

Emotion and Memory

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June 5, 2026

RECOMMENDED CITATION

mohammad looti (2026). *Emotion and Memory*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=38269>

Emotion can have a powerful impact on memory. Numerous studies have shown that the most vivid autobiographical memories tend to be of emotional events, which are likely to be recalled more often and with more clarity and detail than neutral events.

The activity of emotionally enhanced memory retention can be linked to human evolution; during early development, responsive behavior to environmental events would have progressed as a process of trial and error. Survival depended on behavioral patterns that were repeated or reinforced through life and death situations. Through evolution, this process of learning became genetically embedded in humans and all animal species in what is known as fight or flight instinct.

Artificially inducing this instinct through traumatic physical or emotional stimuli essentially creates the same physiological condition that heightens memory retention by exciting neuro-chemical activity affecting areas of the brain responsible for encoding and recalling memory. This memory-enhancing effect of emotion has been demonstrated in a large number of laboratory studies, using stimuli ranging from words to pictures to narrated slide shows, as well as autobiographical memory studies. However, as described below, emotion does not always enhance memory.

Emotional arousal and valence

One of the most common frameworks in the emotions field proposes that affective experiences are best characterized by two main dimensions: arousal and valence. The dimension of valence ranges from highly positive to highly negative, whereas the dimension of arousal ranges from calming or soothing to exciting or agitating.

Most studies so far focused on the arousal dimension of emotion as the critical factor contributing to the emotional enhancement effect on memory. Different explanations have been offered for this effect, according to the different stages of memory formation and reconstruction.

Even though the majority of studies have focused on the arousal dimension, a growing body of research is dedicated to the emotional valence dimension and its effects on memory. It has been claimed that this is an essential step towards a more complete understanding of emotion effects on memory. The studies that did investigate this dimension have found that emotional valence alone can enhance memory, that is, nonarousing items with positive or negative valence can be better remembered than neutral items.

Emotional arousal and encoding

From an information processing perspective, encoding refers to the process of interpreting incoming stimuli and combining the processed information. At the encoding level the following mechanisms have been suggested as mediators of emotion effects on memory:

Selectivity of attention

Easterbrook's (1959) cue utilization theory predicted that high levels of arousal will lead to attention narrowing, defined as a decrease in the range of cues from the stimulus and its environment to which the organism is sensitive. According to this hypothesis, attention will be focused primarily on the arousing details (cues) of the stimulus, so that information central to the source of the emotional arousal will be encoded while peripheral details will not.

Accordingly, several studies have demonstrated that the presentation of emotionally arousing stimuli (compared to neutral stimuli) results in enhanced memory for central details (details central to the appearance or meaning of the emotional stimuli) and impaired memory for peripheral details. Also consistent with this hypothesis are findings of weapon focus effect, in which witnesses to a crime remember the gun or knife in great detail but not other details such as the perpetrator's clothing or vehicle. In laboratory replications it was found that participants spend a disproportionate amount of time looking at a weapon in a scene, and this looking time is inversely related to the likelihood that individuals will subsequently identify the perpetrator of the crime. Other researchers have suggested arousal may also increase the duration of attentional focusing on the arousing stimuli, thus delaying the disengagement of attention from it. Ochsner (2000) summarized the different findings and suggested that by influencing attention selectivity and dwell time, arousing stimuli are more distinctively encoded, resulting in more accurate memory of those stimuli.

Prioritized processing

Emotional items also appear more likely to be processed when attention is limited, suggesting a facilitated or prioritized processing of emotional information. This effect was demonstrated using the attentional blink paradigm in which 2 target items are presented in close temporal proximity within a stream of rapidly presented stimuli.

The typical finding is that participants often miss the second target item, as if there were a "blink" of attention following the first target's presentation, reducing the likelihood that the second target stimulus is attended. However, when the second target stimulus elicits emotional arousal (a "taboo" word), participants are less likely to miss the target's presentation, which suggests that under conditions of limited attention, arousing items are more likely to be processed than neutral items.

Additional support for the Prioritized processing hypothesis was provided by studies investigating the visual extinction deficit. People suffering from this deficit can perceive a single stimulus in either side visual field if it is presented alone but are unaware of the same stimulus in the visual field opposed to the lesional side, if another stimulus is presented simultaneously on the lesional side.

Emotion has been found to modulate the magnitude of the visual extinction deficit, so that items that signal emotional relevance (e.g., spiders) are more likely to be processed in the presence of competing distractors than nonemotional items (e.g., flowers).

Emotional arousal and memory storage

In addition to its effects during the encoding phase, emotional arousal appears to increase the likelihood of memory consolidation during the retention (storage) stage of memory (the process of creating a permanent record of the encoded information). A number of studies show that over time, memories for neutral stimuli decrease but memories for arousing stimuli remain the same or improve.

