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TOP STORIES - Posted by Angie Hunt-Iowa State on Thursday, June 6, 2013 6:53 - 2 Comments (NO RATINGS YET)

New input can warp fresh memories

IOWA STATE (US) — It may be possible to alter memory simply by suggesting different information, but timing and context are key.

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Based on other studies, it appears there is a six-hour window before the memory is reconsolidated after recall and cannot be altered. Likewise, there is no effect if the information is presented in a different context than the original memory. (Credit: Andrew Mason/Flickr)

"If you reactivate a memory by retrieving it, that memory becomes susceptible to changes again. And if at that time you give people new contradictory information, that can make the original memory much harder to retrieve later," says Jason Chan, assistant professor of psychology at Iowa State.

The findings have bearing on declarative memory—a memory that can be consciously recalled and verbally described, such as what you did last weekend. The effects are powerful because people are retrieving memory and then incorporating new information.

Straight from the Source

Read the original study

DOI: 10.1073/pnas.1218472110

For the new study, Chan and graduate student Jessica LaPaglia, tested the impact of new information when presented at different time intervals after the retrieval of the original memory.

If it was immediate, the memory could be altered. But there was no effect on the original memory when the information was presented 48 hours later.

Based on other studies, it appears there is a six-hour window before the memory is reconsolidated after recall and cannot be altered. Likewise, there is no effect if the information is presented in a different context than the original memory.

"During that reconsolidation period, that's when the memory is easy to be interfered with. Once that window closes and that memory is stable again, if you get new information it should not interfere with that original memory," Chan says.

"We found support for that idea in a number of experiments in which we varied the delay between the interfering memory or the misinformation and when people took

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that initial test."

Crime scene witness

For the studies, participants watched a 40-minute episode of the TV show *24* in which a terrorist uses a hypodermic needle to attack a flight attendant. They were then tested to reactivate their memory of the show.

Following the test, participants listened to an audio recap that included different details, such as the terrorist using a stun gun instead of a needle. As a result, those participants had a harder time remembering the needle when asked about it on a test—but only if they had recalled the needle before hearing about the stun gun.

Outside the lab, this could have implications in the context of an eyewitness to a crime, Chan says. For example, if someone witnessed a bank robbery and later recalls that event while watching a movie with a scene of a bank robbery, it's possible the movie could interfere with the original memory.

"One thing we know about how memory works is that you don't need something to be exactly the same for new things to interfere with your old memory," Chan says.

In this series of studies, researchers found that context does matter. In one experiment, participants were given information about a stun gun, but it was used in a drug bust. When tested later, there was no effect on their memory of the needle and the flight attendant.

"People don't always update a previously established memory based on new encoding because new encoding happens all the time. It has to be specific to the original memory in order for that original memory to be updated," Chan says.

Published in ***Proceedings of the National Academy of Sciences,*** the research provides a better understanding of how we process new information that we learn at work or school—it can impact how students remember material for an exam.

If, for example, students are discussing a class lecture and one student inadvertently provides the others with the wrong information, that could make it more difficult to recall the correct information on the test.

The exact timing and the context of the new information are two areas Chan plans to explore with future experiments. He also wants to identify ways for using this noninvasive technique to manipulate memory instead of using prescription drugs that often have side effects. Cases of post-traumatic stress disorder are one possibility.

The method can target specific unwanted memories while preserving others that are less traumatic. His next step is to see how far they can take this effect and to determine if the method actually weakens the memory or impairs the retrieval.

Source: ***Iowa State***

(Viewed 1,242 times)

Tags: brains , Iowa State University , memory

2 Comments

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Anechidna
Jun 7, 2013 8:14

Would explain why there are lots of problems with witness statements and our own recall of specific events. Maybe it could even explain confusion in the elderly !!!!

Mary J
Jun 7, 2013 12:00

That's why good college students go home and immediately go over their notes from each class – to rewrite or type up the notes also helps clarify any ambiguous symbols used.

