Original Communication

Suppressed, but Not Forgotten

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Abstract. This study investigates the impact of thought suppression over a 1-week interval. In two experiments with 80 university students each, we used the think/no-think paradigm in which participants initially learn a list of word pairs (cue-target associations). Then they were presented with some of the cue words again and should either respond with the target word or avoid thinking about it. In the final test phase, their memory for the initially learned cue-target pairs was tested. In Experiment 1, type of memory test was manipulated (i.e., direct vs. indirect). In Experiment 2, type of no-think instructions was manipulated (i.e., suppress vs. substitute). Overall, our results showed poorer memory for no-think and control items compared to think items across all experiments and conditions. Critically, however, more no-think than control items were remembered after the 1-week interval in the direct, but not in the indirect test (Experiment 1) and with thought suppression, but not thought substitution instructions (Experiment 2). We suggest that during thought suppression a brief reactivation of the learned association may lead to reconsolidation of the memory trace and hence to better retrieval of suppressed than control items in the long term.

Keywords: episodic memory, repression, retention interval, indirect memory test

Avoiding and forgetting unwanted memories is highly relevant in everyday life, and indeed is sometimes necessary to regulate well-being (Nolen-Hoeksema, 2000). One line of research suggests that trying to avoid an unwanted thought can have a paradoxical effect because checking whether avoidance was successful immediately brings back the unwanted thought into consciousness (Wegner, 1994). In contrast, another line of research suggests that repeatedly and intentionally avoiding thinking about a memory that is associated with a particular cue inhibits the unwanted memory, making it harder to recall later, even when desired (Anderson & Green, 2001; Anderson et al., 2004). The latter mechanism has been linked to the voluntary form of repression originally introduced by Freud. According to Freudian theory, repression is a long-lasting and persistent phenomenon. However, so far, the impact of thought suppression has only been established over short periods of time – typically with learning, suppression, and testing on the same day. Here, we investigate the impact of thought suppression across a 1-week interval.

We used the think/no-think paradigm, which was initially introduced by Anderson and colleagues (Anderson & Green, 2001; Anderson et al., 2004). This paradigm consists of three phases: In a study phase, participants learn word pairs (i.e., a cue word and a target word). In the think/no-think phase, they are instructed to recall the previously learned paired associate in response to the cue word and vocalize it (i.e., think items) or to suppress the respective memory (i.e., no-think items). Some of the cue words from the study phase are not presented during this phase to create a control condition for the following memory test (i.e., control items). In the test phase, participants have to recall the initially learned target words in response to the presented cue word. Retrieval rates are typically higher for think items compared to both no-think and control items and increase linearly with the number of repetitions of think trials. Conversely, for no-think items, retrieval is often reduced with an increasing number of no-think trials and in some studies retrieval for no-think items has been found to fall below the retrieval rate for control items, suggesting an active suppression of no-think items (Anderson & Green, 2001; Anderson et al., 2004). However, the latter result was not found consistently (e.g., Bergström, Velmans, de Fockert, & Richardson-Klavehn, 2007; Bulevich, Roediger, Balota, & Butler, 2006; Hertel & Calcaterra, 2005; Hertel & Gerstle, 2003; Mecklinger, Parra, & Waldhauser, 2009). In Experiment 1 reported here, we also did not find lower retrieval for no-think than for control items in the immediate test conditions. Nevertheless, the absence of an active suppression effect in the immediate test condition does not limit the value of the think/no-think paradigm for examining thought suppression across a 1-week retention interval. In fact, the absence of differential retrieval in the no-think and control condition enables an assessment of the endurance of the formed memories unconfounded by differences in immediate recall.