Others have discovered that memory enhancements for emotional information tend to be greater after longer delays than after relatively short ones. This delayed effect is consistent with the proposal that emotionally arousing memories are more likely to be converted into a relatively permanent trace, whereas memories for nonarousing events are more vulnerable to disruption.

A few studies have even found that emotionally arousing stimuli enhance memory only after a delay. The most famous of these was a study by Kleinsmith and Kaplan (1963) that found an advantage for numbers paired with arousing words over those paired with neutral words only at delayed test, but not at immediate test. As outlined by Mather (2007), the Kleinsmith and Kaplan effects were most likely due to a methodological confound. However, Sharot and Phelps (2004) found better recognition of arousing words over neutral words at a delayed test but not at an immediate test, supporting the notion that there is enhanced memory consolidation for arousing stimuli. According to these theories, different physiological systems, including those involved in the discharge of hormones believed to affect memory consolidation, become active during, and closely following, the occurrence of arousing events.

Another possible explanation for the findings of the emotional arousal delayed effect is post-event processing regarding the cause of the arousal. According to the post stimulus elaboration (PSE) hypothesis, an arousing emotional experience may cause more effort to be invested in elaboration of the experience, which would subsequently be processed at a deeper level than a neutral experience. Elaboration refers to the process of establishing links between newly encountered information and previously stored information.

It has long been known that when individuals process items in an elaborative fashion, such that meaning is extracted from items and inter-item associations are formed, memory is enhanced. Thus, if a person gives more thought to central details in an arousing event, memory for such information is likely to be enhanced. However, these processes could also disrupt consolidation of memories for peripheral details. Christianson (1992) suggested that the combined action of

perceptual, attentional, and elaborative processing, triggered by an emotionally arousing experience, produces memory enhancements of details related to the emotion laden stimulus, at the cost of less elaboration and consolidation of memory for the peripheral details.

Emotional valence and elaboration

The processes involved in this enhancement may be distinct from those mediating the enhanced memory for arousing items. It has been suggested that in contrast to the relatively automatic attentional modulation of memory for arousing information, memory for non-arousing positive or negative stimuli may benefit instead from conscious encoding strategies, such as elaboration. This elaborative processing can be autobiographical or semantic.

Autobiographical elaboration is known to benefit memory by creating links between the processed stimuli, and the self, for example, deciding whether a word would describe the personal self. Memory formed through autobiographical elaboration is enhanced as compared to items processed for meaning, but not in relation to the self.

Since words such as "sorrow" or "comfort" may be more likely to be associated with autobiographical experiences or self-introspection than neutral words such as "shadow", autobiographical elaboration may explain the memory enhancement of non-arousing positive or negative items. Studies have shown that dividing attention at encoding decreases an individual's ability to utilize controlled encoding processes, such as autobiographical or semantic elaboration.

Thus, findings that participants' memory for negative non-arousing words suffers with divided attention, and that the memory advantage for negative, non-arousing words can be eliminated when participants encode items while simultaneously performing a secondary task, has supported the elaborative processing hypothesis as the mechanism responsible for memory enhancement for negative non-arousing words.

Contextual effects of emotion on memory

Contextual effects occur as a result of the degree of similarity between the encoding context and the retrieval context of an emotional dimension. The main findings are that the current mood we are in affects what is attended, encoded and ultimately retrieved, as reflected in two similar but subtly different effects: the mood congruence effect and mood-state dependent retrieval.

The mood congruence effect

The mood congruence effect refers to the tendency of individuals to retrieve information more easily when it has the same emotional content as their current emotional state. For instance, being

in a depressed mood increases the tendency to remember negative events.

This effect has been demonstrated for explicit retrieval as well as implicit retrieval.

Mood-state dependent retrieval

Another documented phenomenon is the mood-state dependent retrieval, a type of context-dependent memory. The retrieval of information is more effective when the emotional state at the time of retrieval is similar to the emotional state at the time of encoding.

Thus, the probability of remembering an event can be enhanced by evoking the emotional state experienced during its initial processing. These two phenomena, the mood congruity effect and mood-state dependent retrieval, are similar to the context effects which have been traditionally observed in memory research (Baddeley, 1993) It may also relate to the phenomena of state-dependent memory in neuropsychopharmacology.