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Impairing existing declarative memory in humans by disrupting reconsolidation

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Author Affiliations

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Abstract

During the past decade, a large body of research has shown that memory traces can become labile upon retrieval and must be restabilized. Critically, interrupting this reconsolidation process can abolish a previously stable memory. Although a large number of studies have demonstrated this reconsolidation associated amnesia in nonhuman animals, the evidence for its occurrence in humans is far less compelling, especially with regard to declarative memory. In fact, reactivating a declarative memory often makes it more robust and less susceptible to subsequent disruptions. Here we show that existing declarative memories can be selectively impaired by using a noninvasive retrieval–relearning technique. In six experiments, we show that this reconsolidation-associated amnesia can be achieved 48 h after formation of the original memory, but only if relearning occurred soon after retrieval. Furthermore, the amnesic effect persists for at least 24 h, cannot be attributed solely to source confusion and is attainable only when relearning targets specific existing memories for impairment. These results demonstrate that human declarative memory can be selectively rewritten during reconsolidation.

forgetting | human memory | misinformation effect | testing effect | eyewitness memory |

Footnotes

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Author contributions: J.C.K.C. and J.A.L. designed research; J.C.K.C. and J.A.L. performed research; J.C.K.C. and J.A.L. analyzed data; and J.C.K.C. wrote the paper.

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Supporting Information

Chan and LaPaglia 10.1073/pnas.1218472110

SI Methods

Experiment 1. ***Participants and design.*** All five experiments used the same 2 (reactivation, no reactivation) × 3 (item type: represented, neutral, misinformed) mixed design. Whether the information was tested (i.e., reactivated) was manipulated between subjects. Item type was manipulated within subjects. Participants were students in undergraduate psychology courses at Iowa State University. Of the 146 participants (67 female, 76 male, three chose not to respond) included in experiment 1, 70 were in the reactivation condition.

Materials and procedure. Participants were tested in groups of as many as eight on individual computers with dividers separating the computer terminals. They first watched an episode of the Fox television program *24* (1). Audio was presented via headphones. The movie was ∼40 min long and depicted a terrorist plot to assassinate a presidential candidate. Participants were told to pay close attention to the movie in preparation for a memory test. Following the movie, participants in the reactivation group were asked 24 questions about the movie (e.g., "What does the terrorist use on the flight attendant?"). The questions were shown individually and were presented in a chronological order according to the movie. Participants were given 25 s to answer each question by typing their response into the computer; they did not receive any corrective feedback. Participants were instructed to be as accurate as possible and not to guess. They were allowed to leave a question blank or to respond with "I don't know." The memory test lasted 10 min. Instead of completing the memory test, participants in the no-reactivation condition played the video game Tetris (2) as a distractor activity for 10 min.

Following a 20-min retention interval that included the operation span working memory task, all participants listened to an 8-min audio narrative (presented via headphones): the relearning phase. Participants were told that the audio narrative was a recap of the movie that they saw earlier and that they should pay close attention to it. They were provided with no additional information regarding the accuracy of the narrative. The 24 critical details that participants were questioned about during the reactivation phase were divided into three groups of eight details each for the narrative. Specifically, the details were presented correctly (a represented item), were not mentioned (a neutral item), or were presented incorrectly (a misinformed item). For example, one critical detail was what the terrorist used to knock out the flight attendant (answer: a hypodermic syringe). If it was a represented item, the narrative indicated that the terrorist used a hypodermic syringe. If it was a neutral item, the narrative stated that the terrorist knocked the flight attendant unconscious, but the weapon used was not mentioned. If it was a misinformed item, the narrative described the weapon as a stun gun. Results from the misinformed items are thus the main interest of the present study. Whether a detail appeared as a represented, neutral, or misinformed item was counterbalanced across participants.

