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Intentional forgetting benefits from thought substitution

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This study provides both experimental and correlational evidence that forgetting in the think/no-think paradigm (Anderson & Green, 2001) is sensitive to the substitution of thoughts about new events for thoughts that are to be suppressed. All the participants learned a list of adjective–noun pairs. Then the adjectives were presented as cues for recalling half of the nouns and as cues for suppressing the other half, 0, 2, or 12 times. *Aided* participants were provided with substitute nouns, to use during suppression. On a final test that requested recall of all initially learned nouns, aided participants showed evidence of below-baseline forgetting of suppressed nouns. *Unaided* participants produced below-baseline forgetting only if their later self-reports indicated that they had complied relatively well with instructions for suppression. Independently, forgetting in the unaided condition was more successful when the participants reportedly thought about something else during suppression trials. In general, the use of self-initiated strategies *seems* to affect the degree of forgetting in the think/no-think paradigm.

Some past events are best not remembered, particularly by people with ruminative tendencies. Intentional forgetting is, therefore, a skill that is worth developing, and a reasonable method is to practice not thinking the unwanted thought whenever a previously effective cue is encountered. However, this method does not *guarantee* later forgetting, as has been illustrated by outcomes from the think/no-think paradigm used by Anderson and Green (2001).

After the participants in the experiments by Anderson and Green (2001) had studied pairs of unrelated nouns, they spent a variable number of trials either rehearsing or suppressing second-item nouns (responses) when cued with the first. On each suppression trial, they were instructed not to think about the response term when the cue appeared on the screen. The final test, requesting recall of all responses, rehearsed and suppressed, revealed below-baseline recall of suppressed responses. Suppressed responses were recalled less well than responses for which cues were never presented between initial learning and the final test. Still, average recall in the most successful suppression conditions hovered around 70%. Although this level of forgetting is impressive, considering the parameters of suppression practice in the paradigm, clearly there is room for improvement.

The responses to be suppressed in the think/no-think paradigm are akin to unwanted thoughts. Unwanted thoughts might be subjected to ironic control processes (Wegner, 1994), whereby checking for success in inhibiting the thought ushers it in once again. To avoid this revolving door, people sometimes stumble upon the technique of thinking about something else when cues for the unwanted thought come to mind. The technique is likely to aid forgetting, because it is analogous to the experimental paradigm of retrieval-induced forgetting (Anderson & Spellman, 1995), in which rehearsal of items related to category cues prevents later recall of other previously studied items in the same categories. More generally, the strategy of thinking about something else is one of deliberately introducing retroactive interference effects in the remembering of unwanted thoughts. (See Anderson & Neely, 1996, for a review of retrieval-induced forgetting situated in the context of the interference literature.)

The relation between success in the think/no-think paradigm and the use of thought substitutes is the issue that motivated the present experiment. Our cues for responding or suppressing were adjectives with meaningful relations to both the original response term and the substitute response (see also Hertel & Gerstle, 2003). Apart from characterizing the nature of cuing in real-world settings, meaningful relations between the cues and the responses seemed particularly important in speeding the learning of the cue substitute pairs during the suppression phase. We examined the effect of learning to use these substitutes on subsequent recall of the originally learned responses. To reduce response competition, instructions on the final test permitted recall of both original responses and substitutes (akin to the MMFR test developed by Barnes & Underwood, 1959). We also examined the correlation between the uninstructed use of a substitution strategy and success in suppression under typical no-think conditions.

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METHOD

Materials

As in the experiment by Hertel and Gerstle (2003), related adjective–noun pairs were selected from those used by Hertel and Parks (2002). All 36 nouns were four to seven letters long ($M = 5.3$), with concreteness and imageability ratings greater than 5 ($M = 6.4$, on 7-point scales from Paivio, Yuille, & Madigan, 1968), emotionality ratings less than 4 ($M = 3.1$), and goodness ratings between 3 and 5 ($M = 4.5$, on 7-point scales from Rubin & Friendly, 1986). All those characteristics, plus frequency of occurrence ($M = 67.5$; Kučera & Francis, 1967), were used to distribute the nouns in a balanced fashion into six sets of six nouns each. Each noun was accompanied by an emotionally neutral adjective (e.g., *porcelain doll, security officer, racing hound*), and the six sets were balanced on ratings of emotionality for the pairs ($M = 4.3$ on a 9-point scale ranging from *extremely positive* to *extremely negative*; Hertel & Parks, 2002). All the pairs were used in the learning phase. Subsequently, three sets were assigned to suppression (baseline or 0 cue presentations, 2 presentations, and 12 presentations), and three sets were assigned to responding (0, 2, and 12). Filler items consisted of 10 additional neutral adjective–noun pairs from the same pool.