Experiment 1 further examines suppression effects on implicit memory and compares the results with the standard explicit cued recall test in order to test whether suppressed associations are eliminated from any form of long-term storage, that is, equivalent suppression effects would be expected in implicit and explicit memory; or whether suppressed associations are simply harder to access when retrieval is intentional, that is, larger suppression effects would be expected

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in explicit than in implicit memory. In the real world, avoiding a traumatic memory in response to a triggering event may alleviate the associated suffering. However, as in real-life situations retrieval of memories is mostly triggered automatically, a corresponding experimental situation would be an indirect memory test. We contrasted the explicit cued recall test (i.e., a direct memory test) with a free association test (i.e., an indirect memory test), in which participants were required to respond with the first word that came to mind when presented with a cue word.

In Experiment 2, we manipulated the instructions for the no-think trials to test whether substituting a target word with a newly learned association, rather than just avoiding thinking about the original target, would change the pattern of forgetting in the standard direct memory test.

Experiment 1

Method

Participants and Design

A total of 80 native German-speaking volunteers (74 women; mean age = 25.3 years; range 23 to 30 years; university students from different departments) participated in this experiment: 40 participants were assigned to the direct test condition, and 40 were assigned to the indirect test condition. In each test condition, half were tested immediately, and half were tested after a 1-week interval. For data analysis, a 2 × 2 × 3 mixed design was used with type of test (direct vs. indirect) and time of testing (immediately vs. 1 week later) manipulated between subjects and item type (think, no-think, control) manipulated within subjects. For all statistical analyses, an α level of 0.05 was set.

Materials

The material consisted of 72 familiar German 4–8-letter words (nouns and adjectives). Three sets of word pairs were created which were matched for word length (mean length = 5.45 letters) and word frequency (mean relative frequency = 10.75; CELEX lexical database). The cue word and the target word for each pair were selected such that no obvious association existed between them (e.g., water – view, duck – modern, broom – knowledge). Three sets of word pairs were created and these were counterbalanced across item types (i.e., think, no-think, control). Thus, six different combinations emerged.

Procedure

Three to four participants were assigned to each counterbalancing condition in each experimental condition. Participants were tested individually. The experimental procedure consisted of three phases: study phase, think/no-think phase, and retrieval phase. In the study phase, all 36 word pairs were presented for 5 min on a sheet of paper. Participants were instructed to learn the word pairs such that when presented with the left-hand cue word they would be able to recall the right-hand target word. Following the study phase, a cued recall test was administered. Participants were presented with the left-hand cue words, and they were required to fill in the missing right-hand target words. This study-test cycle was repeated such that all participants had a total of 10 min study time (i.e., two study-test cycles). After the final cycle, the mean proportion of remembered word associates was .84 (SD = .15).

In the second phase, the think/no-think task was computer-administered. Participants were told that they would be presented with a cue word from the previously learned word pairs. They were also told that below the cue word an instruction would be presented and that depending on that instruction one of two operations was to be performed. If the instruction on the screen was DENKEN (German for "think"), they were to respond aloud with the learned member of that pair. If the instruction was NICHT DENKEN (German for "do not think"), they were to remain silent and to avoid thinking of the target word. On each trial, a cue word was presented in the center of the computer screen for 4 s with the corresponding instruction written below the cue, followed by 500 ms blank screen. Each cue word was displayed in black against a white background in 24-point Courier New font and the instruction was presented in a blue box below the cue word in white 24-point Arial font. The think/no-think phase consisted of 240 trials, that is, each cue word appeared 10 times in pseudorandom order. Word pairs from the control condition were not presented during this phase of the experiment. Following the think/no-think phase, participants were given a 10-min distracter task, during which they were required to fill out a personality questionnaire.

The third phase consisted of the final memory test. Memory for the initially learned associations was tested with a direct memory test for one half of the participants and with an indirect test for the other half. Depending on the experimental condition, testing either followed immediately after the distracter task or after a 1-week interval. Participants in the direct test condition were to recall the target words when shown the cue words. The cue words from the study phase were presented to them on a sheet of paper and they were to write down the corresponding target words. Participants in the indirect test condition were also presented with the cue words from the study phase on a sheet of paper, but they were instructed to write down the first word that came to mind in response to the cue words. Delayed and immediate testing followed exactly the same test procedure. On completion of the final memory test, participants were debriefed, thanked for participation, and dismissed.