Following the audio narrative, all participants played the video game Tetris for 5 min to remove the short-term memory associated with the narrative. They then took a final recognition test. Participants were shown 24 statements (concerning each of the critical details) one at a time and were instructed to indicate whether each statement was true or false based on the movie they watched earlier. The statements were either true (e.g., "the terrorist used a hypodermic syringe on the flight attendant") or false ("the terrorist used a chloroform rag on the flight attendant"). Because we sought to examine the true accessibility of the original memory, the misinformed items (e.g., the stun gun) were never presented during this final recognition test. Whether a statement was presented correctly or incorrectly was randomized, but there were always 12 true statements and 12 false statements.

Experiment 2. ***Participants.*** Sixty-six participants (34 female, 30 male) were included in experiment 2, with 32 in the reactivation condition and 32 in the no-reactivation condition.

Materials and procedure. The materials and procedure of experiment 2 were identical to those of experiment 1 with the exception of the retention interval that separated the reactivation phase and the relearning phase. Following the reactivation/no-reactivation phase, participants were dismissed and asked to return 48 h later. This retention interval replaced the operation span task from experiment 1.

Experiment 3. ***Participants.*** Sixty-four participants (28 female, 36 male) were included in experiment 3, with 32 each in the reactivation and no-reactivation condition.

Materials and procedure. The materials and procedure of experiment 3 were identical to those of experiment 2 except that the 48-h delay occurred after the original learning phase (i.e., the movie). In keeping with the procedures in experiment 2, participants did not complete the operation span task; instead, the relearning phase started immediately after the reactivation phase.

Experiment 4. ***Participants.*** Seventy-two participants (33 female, 39 male) were included in experiment 4, with 36 each in the reactivation and no-reactivation condition.

Materials and procedure. The materials and procedure of experiment 4 were identical to those of experiment 1 with the exception of the instructions presented before the final, source-free recognition test. Participants were shown the same statements as in the original recognition test; however, instead of determining whether each statement was true or false, they were instructed to respond "old" if they remembered the information from the video (original learning) or the audio narrative (relearning) and to respond "new" otherwise.

Experiment 5. ***Participants.*** Eighty-four participants (47 female, 36 male, one chose not to respond) were included in experiment 5, with 42 each in the reactivation and no-reactivation condition.

Materials and procedure. The materials and procedure of experiment 5 were identical to those of experiment 1 with the exception of the audio narrative. In this experiment, the story presented in the audio narrative was unrelated to that shown in the movie during original learning. Instead of a story about a terrorist attack, the new narrative described a drug dealer attempting to outsmart the Drug Enforcement Administration. Although this narrative was unrelated to the movie, it contained the same critical details as the narrative used in the previous experiments (Table S1 provides excerpts from the narratives). In addition, the writing style and length (∼7.5 min) of the narrative were matched as close to the original narrative as possible.

Experiment 6. ***Participants.*** Sixty-six participants (40 female, 26 male) were included in experiment 6, with 33 each in the reactivation and no-reactivation condition.

Materials and procedure. The materials and procedure of experiment 6 were identical to those of experiment 1 with the following exceptions. First, a 24-h retention interval separated original learning and memory reactivation. This delay was inserted to ensure completion of initial consolidation of the original memory before the reactivation manipulation. Second, a 24-h delay separated the relearning phase and the final memory test. This delay was included to examine the long-term effects of the retrieval–relearning procedure on the original memory.

SI Results

Fig. S1 displays results from the final recognition test for the represented items relative to the neutral items. For experiments 1–3, 5, and 6, recognition accuracy was indicated by hit rate minus false alarm rate. For experiment 4, in which participants were given the source-free recognition instructions, the dependent variable of interest was the hit rate (i.e., proportion of correct statements claimed old).