Substitutes to be used in the aided condition of suppression consisted of new nouns associated with the original adjectives (in our judgment). Examples include *porcelain goblet, security vehicle,* and *racing costume*. The substituted nouns averaged 5.7 letters long, 6.7 in concreteness, 2.5 in emotionality, 4.1 in goodness, and 69.3 in frequency. The six sets of six original pairs were also balanced on these measures for the substitutes.

Participants and Design

Under the constraint of equal cell sizes, 72 students (48 women and 24 men) were randomly assigned to the unaided or aided condition of suppression.[1] Within each condition, equal numbers within each gender were then assigned to the six counterbalancing conditions for rotating material sets across the factorial combination of instructions (respond vs. suppress) and number of cue presentations (0, 2, and 12).

Procedure

All tasks were implemented on Superlab Pro software. Most details of the procedure replicated those used by Hertel and Gerstle (2003), which were based on Anderson and Green (2001).

Learning phase. We presented each word pair in black font, centered on the screen, for 5 sec, during which time the participant created a self-referential mental image involving the concept denoted by the pair. (Beforehand, we gave them the example pair *sandy beach* and suggested that they might imagine themselves walking along a sandy beach.) Next, the rated meaningfulness of the image was reported aloud and keyed by the experimenter. The order of presentation, constant across participants, consisted of six randomized blocks of seven pairs (one pair from each of the six sets, plus one filler pair). Two additional filler pairs were placed at the beginning of the list, and two at the end.

Learning was assessed by requesting recall of the response word to each cue. The cues were displayed in black font, centered, for 5,200 msec (or less, if the participant responded sooner). Feedback consisted of a 2-sec exposure of the response word in blue font. If fewer than 50% of the responses on the first assessment were correct, another test was administered (for a maximum of three cycles with different orders within blocks of seven cues). All the participants achieved the criterion by three tests.

Suppression-training phase. We instructed all the participants that they would again see cue words, but this time the words would be presented in either green or red font. They were asked to respond to green cues with the responses, as they had done during the previous assessment. To red cues, they were asked to continue to attend but to avoid saying or even thinking about the associated response word. Nine filler cues appeared in green, once or twice each, and one cue appeared in red eight times (for suppression practice). In the aided condition, we gave the participants a substitute to recall when the red cue appeared and told them it would help them not to think about the response word. Other procedural details duplicated those used in the main suppression phase. At the end of the training phase, a short questionnaire assessed whether the participant understood the procedure, and corrections were provided if necessary.

Immediately before the main suppression phase, the aided participants viewed the 12 randomly ordered cue substitute pairs for 3 sec each. They were instructed to learn them in whatever way they preferred but never to think about the original response to each cue.

Suppression phase. In the main suppression phase, green cues for responding 2 or 12 times and red cues for suppressing 2 or 12 times were presented for a total of 168 trials. Six filler cues for responding (used during practice) were also each presented 12 times, in green, for an additional 72 trials. The trials were randomly ordered and separated by a 400-msec intertrial interval (ITI). Each trial was announced by a set of small crosses for 200 msec. The cue was then presented for 3 sec (or less, if the participant responded sooner). Incorrect or absent responses on response trials were followed by a 500-msec display of the response word in blue font. Responses to a cue for suppression initiated the display of very large red *X*s, followed by a 500-msec display of the substitute in the aided condition.