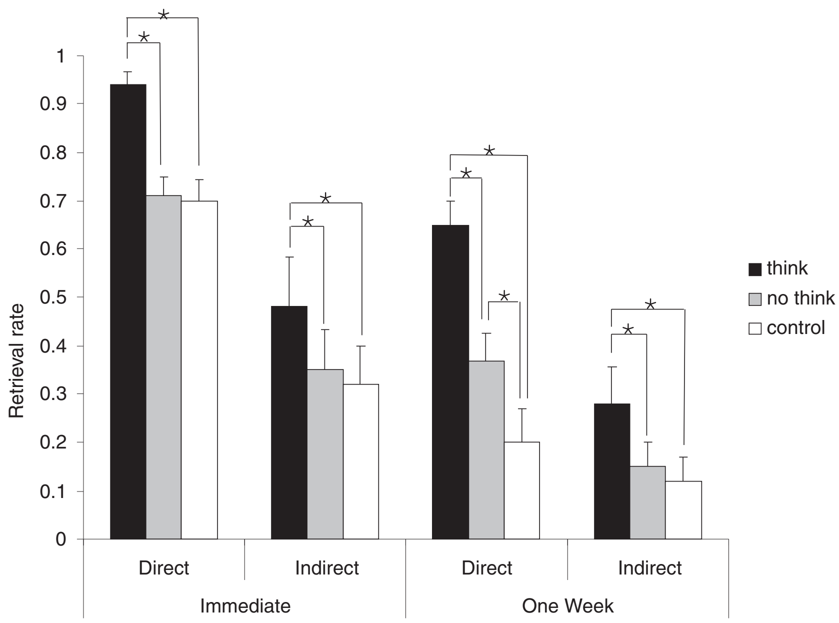

Figure 1. Memory performance for think, no-think, and control items in Experiment 1. Error bars represent standard errors of the mean. Asterisks indicate significant differences ($p < .05$).

Results

The results are shown in Figure 1. Retrieval rates for no-think and control items were equivalent in the immediate test condition, but higher for no-think as compared to control items after a 1-week retention interval. Retrieval for think items was superior to both no-think and control items, in both retention interval conditions. In the indirect test, a similar number of no-think and control target words were produced in both interval conditions. Again, more think items were produced compared to no-think and control items in both interval conditions.

This pattern of results was reflected in a three-factorial analysis of variance (ANOVA) with Type of test (direct vs. indirect) and Time of testing (immediate vs. 1 week) manipulated between subjects and with Item type (think, no-think, control) manipulated within subjects. It revealed a threefold interaction, $F(2, 152) = 3.19$, MSE = .018, $p < .05$, and in addition, both twofold interactions were also significant, $F(2, 152) = 10.4$, $MSE = .018$, $p < .001$, for type of test × item type, and $F(2, 152) = 3.10$, $MSE = .018$, $p < .05$, for time of testing × item type. To localize the source of the triple interaction, separate 2 × 3 mixed-design ANOVAs were conducted for each type of test. For the direct memory test, the time of testing × item type interaction and both main effects were significant (all Fs > 6.6, ps < .01). To further localize the source of the interaction, separate pairwise comparisons of item type were calculated separately for each interval condition. In the immediate test condition, think items were recalled more often than either no-think or control items (ps < .001), while no-think and control items did not differ ($p = .62$). In the 1-week test condition, think items were again recalled more often than either no-think or control items. In addition, more no-think items than control items were recalled ($p < .005$) after 1 week. For the indirect memory test, there was a main effect of item type, $F(2, 76) = 14.92$, $MSE = .019$, $p < .001$, and a marginally significant effect of time of testing $F(1, 38) = 3.94$, $MSE = .312$, $p = .054$, while the interaction was not significant $F(1, 38) < 1$. Posthoc comparisons revealed that overall, think items were produced more often than either no-think or control items (ps < .001), while performance for no-think and control items did not differ ($p > .05$).