Thematic vs. sudden appearance of emotional stimuli

A somewhat different contextual effect stemmed from the recently made distinction between thematical and sudden appearance of an emotionally arousing event, suggesting that the occurrence of memory impairments depends on the way the emotional stimuli are induced. Laney et al. (2003) argued that when arousal is induced thematically (i.e., not through the sudden appearance of a discrete shocking stimulus such as a weapon but rather through involvement in an unfolding event plot and empathy with the victim as his or her plight becomes increasingly apparent), memory enhancements of details central to the emotional stimulus need not come at the expense of memory impairment of peripheral details.

Laney et al. (2004) demonstrated this by using an audio narrative to give the presented slides either neutral or emotional meaning, instead of presenting shockingly salient visual stimuli. In one of the experiments, participants in both the neutral and emotional conditions viewed slides of a date scenario of a woman and man at a dinner date. The couple engaged in conversation, then, at the end of the evening, embraced. The event concluded with the man leaving and the woman phoning a friend.

The accompanying audio recording informed participants in the neutral condition that the date went reasonably well, while participants in the emotional condition heard that, as the evening wore on, the man displayed some increasingly unpleasant traits of a type that was derogatory to women, and the embrace at the end of the evening was described as an attempt to sexually assault the woman.

As expected, the results revealed that details central to the event were remembered more

accurately when that event was emotional than when neutral, However, this was not at the expense of memory for peripheral (in this case, spatially peripheral or plot-irrelevant) details, which were also remembered more accurately when the event was emotional. Based on these findings it has been suggested that the dual enhancing and impairing effects on memory are not an inevitable consequence of emotional arousal.

Memory of felt emotion

Many researchers use self report measures of felt emotion as a manipulation check. This raises an interesting question and a possible methodological weakness: are people always accurate when they recall how they felt in the past? Several findings suggest this is not the case. For instance, in a study of memory for emotions in supporters of former U.S. presidential candidate Ross Perot, supporters were asked to describe their initial emotional reactions after Perot's unexpected withdrawal in July 1992 and again after the presidential election that November.

Between the two assessment periods, the views of many supporters changed dramatically as Perot re-entered the race in October and received nearly a fifth of the popular vote. The results showed that supporters recalled their past emotions as having been more consistent with their current appraisals of Perot than they actually were.

Another study found that people's memories for how distressed they felt when they learned of 9/11 terrorist attacks changed over time and more so, were predicted by their current appraisals of the impact of the attacks (Levine et al., 2004). It appears that memories of past emotional responses are not always accurate, and can even be partially reconstructed based on their current appraisal of events.

Emotion regulation effects on memory

An interesting issue in the study of the emotion-memory relationship is whether our emotions are influenced by our behavioral reaction to them, and whether this reaction--in the form of expression or suppression of the emotion--might in itself affect what we remember about an event. Researchers have begun to examine whether concealing feelings influences our ability to perform common cognitive tasks, such as forming memories, and found that the emotion regulation efforts do have cognitive consequences. In the seminal work on negative affect arousal and white noise, Seidner found support for the existence of a negative affect arousal mechanism through observations regarding the devaluation of speakers from other ethnic origins."

In a study of Richards and Gross (1999), participants viewed slides of injured men that produced increases in negative emotions, while information concerning each man was presented orally with his slide. The participants were assigned to either an expressive suppression group (where they

were asked to refrain from showing emotion while watching the slides) or to a control group (where they were not given regulatory instructions at all). As predicted by the researchers, suppressors showed significantly worse performance on a memory test for the orally presented information. Several related studies have reached similar results. It was demonstrated that the effects of expressive suppression on memory generalize to emotionally positive experiences and to socially relevant contexts.

One possible answer to the question "why does emotion suppression impair memory? might lay in the self monitoring efforts invested in order to suppress emotion (thinking about the behavior one is trying to control). A recent study found heightened self- monitoring efforts among suppressors relative to control participants.

That is, suppressors were more likely to report thinking about their behavior and the need to control it during a conversation. Increases in self-monitoring predicted decreases in memory for what was said, that is, people who reported thinking a lot about controlling their behavior had particularly impoverished memories. However, additional research is needed to confirm whether self-monitoring actually exerts a causal effect on memory

Emotion-induced forgetting

Emotionally arousing stimuli can lead to retrograde amnesia for preceding events and anterograde amnesia for subsequent events. This has been demonstrated in lab studies with lists of words or pictures, in which people show impaired memory for stimuli appearing before or after arousing stimuli.

Depression and memory

Memory recall tends to be congruent with one's current mood, with depressed people more likely to recall negative events from the past. In addition, depression is often associated with poor memory in general, as outlined here.

Aging and emotional memory

The enhancing effects of emotional arousal on later memory recall tend to be maintained among older adults and the amygdala shows relatively less decline than many other brain regions. However, older adults also show somewhat of a shift towards favoring positive over negative information in memory, leading to a positivity effect.