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Neutral mood induction during reconsolidation reduces accuracy, but not vividness and anxiety of emotional episodic memories



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ABSTRACT

Background and objectives: Consolidated memories become labile upon reactivation and as a result have to go through reconsolidation to become re-stabilized. This property of memory may potentially be used to reduce the impact of highly negative episodic memories. Because detailed and vivid negative memories are mediated by high arousal, if arousal is lessened during reconsolidation, memory accuracy and vividness should diminish. In this study, we examined this hypothesis.

Methods: Participants ($N = 72$) viewed a stressful, suspenseful video on Day 1 to develop negative episodic memories. Then, 24–29 h later, they saw a brief reminder of the stressful video (or not), and then viewed a neutral, calming (or positive) video. Another 24–29 h later, participants were tested on the accuracy, vividness, and anxiety associated with their memory of the stressful video on Day 1.

Results: Participants who watched the reminder and then the neutral video showed reduced memory accuracy compared to participants in the other groups. Despite the reduction in memory accuracy, their memory vividness and anxiety associated with the stressful video did not decrease.

Limitations: The use of undergraduates prevents generalizations to clinical populations. Also, the study did not test long-term memories that were more than 2 days old.

Conclusions: Neutral mood induction during reconsolidation reduces the accuracy of highly negative episodic memories.

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When consolidated memories are reactivated, they become labile, thereby requiring reconsolidation to become restabilized (Dudai, 2004; Sara, 2000). During reconsolidation, memories become subject to modification (e.g., Nader, Schafe, & LeDoux, 2000). Such malleability represents an opportunity to reduce the stressful quality of negative memories (Kindt & Soeter, 2013; Schiller, Kanen, LeDoux, Monfils, & Phelps, 2013).

Stressful experiences are memorable because they are usually arousing (Kensinger & Schacter, 2008; McNally, 2003). Arousal stimulates the release of stress hormones that strengthen memories (McGaugh, 2000). Although the memory-enhancing effect of arousal is generally adaptive, it can lead to pathological memory expressions after trauma (e.g., flashbacks or intrusive memories; McNally, 2003).

Because arousal mediates the accuracy and vividness of negative memories, lowering arousal during reconsolidation may diminish their subsequent accuracy and vividness. For example, Schwabe, Nader, and Pruessner (2013) found that administering propranolol during reconsolidation reduced the accuracy and vividness of negative memories. Similarly, Kroes et al. (2014) found that administering electroconvulsive therapy (ECT) on depressive patients during reconsolidation reduced the accuracy

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of negative memories.¹ The clinical implications of such procedures are limited as both require medical supervision and both have side effects.

Accordingly, in this experiment, we endeavored to replicate the findings of these recent studies, but without relying on propranolol or ECT as the agents of reconsolidation disruption. In addition, we explored whether anxiety associated with negative episodic memories could be reduced. The reason for this exploration is twofold: First, anxiety is a frequent response to recalling negative episodic memories (McNally, 2003). Second, anxiety reduction has not been tested in the reconsolidation of emotional episodic memories despite having been tested in the reconsolidation of conditioned fear memory (Agren, 2014).

We tested whether exposing participants to a neutral, calming video during reconsolidation of negative episodic memories would attenuate the accuracy, vividness, and anxiogenic qualities of such memories. We used a neutral video because neutral, non-sensational video can reduce arousal (Zillmann & Johnson, 1973).

The experiment was conducted over three days. On Day 1, all participants viewed a stressful video comprising scenes from the suspense film *The Shining* (Kubrick & Kubrick, 1980), shown in a darkened laboratory testing room. Immediately thereafter, they recalled the video and took a quiz about it. On Day 2, participants were randomized to one of four groups (i.e., reminder/neutral, no reminder/neutral, reminder/positive, no reminder/positive). In the same darkened room, the reminder/neutral group viewed a brief segment from Day 1's video to reactivate their memory prior to watching a calming, neutral clip from the documentary *Baraka* (Magidson & Fricke, 1993). The reminder/positive group, in the same darkened room, viewed the same reminder prior to watching an amusing clip from *America's Funniest Home Videos* (Di Bona, 1989). In a different, brightly lit testing room, the no reminder/neutral and the no reminder/positive groups watched only the neutral and positive videos, respectively. On Day 3, all participants underwent tests for memory accuracy, vividness, and anxiety associated with the stressful video on Day 1. We included the positive video as a control condition to rule out the possibility that it was the relatively positive valence in the neutral video that caused the reduction in the dependent variables.