Discussion

The primary purpose of Experiment 1 was to investigate the durability of the thought suppression effect in the think/no-think task. With both direct and indirect test instructions, think items were better remembered than suppressed items and control items at both interval conditions. In the direct memory test, performance was lower after 1 week. Critically however, while a similar number of no-think and control items were remembered in the immediate test condition, more no-think than control items were remembered after a 1-week interval, suggesting that thought suppression had a deferred effect. In the indirect memory test, the number of no-think and control items did not differ, neither in the immediate test condition nor after a 1-week interval. We hypothesized that if suppressed associations were eliminated from long-term memory, an equivalent pattern of results would emerge for direct and indirect tests. While the results of the immediate test conditions showed no obvious difference in the pattern of the direct and indirect tests, the results from the 1-week delayed test showed that no-think items are more accessible than control items in the direct memory test, suggesting that suppression had a deferred effect on long-term memory. One reason why the pattern of results remained unchanged in the indirect test might be the relatively low performance level after the 1-week interval. A potential floor effect may have precluded the expression of a significantly lower performance in the control compared to the no-think condition. Another reason may be that indirect testing is often less reliable than direct testing (Meier & Perrig, 2000), making it more difficult to detect a difference between no-think and control conditions. The fact that retrieval of no-think items relative to control items improved in the direct test across 1 week speaks against the elimination of suppressed associations from long-term memory.

Overall, the results suggest that active thought suppression has a deferred and reversed effect when tested with a direct memory test. Despite the initial instruction to suppress target words, these were retrieved better than control words after 1 week. It is possible that during the think/no-think phase, participants had briefly recollected the to-be-suppressed targets when a cue word appeared on the screen. This brief recovery may have led to enhanced consolidation of the suppressed cue-target associations. If the brief recovery of the no-think targets had reactivated their memory traces, then differences in consolidation should be expected for control items versus no-think items (see Dudai, 2006; Eichenbaum, 2006). Because the retrieval of a memory can destabilize it and require restabilization for the memory to persist, a reactivated memory may require a further cycle of memory consolidation, that is, reconsolidation (Nader & Hardt, 2009). Through repeated cycles of (re)consolidation, a memory may become strengthened and more easily retrievable than one-time consolidated memories (i.e., those from the control condition). Both long-term consolidation and reconsolidation are time-consuming processes because they involve gene expression and protein synthesis to structurally fixate memories in the neural network (Milner, Squire, & Kandel, 1998; Nader & Hardt, 2009). Therefore, differential effects of consolidation for reactivated versus nonreactivated words can become apparent after 1 week, but not after 10 min. Even if participants successively suppressed the recovery of target words in the no-think condition, perhaps even weakening the no-think associations (which was not apparent here in the immediate recall performance), the no-think associations may still have undergone preferential long-term consolidation due to having profited more from sleep-dependent memory consolidation than the stronger control associations. In fact, Drosopoulos, Schulze, Fischer, and Born (2007) found that the benefit of sleep for declarative memory consolidation is greater for weaker associations, regardless of whether weak associations result from retroactive interference or poor encoding/consolidation.

A further potential explanation for better retention of no-think than control items is related to retrieval-induced forgetting. A brief reactivation of associations in the no-think condition may have strengthened the retention of these associations at the cost of the control associations that were not practiced (Anderson, Bjork, & Bjork, 1994; Macrae & MacLeod, 1999). This explanation would imply that control words were actively inhibited by the brief retrieval of no-think words and by the full retrieval of think items which may have weakened the consolidation of control words. However, retrieval-induced forgetting effects are short-lived and therefore cannot explain the effects that emerge a week but not 10 min after the think/no-think phase (see MacLeod & Macrae, 2001).