Final test phase. The constant test order consisted of four filler cues, then six randomized blocks of one cue from each of the six sets. On each trial, following a 200-msec display of crosses, the cue was displayed for 4 sec (or less, if the participant responded sooner). The ITI was 400 msec, and no feedback was given. The participants were asked to recall the initial response word for each cue, regardless of prior instructions. In both conditions, they were told that if more than one word should come to mind, they might say that other word as well and not be concerned about which one was correct. In the aided condition, we added the explanation that, because they had also learned substitutes for some of the cues, they might say both initial responses and substitutes aloud. Everyone was reminded that it was very important to recall the correct response word from the first part of the experiment.

Strategy questionnaire. After the final test, we asked the participants to fill out a questionnaire concerning strategies for suppression. Table 1 lists the items. The first three were obtained from Michael Anderson (personal communication, May 18, 2002), and we added the last two. Each item was followed by a scale—0 (*never*), 1 (*rarely*), 2 (*sometimes*), 3 (*frequently*), and 4 (*very frequently*)—and the participants were instructed to circle a number that represented their use of the strategy.

RESULTS

Overall Analysis

The mean percentages of response words recalled on the final test are depicted in Figure 1. The percentages were submitted to a mixed design analysis of variance (ANOVA), with a between-subjects factor for the condition for suppression (unaided vs. aided) and within-subjects factors for instruction during the suppression phase (suppress vs. respond) and the number of times that the cues were presented (0, 2, or 12).[2] The significance level was set at .05. Significant main effects qualified by significant interactions are not reported.

The effect of instruction (suppress vs. respond) depended on the number of times the cues were presented [$F(2,96) = 27.25$, $MS_e = 217.34$, $p < .001$]. As was anticipated, this interaction was qualified by the higher order interaction of instruction and cue presentation with sup-

Table 1
Items on the Strategy Questionnaire

I read the hint word [and then]:
Made sure I still knew the associated word first, and *then* tried to *not think* of this associated word.
Tried to not think of the associated response, but then *after the trial was over* I made sure I still remembered the response word.
Kept myself from *saying* the response word aloud, but kept repeating the response word to myself to improve my memory for it.
Kept myself from *thinking* about the original response word by thinking about something else (another word or image, for example).
Kept myself from *thinking* about the response word by keeping my mind completely blank.

pression condition [unaided vs. aided; $F(2,96) = 5.40, p < .01$]. Figure 1 shows that forgetting was aided by the provision of substitutes in both the 2- and the 12-presentation conditions. In the unaided condition, the mean percentages of suppressed responses recalled were 82, 83, and 82 (for 0, 2, and 12 cue presentations, respectively). The corresponding means in the aided condition were 83, 70, and 68. Clearly, below-baseline suppression obtained only in the aided condition [$F(1,30) = 27.95$, $MS_e = 248.46$, $p < .001$].

Compliance in the Unaided Condition

Next, to evaluate the lack of below-baseline suppression in the unaided condition, we included a factor for how well the participants reportedly complied with suppression instructions. Their responses to the first three items on the strategy questionnaire were summed to constitute a score for noncompliance. A median split on these scores within each counterbalancing condition produced the noncompliance factor,[3] which was included in an ANOVA, along with within-subjects factors for instruction (respond vs. suppress) and number of cue presentations. The three-way interaction was significant [$F(2,48) = 5.36$, $MS_e = 156.25$, $p < .01$].

Figure 2 shows that only the participants who reported lower use of strategies in conflict with suppression instructions produced below-baseline suppression, according to a comparison of baseline with 2 and 12 cue presentations [$F(1,12) = 4.85$, $MS_e = 420.52$, $p < .05$]. The means were 88% (baseline), 74% (2 presentations), and 80% (12 presentations). However, the comparison between baseline and recall of responses suppressed 12 times was nonsignificant, perhaps due to low power. In contrast, the noncompliant participants tended to recall responses that they had been instructed to suppress more frequently than baseline responses [$F(1,12) = 3.69$, $MS_e = 706.02$, $p < .08$]. The means were 75% (baseline), 92% (2 presentations), and 82% (12 presentations). Again, the comparison between baseline and recall of responses "suppressed" 12 times was nonsignificant.