Additional exploratory analyses were conducted to further scrutinize the data from each experiment. First, we examined whether the proportion of participants demonstrating poorer, equal, or better performance for the misinformed items compared with the neutral items varied depending on reactivation. Poorer performance indicates that recognition accuracy was lower for the misinformed items than the neutral items (i.e., accuracy on misinformed items – neutral items < 0), better performance indicates the opposite (i.e., accuracy on misinformed items – neutral items > 0), and equal performance indicates no difference (i.e., accuracy on misinformed items – neutral items $= 0$). These data are presented in Table S2. Unsurprisingly, not all participants exhibited lower performance for the misinformed items than the neutral items. Perhaps more counterintuitively, a substantial portion showed better performance on the misinformed items than the neutral items. On face value, this may suggest that relearning, or misinformation, somehow improved memory performance for some participants. However, such a conclusion is unjustified. We caution that a positive or negative value, by itself, does not necessarily indicate that relearning had improved or impaired the original memory, because the misinformed and neutral items dealt with different event details within an individual (e.g., for a given participant, the misinformed items might simply be more memorable than the neutral items, and the reverse might be true for another participant). Therefore, the exact value or even the direction (i.e., positive or negative) of the difference is not particularly meaningful on an individual level. This is not a problem on the group level because all details were represented equally often across item types through counterbalancing.

Moreover, because memory reactivation was manipulated between subjects, it is not possible to ascertain whether any given participant was resistant to the reactivation–relearning procedure. Far more informative and important is whether memory reactivation (*i*) increased the proportion of participants showing poorer performance for the misinformed items than the neutral items and (*ii*) decreased the proportion of participants showing better performance for the misinformed items than the neutral items. Judging from the data in Table S2, it appears that, in every experiment that demonstrated reconsolidation-associated amnesia, a larger proportion of participants appeared in the poorer category (experiments 3 and 6) or a smaller proportion of participants appeared in the better category following memory reactivation (experiments 1, 3, and 6). Notably, although we found a significant reconsolidation associated amnesia effect in experiment 4, the proportions of participants in the poorer or better categories are comparable regardless of reactivation status. So how did reactivation produce greater memory impairment in this experiment? The next analysis addresses this question.

Aside from increasing the proportion of participants in the poorer category or decreasing the proportion of participants in the better category, reactivation can produce memory impairment by altering the magnitude of difference in performance between the misinformed and neutral items (instead of changing the proportion of participants showing a particular direction of difference). The relevant data are presented in Table S3. Among the experiments demonstrating reconsolidation-associated amnesia, reactivation increased the magnitude of poorer performance (experiments 3 and 4) or decreased the magnitude of better performance (experiments 1, 4, and 6). Of particular interest are the data from experiment 4, in which reactivation did not alter the proportion of participants who exhibited poorer or better performance on the misinformed items relative to the neutral items. As can be seen in Table S3, although reactivation had little influence on the proportion data, it had a major impact on the magnitude of performance.

In this exploratory analysis, we hoped to shed further light on how reconsolidation-associated amnesia was produced. Specifically, we sought to identify whether reactivation altered the proportion of participants showing relearning-based impairment or the magnitude of relearning-based impairment. Overall, it appears that both mechanisms can contribute to the overall reconsolidation-associated amnesia effect, but it is presently unclear whether the differential contributions from these factors across the experiments were systematic, and, if so, what led to the differences in each experiment.

Next, we computed a correlation analysis to examine whether performance during the reactivation phase was related to the magnitude of relearning-based impairment observed during the final test (i.e., accuracy on misinformed items minus accuracy on neutral items, such that impairment is indicated by a negative number). Thus, a positive correlation indicates that higher performance during the reactivation phase is associated with less memory impairment during the final test. Overall, we found no significant correlations between these measures in all experiments ($r_{E1} = 0.01$, $r_{E2} = -0.15$, $r_{E3} = 0.12$, $r_{E4} = 0.08$, $r_{E5} = -0.14$, $r_{E6} = 0.10$; all $P > 0.36$), and including only participants who showed poorer performance on the misinformed items than the neutral items did not change the results (all $r < 0.30$, all $P > 0.29$).

