Sustained experience of emotion after loss of memory in patients with amnesia

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Can the experience of an emotion persist once the memory for what induced the emotion has been forgotten? We capitalized on a rare opportunity to study this question directly using a select group of patients with severe amnesia following circumscribed bilateral damage to the hippocampus. The amnesic patients underwent a sadness induction procedure (using affectively-laden film clips) to ascertain whether their experience of sadness would persist beyond their memory for the sadness-inducing films. The experiment showed that the patients continued to experience elevated levels of sadness well beyond the point in time at which they had lost factual memory for the film clips. A second experiment using a happiness induction procedure yielded similar results, suggesting that both positive and negative emotional experiences can persist independent of explicit memory for the inducing event. These findings provide direct evidence that a feeling of emotion can endure beyond the conscious recollection for the events that initially triggered the emotion.

declarative memory | emotional memory | memory erasure | implicit memory | hippocampus

A large body of work has investigated the psychological and neurobiological mechanisms underlying the influence of emotion on memory (1–9). Yet, very little is known about the opposite relationship, namely, how memory impacts emotion.[†] One especially intriguing question is whether the sustained experience of emotion is dependent upon, versus independent of, intact declarative memory for the events that initially caused the emotion. Consider the following real-life examples: the death of a close friend or family member, the fall of the twin towers, the end of a romantic relationship—these are all events capable of eliciting an intense and prolonged state of emotion such as sadness. In these previous examples, the experience of sadness and the memory for the sadness-inducing event are often inseparable, fused together within our stream of consciousness as we ruminate, regret, and repeatedly replay the event (10, 11). The tight fusion between emotion and memory is well known to those suffering from affective disorders. For example, individuals with depression or posttraumatic stress disorder show a striking tendency to ruminate about the causes of their negative affect, which in turn escalates and prolongs their emotional pain and suffering (12–14). Thus, there are compelling reasons to predict that the persistence of an emotional experience, such as sadness, is highly dependent on remembering the emotion-inducing event.

However, what would happen to the feeling of an emotion if we could no longer remember the emotion-inducing event? Would the feeling fade away in parallel with the vanquished memory? Alternatively, is it possible that the feeling could persist without the memory? To answer these questions, an experiment needs to be devised that can disconnect the experience of an emotion from the memory for what caused the emotion. In healthy people with normal memory, a reliable disconnection of this sort is very difficult to establish given the intertwined relationship between an emotional experience and its cause.[‡] To overcome this obstacle we investigated a rare group of five patients who have severe anterograde amnesia following circumscribed bilateral hippocampal brain damage (Fig. 1, Table 1, and Tables S1 and S2). A central feature of these patients' condition is a profound impairment in forming new conscious memories about events that unfold in their daily lives. This severe memory deficit confers a unique opportunity to investigate whether the experience of an emotion can outlast the memory for what caused it.

The dissociation between emotion and memory in patients with amnesia harkens back to 1911, when the Swiss neurologist Claparède concealed a pin between his fingers while greeting one of his amnesic patients with a handshake (18). The sharp pin surprised the patient and elicited a small amount of pain that quickly dissipated. Within minutes, the patient had forgotten the encounter. Yet, when Claparède tried to reintroduce himself shortly thereafter, the amnesic patient adamantly refused to shake his hand. When pressed to explain her reaction, the patient retorted, "Is there perhaps a pin hidden in your hand?" Claparède claims, however, that even with repeated questioning the patient could never explicitly remember that she, herself, had been stuck in the hand with a pin. Despite her impoverished memory for the devious handshake, Claparède's patient continued to demonstrate preserved avoidance learning. Similar forms of "nonconscious" emotional learning in amnesic patients have been shown using a variety of different tasks, including preserved conditioned responses during a fear conditioning paradigm (19), preserved learning of the advantageous strategy on a gambling task (20; but see refs. 21, 22), and preserved affective associations for different people using variations of a "Good Guy-Bad Guy" paradigm (23–25). Analogous results have also been obtained in patients with Alzheimer's disease (26–28) and even in rats with amnesia (29). A common theme in all of these previous experiments is the finding of preserved behavioral changes (as measured by avoidance responses, autonomic responses, or forced-choice preference judgments) in the face of impaired memory for the learning conditions. Moreover, the behavioral changes were only evident when the amnesic patients were re-exposed to the stimulus that was conditioned during the original learning trials. Beyond these behavioral changes, little is known

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[†]Emotion is typically parsed into two components: emotional expression and emotional experience. The expression of emotion includes a myriad of responses (physiological, behavioral, and cognitive) that are induced by a triggering stimulus. The experience of emotion represents the conscious subjective "feeling" state associated with these responses. Throughout this paper, references to emotion mainly refer to this latter component (i.e., the feeling of emotion).

[‡]We may, on occasion, have an ephemeral whisper of such a disconnection, for example, when we feel a burst of emotion and, for a brief second, do not remember the cause. Our declarative memory, however, rapidly supplies knowledge of the trigger, and we are back to the state of feeling the emotion and knowing what caused it. In fact, most definitions of emotion explicitly assume that emotional experiences are intentional states triggered by an identifiable source or object (15–17). Moods, on the other hand, do not necessarily have a clear cause and can persist independent of our awareness for their source (16, 17). The present study specifically focuses on emotions that are triggered by a clearly identifiable source.

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