

LEARNING AND MEMORY

Learning to forget



PHOTODISC

“ This study shows that prediction error is indeed required for fear memory reconsolidation but also provides an independent way to measure whether reconsolidation occurs ”

Studies in animals and humans have shown that memories, once reactivated, undergo reconsolidation that depends, like the initial consolidation of a memory, on protein synthesis. In some circumstances, pharmacological blockade of protein synthesis at the right point can prevent reconsolidation and produce a memory deficit. A new study sheds light on the conditions that are needed for reconsolidation, showing that it requires a ‘prediction error’ between the memory and a new experience.

Sevenster, Beckers and Kindt studied fear memory reconsolidation and pharmacologically induced amnesia in humans. There were three study groups and each was designed to produce different types of prediction error. One group learned that one of two pictures was always paired with a shock and had their memory reactivated the next day by seeing that picture, which was again paired with a shock. This protocol should not produce a prediction error, because this group expected the shock to occur after seeing the picture based on their experience the previous day. Another group also learned that a shock always followed one picture, but the next day, they did not receive a shock when they saw the picture. This should produce

a negative prediction error — they expected a shock but did not receive one. The third group received a shock only on some trials during training, so they were unsure whether they would get a shock after seeing the picture the next day — when they did receive a shock, it produced a positive prediction error, reinforcing the idea that the picture was associated with a shock.

After the memory reactivation trial, each participant received propranolol — a beta-blocker that impairs memory reconsolidation. To test subjects’ fear memory, the authors measured fear-potentiated startle responses and found that propranolol reduced these responses in the prediction error groups but not in the no-prediction error group. Thus, reconsolidation, which could be blocked by propranolol, occurred only when a prediction error was present.

The authors also asked each person to rate their expectancy of receiving the shock every time they saw a picture. Previous work has shown that these expectancy ratings are not affected by propranolol after single-trial reactivation. The group that had no prediction error did not change their expectancy after the memory reactivation trial (when tested again

on day 3); the group that had a negative prediction error showed lower shock expectancy on day 3; and the group that had a positive prediction error showed increased shock expectancy. These findings demonstrate that the prediction error was associated with further learning.

This study shows that prediction error is indeed required for fear memory reconsolidation but also provides an independent way to measure whether reconsolidation occurs by asking subjects to rate expectancy before and after the reactivation trial. This should help researchers to design protocols in which memories undergo reconsolidation, which is not always straightforward. A better understanding of what is required for reconsolidation should help in the development of therapies to disrupt memories associated with conditions such as post-traumatic stress disorder.

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ORIGINAL RESEARCH PAPER Sevenster, D., Beckers, T. & Kindt, M. Prediction error governs pharmacologically induced amnesia for learned fear. *Science* **339**, 830–833 (2013)