Thought Substitution in the Unaided Condition

We examined the correlation between ratings on Item 4 on the strategy questionnaire (*kept myself from thinking about the original response word by thinking about something else*) and the size of the instruction effect (the number recalled from all cues for responding minus the number recalled from all cues for suppression, omitting baseline data). The participants who produced larger instruction effects reported more frequently having thought about something else [$r(34) = .45$, $p < .01$]. Although the instruction effect was also significantly correlated with the noncompliance score [$r(34) = -.33$, $p < .05$], the noncompliance score was not significantly correlated with reported use of the substitution strategy [$r(34) = -.16$, $p > .30$]. (The mean rating for use of the substitution strategy was 3.3 for more compliant participants and 2.7 for less compliant participants.) And when the noncompliance score was entered first in an equation to predict the size of the instruction effect, the increase in R^2 by adding the substitution rating was .16 [$F(1,33) = 7.13$, $p < .02$]. Therefore, the ability of a substitution strategy to account for success in suppression was not an artifact of whether the participant complied with instructions.

As an illustration of the advantage of substitution, median splits within each counterbalancing condition identified low and high users of this strategy.[4] The average rating was 2.2 (sometimes) in the low-use group and 3.9 in the high-use group (very frequently). Although performing an ANOVA with the dichotomized substitution strategy as a factor lacks the power of the regression analysis, it was performed to address the issue of below-baseline suppression. As is shown in Figure 3, substitution interacted significantly with instruction (respond vs. suppress) and number of cue presentations [$F(2,48) =$

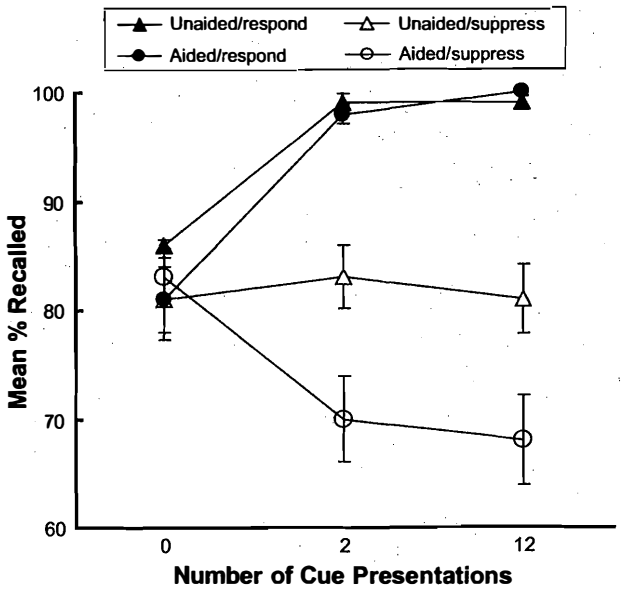

Figure 1. Mean percentages of original response words recalled as a function of number of cue presentations for suppressing or responding in each condition for practicing suppression (unaided vs. aided). An error bar represents one standard error of the mean.

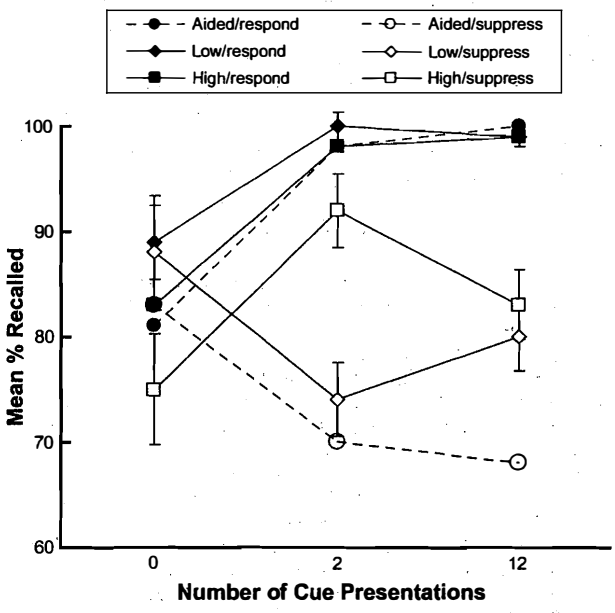

Figure 2. Mean percentages of response words recalled according to the number of cue presentations for suppressing or responding in the unaided condition (solid lines). Noncompliance with suppression instructions (low vs. high) was determined by a median split on the summed ratings for Items 1–3 on the strategy questionnaire. The means in the aided condition (dashed lines) are provided for comparison. An error bar represents one standard error of the mean.

