there are shifts with age in how valence shapes memory. Older adults show a positivity effect compared with younger adults, remembering in ways that should optimize current emotional well-being.

SEE ALSO: Central Nervous System; Cognitive Processes; Emotions and Aging; Executive Functions; Memory

References

Allen, J. S., Bruss, J., Brown, C. K., & Damasio, H. (2005). Normal neuroanatomical variation due to age: The major lobes and a parcellation of the temporal region. *Neurobiology of Aging, 26(9),* 1245–1260. doi: 10.1016/j.neurobiolaging.2005.05.023

Baumeister, R. F., Bratslavsky, E., Fickenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5(4),* 323–370. doi: 10.1037//1089-2680.5.4.323

Berridge, C. W., & Waterhouse, B. D. (2003). The locus coeruleus-noradrenergic system: Modulation of behavioral state and state-dependent cognitive processes. *Brain Research Reviews, 42(1),* 33–84. doi: 10.1016/s0165–0173(03)00143-00147

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist, 54,* 165–181. doi: 10.1037//0003-066X.54.3.165

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General, 132,* 310–324. doi: 10.1037/0096-3445.132.2.310

Fawcett, J. M., Russell, E. J., Peace, K. A., & Christie, J. (2013). Of guns and geese: A meta-analytic review of the "weapon focus" literature. *Psychology, Crime & Law, 19(1),* 35–66. doi: 10.1080/1068316X.2011.599325

Henkel, L. A., & Mather, M. (2007). Memory attributions for choices: How beliefs shape our memories. *Journal of Memory and Language, 57(2),* 163–176. doi: 10.1016/j.jml.2006.08.012

Hirst, W., Phelps, E. A., Buckner, R. L., Budson, A. E., Cuc, A., Gabrieli, J. D., … & Mather, M. (2009). Long-term memory for the terrorist attack of September 11: Flashbulb memories, event memories, and the factors that influence their retention. *Journal of Experimental Psychology: General, 138(2),* 161–176. doi: 10.1037/a0015527

Kensinger, E. A. (2009). Remembering the details: Effects of emotion. *Emotion Review, 1,* 99 – 113. doi: 10.1177/1754073908100432

Kensinger, E. A., Piguet, O., Krendl, A. C., & Corkin, S. (2005). Memory for contextual details: Effects of emotion and aging. *Psychology and Aging, 20,* 241 – 250. doi: 10.1037/0882-7974.20.2.241

Knight, M., & Mather, M. (2009). Reconciling findings of emotion-induced memory enhancement and impairment of preceding items. *Emotion, 9(6),* 763 – 781. doi: 10.1037/a0017281

Mather, M., & Johnson, M. K. (2000). Choice-supportive source monitoring: Do our decisions seem better to us as we age? *Psychology and Aging, 15,* 596 – 606. doi: 10.1037/0882-7974.15.4.596

Mather, M., Shafir, E., & Johnson, M. K. (2000). Misrememberance of options past: Source monitoring and choice. *Psychological Science, 11(2),* 132 – 138. doi: 10.1111/1467-9280.00228

Mather, M., & Sutherland, M. R. (2011). Arousal-biased competition in perception and memory. *Perspectives on Psychological Science, 6,* 114 – 133. doi: 10.1177/1745691611400234

McGaugh, J. L. (2004). The amygdala modulates the consolidation of memories of emotionally arousing experiences. *Annual Review of Neuroscience, 27,* 1 – 28. doi: 10.1146/annurev.neuro.27.070203.144157

Nashiro, K., Sakaki, M., & Mather, M. (2012). Age differences in brain activity during emotion processing: Reflections of age-related decline or increased emotion regulation? *Gerontology, 58,* 156 – 163. doi: 10.1159/000328465

Nielson, K. A., & Jensen, R. A. (1994). Beta-adrenergic-receptor antagonist antihypertensive medications impair arousal-induced modulation of working-memory in elderly humans. *Behavioral and Neural Biology, 62(3),* 190 – 200. doi: 10.1016/S0163-1047(05)80017-2

Reed, A. E., Chan, L., & Mikels, J. A. (2014). Meta-analysis of the age-related positivity effect: Age differences in preferences for positive over negative information. *Psychology and Aging, 29(1),* 1 – 15. doi: 10.1037/a0035194

Reisberg, D., & Hertel, P. (2004). *Memory and emotion*. London, UK: Oxford University Press.

Ross, M., & Wilson, A. E. (2003). Autobiographical memory and conceptions of self: Getting better all the time. *Current Directions in Psychological Science, 12(2),* 66 – 69. doi: 10.1111/1467-8721.01228

Schmidt, S. R. (2002). Outstanding memories: The positive and negative effects of nudes on memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28(2),* 353 – 361. doi: 10.1037//0278 – 7393.28.2.353

Sheen, M., Kemp, S., & Rubin, D. (2006). Disputes over memory ownership: What memories are disputed? Genes, *Brain and Behavior, 5(Suppl. 1),* 9 – 13. doi: 10.1111/j.1601-183X.2006.00189.x

Sutherland, M. R., & Mather, M. (2012). Negative arousal amplifies the effects of saliency in short-term memory. *Emotion, 12(6),* 1367 – 1372. doi: 10.1037/a0027860

Sutherland, M. R., & Mather, M. (in press). *Negative arousal increases stimulus priority in older adults*. Experimental Aging Research.

Walker, W. R., Skowronski, J. J., & Thompson, C. P. (2003). Life is pleasant—and memory helps to keep it that way! *Review of General Psychology, 7,* 203 – 210. doi: 10.1037/1089-2680.7.2.203

Wright, C. I., Wedig, M. M., Williams, D., Rauch, S. L., & Albert, M. S. (2006). Novel fearful faces activate the amygdala in healthy young and elderly adults. *Neurobiology of Aging, 27(2),* 361 – 374. doi: 10.1016/j.neurobiolaging.2005.01.014