In Experiment 2, we further examined whether suppress instructions would allow for a brief recovery of no-think targets. The standard thought suppression condition was contrasted with a substitution condition. Thought substitution should effectively prevent the reactivation or at least the reconsolidation of the original associations because it engages participants in an interfering encoding task. While A-B word associations were learned initially, participants were required to form A-C associations during thought substitution. Indeed, Hertel and Calcaterra (2005) demonstrated that instructing participants to form diversionary thoughts is a powerful strategy for creating thought substitution effects.

In a further attempt to prevent the brief rehearsal of associations during the suppress trials, we changed the presentation format of the cues. While in Experiment 1, the think and no-think instructions were displayed below each cue word – which may have allowed the recovery of associations before the instruction was processed – in Experiment 2 we used the print color of each cue word to indicate whether the paired associate was to be suppressed or remembered (see Anderson & Green, 2001). If the different forgetting rates of suppress compared to control words in Experiment 1 was caused by this procedural characteristic, one would expect it to disappear in Experiment 2.

Experiment 2

Method

Participants and Design

Another 80 native German-speaking volunteers (66 women; mean age = 23.4 years; range 19 to 41 years) participated in this experiment. They were all psychology undergraduates recruited from the departmental subject pool: 40 participants were assigned to the suppress condition which was conceptually identical to the direct test condition in Experiment 1, and 40 participants were assigned to the substitution condition. In each condition, half of the participants were assigned to the immediate test condition and half to the delayed test condition. For data analysis, a 2 × 2 × 3 mixed design was used with instruction (suppress vs. substitute) and time of testing (immediate vs. 1 week) manipulated between subjects and item type (think, no-think, control) manipulated within subjects.

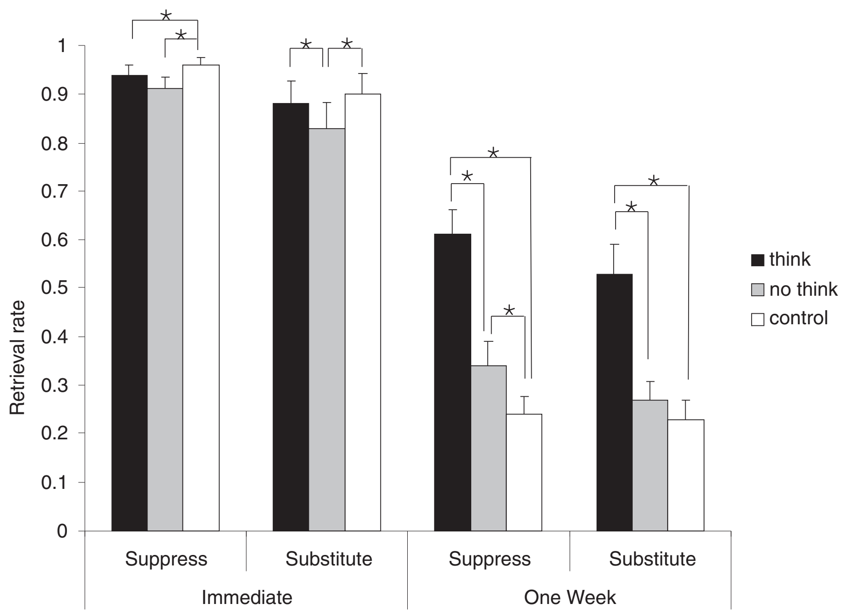

Figure 2. Memory performance for think, no-think, and control items in Experiment 2. Error bars represent standard errors of the mean. Asterisks indicate significant differences ($p < .05$).