5.76, $MS_e = 158.18$, $p < .01$]. High substitute users recalled fewer responses suppressed 12 times than responses in the baseline condition [$F(1,12) = 4.97$, $MS_e = 524.69, p < .05$]. Means were 85%, 77%, and 73% following 0, 2, and 12 cue presentations, respectively.

Recall of Substitutes in the Aided Condition

On the final test, the aided participants recalled an average of 34% of the substitutes used twice and 56% of those used 12 times [$F(1,24) = 16.50, MS_e = 374.23, p < .001$]. Recall instructions emphasized the importance of recalling the original response words but merely permitted the recall of substitutes, so these levels are likely to underestimate participants' ability to recall substitutes if the importance of doing so is stressed.

Recall of substitutes did not clearly predict the forgetting of original responses on a trial-by-trial basis. When substitutes were recalled, they were accompanied by original responses on 56% of the trials ($SD = 40.73$). Out of the trials during which the participants failed to recall the original response, only 54% of the substitutes were recalled ($SD = 36.37$).

DISCUSSION

According to these results, our advice to those who want to forget is to think about something else that can be meaningfully related to the cue most likely to invoke the unwanted memory. This is the advice derived from experiments on retrieval-induced forgetting, as well as from experiments on retroactive interference in general, and it now applies to situations in which unwanted thoughts are deliberately suppressed.

The provision of substitutes in this experiment caused more forgetting of suppressed responses than did the instruction merely to suppress thoughts of the to-be-forgotten responses. Importantly, substitutes were provided *in addition to* the typical suppression instructions used by Anderson and Green (2001), and the instructions emphasized the importance of never thinking about the original responses during the learning of the substitutes. Otherwise, retrieval-induced forgetting would likely be impaired by relations between the responses to each cue (see Anderson & McCulloch, 1999). The primary emphasis on the suppression of initial responses also makes the results in the aided condition not merely a replication of classic retroactive interference experiments but, instead, shows how retroactive interference can contribute to intentional forgetting.

One possible explanation for the effect of substitutes is that there was simply more to be remembered—36 initial responses and 12 substitutes. Against this explanation, we found similar ceiling levels for the recall of responded items in both groups, as well as a significant correlation between the instruction effect and the self-

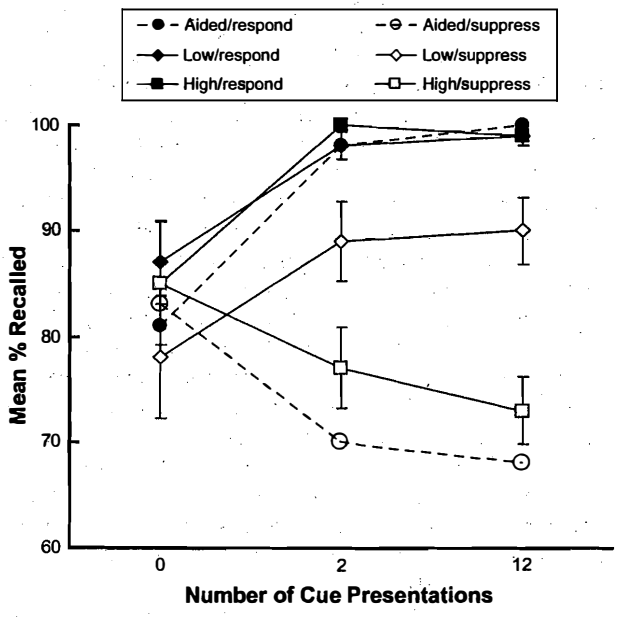

Figure 3. Mean percentages of response words recalled according to the number of cue presentations for suppressing or responding in the unaided condition (solid lines). Low versus high use of the thought substitution strategy was determined by a median split on the ratings for Item 4 on the strategy questionnaire. The means in the aided condition (dashed lines) are provided for comparison. An error bar represents one standard error of the mean.