¹ Research on episodic memory reconsolidation has examined neutral episodic memory (Hubbach, Gomez, Hardt, & Nadel, 2007), autobiographical memory (Schwabe & Wolf, 2009), negative episodic memory (Schwabe et al., 2013), and trauma memory (Kredlow & Otto, 2015). Hubbach et al. (2007) were the first to report a reconsolidation update effect of episodic memory. Participants learned a list of unrelated objects on Day 1. On Day 2, they either received a reminder or not and then learned a second list of objects. Their memory for the first list was tested on Day 3. Results showed that participants who received the reminder before learning the 2nd list incorrectly mixed more objects from the 2nd list into the 1st list, thereby demonstrating a reconsolidation update. Schwabe and Wolf (2009) investigated the reconsolidation of autobiographical memory. They had participants first recall positive, neutral, and negative autobiographical events and then receive a neutral interference task (a short story). One week later, participants' memories of these events were tested. Results showed that memory (number of details remembered) decreased only for the neutral events; it did not decrease for the positive or negative events. Schwabe et al. (2013) used the beta-adrenergic blocker to examine the reconsolidation of negative episodic memory. Participants encoded 25 negative and 25 neutral photos on Day 1. On Day 2, depending on the condition, participants received either propranolol or placebo, and they received either a reminder or no reminder. Participants' memory for the photos was tested on Day 3. Results showed that participants who received propranolol and the reminder remembered fewer photos than did participants in the other 3 conditions. For the photos they remembered, they also reported less vividness than the other 3 groups. Kredlow and Otto (2015) was the first to report on a reconsolidation update effect on trauma memory. In the experiment, participants first recalled (negative) memories of the Boston Marathon bombings before receiving either a positive, neutral, or negative interference in the form of a short story. Results showed that participants who received the negative interference showed the greatest reduction in the number of details recalled.

We predicted that participants exposed to the neutral video following reactivation of the memory of the stressful video would exhibit decrements in memory accuracy, vividness, and anxiety for the stressful video on Day 3, relative to the other groups.

1. Method

1.1. Participants

Participants were recruited from the Harvard University Psychology Study Pool. Eligible participants were between 18 and 65 years of age, fluent in English, and free of psychiatric or neurological disorders. Eighty-eight eligible participants were initially enrolled, but 16 had to be excluded prior to data analyses. Seven failed to follow instructions; four terminated participation because they found the stressful video too scary; and five failed to return for either session 2 or 3.

The final group consisted of 72 participants (44 women) aged 18–40 ($M = 20.18$, $SD = 3.49$). Their ethnic backgrounds were Caucasian (47.2%), Asian (31.9%), Hispanic (9.7%), Multi-racial (5.6%), African-American (4.2%), and Arabic (1.4%). They received course credits for their participation.

A post hoc power analysis indicated that the study had 80% power to detect an interaction effect of 0.33 (Faul, Erdeelder, Buchner, & Lang, 2009).

1.2. Design

The experiment was a 2×2 between-subjects design with main factors of Reactivation (reminder, no reminder) and Video (neutral, positive). The dependent variables were three self-report measures: memory accuracy, memory vividness, and memory anxiety. The study was approved by the Harvard Committee on the Use of Human Subjects.

1.3. Materials

Apparatus. The experiment was programmed in OpenSesame, a free, cross-platform experiment builder (Mathot, Schreij, & Theeuwes, 2012), and was administered on an HP Pavillion dv6 laptop computer.

Videos. Three video clips having negative, positive, and neutral valence were used. Prior to launching the study, six pilot participants rated the emotionality of the videos. They rated each video on two 1–7 Likert scales in which 1 denoted highly negative (valence)/highly calming (arousal), 4 denoted neutral (both valence and arousal), and 7 denoted highly positive (valence)/highly arousing (arousal).

The negative video clip lasted 20 min and 22 s. It comprised four scenes from *The Shining* (Kubrick & Kubrick, 1980), a suspense film confirmed as strongly fear-evocative (Gross & Levenson, 1995). During piloting, its valence and arousal ratings and standard deviations were 1.83 ± 0.98 and 6.5 ± 0.55 .

The positive video clip lasted 20 min and 25 s. It comprised amusing episodes from the television program *America's Funniest Home Videos* (Di Bona, 1989). During piloting, its valence and arousal ratings and standard deviations were 5.83 ± 0.75 and 4.83 ± 0.98 .

The neutral video clip lasted 20 min and 30 s. It comprised scenes of people and landscapes from the documentary, *Baraka* (Magidson & Fricke, 1993). During piloting, its valence and arousal ratings and standard deviations were 4 ± 0 and 1.75 ± 0.5 , ($N = 4$).

An excerpt from the stressful video clip, lasting 1 min and 30 s, was used as a reminder to reactivate participants' memory of the stressful video. Moreover, it was edited to create an abrupt,

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