We also examined whether the median response times for correct recognition of studied statements (i.e., hits) was affected by the reactivation–relearning procedure. The data are shown in Table S4. No notable and consistent patterns emerged across the experiments.

1. *24* 12:00 a.m.–1:00 a.m. [dvd]. Fox Television Studio, producer; 60 min, sound, color.

2. Neave P (2009) Tetris N-Blox (Tetris Holding, LLC, Hawaii).

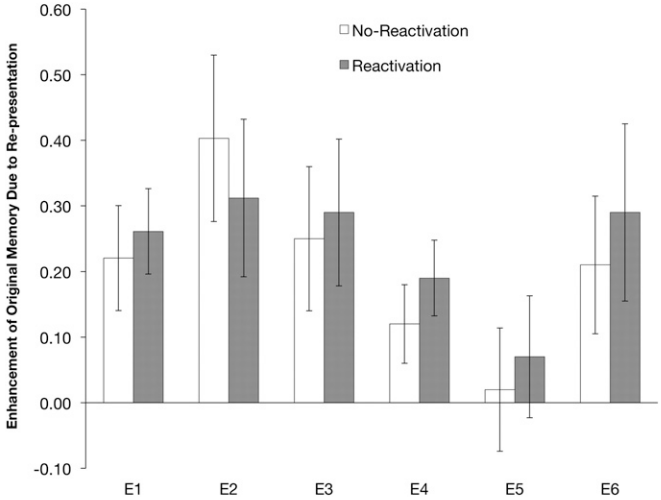

Fig. S1. Recognition performance for represented relative to neutral items in experiments 1–6. Similarly to Fig. 3, each bar represents the difference in recognition accuracy between the represented items and the neutral items. The white bars indicate performance in the no-reactivation condition and the gray bars indicate performance in the reactivation condition. A positive score indicates better memory following representation. As expected, representation enhanced recognition performance regardless of whether memory reactivation occurred. Error bars display 95% CI.

Table S1. Excerpts from the audio narratives used during relearning phase

Excerpt from the audio narrative from experiments 1–4 and 6	Excerpt from the audio narrative from experiment 5
Meanwhile, Teri and Alan York decide to try to find the girls at the furniture store found in Kimberly's e-mail account. Seeing her mother has left **seven messages** on her cell phone, Kimberly asks the guys to drive her home. Martin and Mandy make love in the airplane bathroom. She asks if they can get together in Los Angeles, but he replies that he will be "pretty busy." At CTU, Tony sends to Jack the accessed wire transfers on the Darcet account, and Jack wakes Mason. He once again asks the District Director who his source is, but this time shows the incriminating Darcet transfers. Mason relents when Jack shows that he can access the account in Aruba. In the air, Mandy goes to the back of the plane and knocks a flight attendant unconscious with a **hypodermic syringe**.	Just as he had begun to relax, Don felt his phone vibrating. He checked and saw that he had **seven messages** from Bob on his phone. This was very odd since Bob was instructed to call him only in an emergency. Out of the corner of his eye he noticed a man that he had never seen before. Don was a very cautious person. He never let someone in his crew that he didn't know and trust. He made the connection. Bob was tipped off by their police informant that a sting was about to go down and was calling to warn him. He remembered that he had brought his gun and discreetly reached for it beneath his shirt, but before he could pull it out he was suddenly knocked unconscious with a **hypodermic syringe**.

The critical details (i.e., the details questioned during the reactivation phase) are in boldface.