initiated strategy of thinking about something else. Another possible explanation can be derived from a response competition or blocking framework. Although we used self-paced recall, invited the report of both response words in the aided condition, and stressed the importance of recalling the original, response competition cannot be ruled out. It is also possible that some participants were satisfied with the recall of just one response, the more recent one, or that the initial response sometimes underwent output interference from the person's having produced the substitute first on the final test trial. Neither situation can be ruled out by the data. Perhaps the use of independent cues for recalling the original responses would help to identify which processes are *mainly* responsible for the effect in the aided condition (see Anderson, 2003). Anderson and Green's (2001) use of independent cues was essential to their argument that inhibition is responsible for forgetting in the think/no-think paradigm. And inhibition from the retrieval of substitutes might similarly be revealed.

Next, we note that the data in the unaided condition conceptually replicated the findings of below-baseline suppression obtained by Anderson and Green (2001; see also Anderson et al., 2004), *if* participants reported compliance with instructions for suppression. As compared with baseline, they forgot responses subjected to suppression attempts, although not significantly so following 12 attempts and clearly not as well as did the aided participants given 12 attempts. Even more interesting was the conceptual replication by the participants who reportedly used a thought substitution strategy and subsequently showed levels of forgetting similar to those obtained in the aided condition. Importantly, both findings of below-baseline suppression were obtained following many fewer suppression trials than those constituting Anderson and Green's suppression phase (2 and 12, as compared with 1, 8, and 16). And unlike in Anderson and Green's studies, they were obtained from related cue–response pairs (as was the marginally significant evidence of below-baseline suppression obtained by Hertel & Gerstle, 2003). However, some recent attempts to replicate the effect have not been successful (e.g., Bulevich, Roediger, & Balota, 2003), and the present results suggest that the size of the suppression effect might indeed depend on the use of self-initiated strategies. If a substantial number of participants choose strategies of noncompliance, the effect will certainly be weakened or eliminated. On the other hand, if a substantial number of participants choose to think about something else while suppressing, perhaps not even explicit substitutes, the effect should clearly be obtained.

As a final note, the thought substitution strategy might be effective either due to practice in retrieving the substitutes (classic inhibition or interference explanations) or simply because the focus on some other matter keeps the temptation of ironic control at bay. The latter hypothesis would be supported indirectly by a significant inverse correlation between reports of noncompliance and reports of substitution use—a correlation that was nonsignificant in this experiment. Nevertheless, there should be more direct ways to discover whether thought substitution succeeds, at least in part, because an idle mind is the memory devil's workshop.

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NOTES

1. Because we thought that substitutes might help depressed participants more than nondepressed, the participants were selected according to their scores (below 6 and above 8) on the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) in a previous class administration. In each cell of the design, 2 women and 1 man scored in the high group, and the same distribution obtained for scores in the low group. The factor for BDI group did not interact with other factors in any of the analyses we performed (all Fs < 1), so these aspects of the procedure are omitted for brevity's sake. Failures to find evidence of depression-related deficits in forgetting (Hertel & Gerstle, 2003) might be due to the nonemotional nature of these materials (as compared with Hertel & Gerstle's emotional pairs), the use of far fewer suppression tri-

als (2 or 12, as compared with 1, 8, or 16), or relatively low BDI scores in the dysphoric group ($M = 15$).

2. A between-subjects factor for the six counterbalancing conditions was included in order to reduce error variance in this and subsequent analyses; those effects are not reported.

3. Three 2-way ties in the split procedure were resolved randomly. The compliance factor was independent of BDI group ($\phi = 0$). The mean noncompliance scores were 1.7 and 4.9 for low versus high noncompliance, respectively.

4. Three 3-way ties in the median split procedures were resolved randomly. The category for substitution was independent of BDI group ($\phi = .222, p > .15$) and the noncompliance categorization ($\phi = -.11$, $p > .50$).

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