Material

For the suppress condition, the material was identical to Experiment 1. For the substitute condition, an additional list of 72 cue-target pairs was created with the same cue words but new target words. These new word pairs corresponded to the stimulus characteristics described for Experiment 1, that is, they were matched for word length and word frequency between sets, and there were no obvious associations between cue and target words.

Procedure

The procedure was also very similar to Experiment 1. After the study phase, which consisted of two study-test cycles, the mean proportion of remembered word associates was .91 ($SD = .14$). In the second phase, rather than presenting task instructions verbally on the screen, participants were instructed to respond with the learned target word when the cue word was presented in green and to suppress the target word when the cue word was presented in red. In the substitute condition, participants were to associate a new target word to the cue word. This new target word was presented in red below the cue word. They were informed that these new associations would be tested later. Cued recall of the A-C associations was administered immediately after the think/no-think phase. In the final test phase, memory for the initially learned A-B associations was tested with a direct memory test. The test procedure was identical to that used in the previous experiment.

Results

The results are presented in Figure 2. A three-factorial ANOVA with Instruction (suppress vs. substitute) and Time of testing (immediate vs. 1 week) manipulated between subjects and with Item type (think, no-think, control) manipulated within subjects revealed an interaction between time of testing and item type, $F(2, 152) = 49.32$, $MSE = .013$, $p < .01$, a main effect of time of testing, $F(1, 76) = 214.37$, $MSE = .081$, $p < .01$, and a main effect of item type, $F(2, 152) = 49.19$, $MSE = .013$, $p < .01$. The main effect of instruction was marginally significant $F(1, 76) = 2.97$, $MSE = .081$, $p = .09$, but there was no interaction involving type of instruction, all *F*s < 1, *p*s .10. Because there was no significant triple interaction, it would appear that the effect of time of testing on item type was consistent across instruction conditions. However, due to the theoretical and practical significance, separate repeated measures ANOVAs were conducted for each instruction condition and each time of testing. Each of the ANOVAs was significant, all *F*s > 4.4, *p*s < .05, and was therefore followed up with Tukey LSD *t*-tests.

For immediate testing, these follow-up tests indicated that with suppress instructions, memory for control items was significantly better than memory for both think and no-think items (*p*s < .05) while the latter two did not differ ($p = 16$). With substitute instructions, memory for no-think items was significantly lower than memory for think items and for control items (*p*s < .05), while the latter two did not differ ($p = .48$).

For testing after a 1-week interval, the three item types differed significantly from each other (all *p*s < .05) with suppress instructions. Memory was higher for think items followed by no-think items and control items, thus replicating the results from Experiment 1 (direct test). In contrast, with substitute instructions think items were remembered better than both no-think and control items (*p*s < .05), and the latter two did not differ ($p = 36$). This indicates that by substituting, rather than just suppressing, the forgetting of an unwanted thought in response to a triggering cue is more likely.

Discussion

Experiment 2 replicated the improved retrieval performance for suppressed compared to nonrehearsed control associations after a 1-week interval. This result materialized despite the change in the instruction format with instructions signaled by print color of cue words (Experiment 2) rather than verbal instructions written below cue words (Experiment 1). This finding suggests that glimpses of target reactivations may occur upon confrontation with a cue word when suppress instructions are used, irrespective of the presentation format of task instructions (i.e., written word vs. print color). In the group with suppress instructions, the brief recovery of the learned associations may have resulted in a reconsolidation of no-think associations over the 1-week interval. In contrast, for control associations no such opportunity existed. This interpretation is substantiated by the findings from the group with substitute instructions. Substituting an already established association A-B with a new association A-C may have prevented reconsolidation and may thus have led to similar performance for no-think and control items. Even if A-B associations were briefly recovered in no-think trials, reconsolidation may have been inhibited by retroactive interference elicited by the newly learned A-C associations (Forcato et al., 2008). Moreover, the reconsolidation of A-B associations in the no-think condition was further counteracted by testing the A-C associations immediately after the think/no-think phase. Hence, the potential reconsolidation of A-B associations was exposed to two sources of interference and A-B associations were weakened to such a degree that they no longer profited from a privileged consolidation during sleep (Drosopoulos et al., 2007). As a consequence, the retrieval advantage of the A-B associations at the 1-week delay was eliminated. In contrast, suppress instructions appear to have allowed for reactivation and reconsolidation of A-B associations during waking and sleep.