Table S2. Proportion of participants who exhibited poorer, equal, and better performance for misinformed items relative to neutral items as a function of reactivation in experiments 1–6

Item	Poorer	Equal	Better
Experiment 1			
No reactivation	0.46	0.04	0.50
Reactivation	0.56	0.16	0.29
Experiment 2			
No reactivation	0.44	0.13	0.44
Reactivation	0.53	0.06	0.41
Experiment 3			
No reactivation	0.50	0.03	0.47
Reactivation	0.75	0.03	0.22
Experiment 4			
No reactivation	0.50	0.19	0.31
Reactivation	0.56	0.11	0.33
Experiment 5			
No reactivation	0.48	0.05	0.48
Reactivation	0.33	0.14	0.52
Experiment 6			
No reactivation	0.39	0.09	0.52
Reactivation	0.58	0.06	0.36

Poorer performance refers to a negative difference between performance for the misinformed items compared with the neutral items (i.e., accuracy on misinformed items − accuracy on neutral items < 0). Equal performance indicates no difference between the two item types (i.e., accuracy on misinformed items − accuracy on neutral items $= 0$). Better performance indicates a positive difference between performance for the misinformed items compared with the neutral items (i.e., accuracy on misinformed items − accuracy on neutral items > 0).

Table S3. Magnitude of difference in recognition performance between misinformed and neutral items as a function of reactivation and whether participants showed poorer or better performance as a result of relearning

Item	Poorer	Better
Experiment 1		
No reactivation	−0.46	0.43
Reactivation	−0.48	0.28
t statistic	$t(72) = 0.26$	$t(56) = 2.08$
P value	0.40	0.02
Experiment 2		
No reactivation	−0.49	0.43
Reactivation	−0.41	0.34
t statistic	$t(29) = 0.75$	$t(25) = 0.81$
P value	0.23	0.21
Experiment 3		
No reactivation	−0.32	0.31
Reactivation	−0.43	0.29
t statistic	$t(35) = 9.17$	$t(20) = 0.11$
P value	< 0.01	0.46
Experiment 4		
No reactivation	−0.26	0.39
Reactivation	−0.39	0.26
t statistic	$t(36) = 1.99$	$t(21) = 1.69$
P value	0.03	0.05
Experiment 5		
No reactivation	−0.37	0.31
Reactivation	−0.31	0.31
t statistic	$t(32) = 0.72$	$t(40) = 0.03$
P value	0.24	0.49
Experiment 6		
No reactivation	−0.46	0.49
Reactivation	−0.39	0.25
t statistic	$t(30) = 0.62$	$t(27) = 2.63$
P value	0.27	< 0.01

Results for the *t* tests (one-tailed, to compensate for the reduced statistical power due to the conditional nature of the analysis) are shown below each pair of means.

Table S4. Median response latency for recognition of correct statements (i.e., hits) during the final test as a function of reactivation in experiments 1–6

	Latency, ms		
Item	Represented	Neutral	Misinformed
Experiment 1			
No reactivation	4,874 (2,742)	4,720 (1,580)	4,475 (1,449)
Reactivation	4,556 (1,523)	4,572 (2,000)	4,566 (1,502)
Experiment 2			
No reactivation	4,573 (1,350)	5,926 (1,883)	4,740 (1,788)
Reactivation	4,672 (1,728)	4,664 (1,563)	4,501 (1,297)
Experiment 3			
No reactivation	4,565 (1,324)	5,070 (1,526)	4,369 (1,362)
Reactivation	3,715 (1,110)	4,199 (1,427)	3,538 (1,112)
Experiment 4			
No reactivation	5,216 (1,629)	5,185 (1,334)	4,930 (1,486)
Reactivation	4,443 (1,350)	4,686 (1,297)	4,510 (1,491)
Experiment 5			
No reactivation	5,493 (1,839)	5,743 (2,911)	5,573 (2,264)
Reactivation	3,870 (1,238)	3,621 (1,226)	3,886 (990)
Experiment 6			
No reactivation	4,281 (1,295)	5,764 (3,194)	5,397 (2175)
Reactivation	3,868 (1,992)	3,876 (1,574)	5,259 (3836)

Values in parentheses are SDs.