Compared to Experiment 1, memory performance in the immediate test was higher in all conditions. We suspect that this is related to the fact that in Experiment 2 participants were psychology students recruited via the departmental subject pool. As they were more experienced in participating in psychology experiments compared to the more naïve students from Experiment 1, they may have profited from this experience in the immediate test conditions. The higher performance may have led to a ceiling effect and as a result, the restricted bandwidth may have caused spurious differences between think, no-think, and control items. Despite this reservation, it can be noted that in both the suppress and substitute conditions, there was at least a tendency toward a thought suppression effect with lower performance in the no-think condition compared to the control condition, as originally reported by Anderson and Green (2001). However, even if this thought suppression effect was real, it was short-lived and was reversed after 1 week.

Conclusions

Our findings are in line with previous reports of thought suppression by showing that the active avoidance of a memory in response to a triggering cue (i.e., the no-think condition) reduces the availability of this memory compared to memories whose retrieval is allowed or even repeatedly enforced (i.e., the think condition). This effect is very robust across studies and in the present investigation we have demonstrated that it occurs for direct and indirect memory tests (Experiment 1) and for thought suppression and substitution instructions (Experiment 2).

In contrast, thought suppression as measured as the difference between the no-think condition and the control condition, in which the cues for the learned associations are not presented at all, seems to be more difficult to find. Contrary to the initial results reported by Anderson and colleagues (e.g., Anderson & Green, 2001; Anderson et al., 2004), but in line with those of other studies (e.g., Bulevich et al., 2006; Mecklinger et al., 2009), we did not find a consistent advantage of control versus suppress conditions when participants were tested immediately. More curiously, however, we did find an advantage for suppressed items when tested after a 1-week interval. We suggest that this latter effect is a result of reactivation and reconsolidation elicited by brief activations of the target words to be suppressed in the no-think condition.

Moreover, thought suppression and substitution had a differential long-term effect, resulting in a performance advantage for suppressed, but not for substituted associations. Our results indicate that by simply suppressing a learned association in response to a cue word, a quick reactivation of this association nevertheless emerged and consequently a reconsolidation of the original memory occurred. In contrast, when the initial association with a new association was substituted, interference with the original memory occurred, which effectively decreased the consolidation of initial A-B associations presumably through retroactive interference.

In real life, for example, in order to get rid of cue-associated traumatic memories (e.g., war trauma), it appears preferable to completely avoid a triggering cue (e.g., airplane noise) similar to the control condition of the present experiments, rather than to expose oneself to the cues and then try to avoid thinking of the associated memories, which would be similar to the no-think condition. There is a high risk that unwanted memories are still recovered in the presence of a cue, and that each recovery simply induces a further cycle of memory consolidation and carves the trace of this memory even deeper into the mind through the mechanism of reconsolidation. If triggering cues cannot be eliminated, the strategy of associating them with new experiences is preferable to trying to avoid their triggering of the old, unwanted memories. Further research on the processes involved in the consolidation – and elimination – of suppressed memories may be promising for real-life applications. This area of research may have the potential to help clinicians develop optimized interventions for overcoming traumatic memories.

Last but not least, thought suppression as tested with the think/no-think paradigm is probably a poor realization of Freud's idea of an active repression mechanism. Freud's conception of repression refers to a persisting and long-lasting phenomenon, while the experimental effects reported so far with the think/no-think paradigm are short-lived. The empirical evidence of this study suggests that thought suppression as induced by the no-think instruction even has an opposite effect in the long term.

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