The selective directed forgetting effect: Can people forget only part of a text?

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Abstract:

Participants studied sentences describing two different characters and then were told to forget the sentences about only one of the characters. A second list contained sentences attributed to a third character. Subsequently, they received a recall test on the sentences about the original two characters. When the sentences could be thematically integrated, participants showed no directed forgetting relative to a control group that was never told to forget. However, with unrelated sentences, participants selectively forgot the target character's sentences without forgetting the other character's sentences. This selective directed forgetting effect is a novel empirical result. We interpret the results as consistent with Radvansky's (1999) ideas about inhibition with textual materials.

Keywords: Directed forgetting; Context; Inhibition; List method; Memory

Article:

The current work is intended to answer a simple empirical question: Can people intentionally forget some of what they have learned without forgetting all of it? We often hear both accurate and inaccurate information during the same conversation. For example, hearing gossip and knowing that some of the information is not true, we would prefer to forget the inaccurate rumour without losing access to the accurate information. This updating of information involves intentional forgetting and, more specifically, selective intentional forgetting.

Intentional forgetting is commonly studied through the *directed forgetting* procedure. In this procedure, participants are asked to forget some of the material they have recently studied. Items that are supposed to be forgotten are called *to-be-forgotten items*. Items that are supposed to be remembered are called *to-be-remembered items*. Forget instructions can follow individual items (the *item method*) or be presented after studying an entire list of items (the *list method*).

In the item method, a cue to remember or forget each individual item immediately follows its presentation, resulting in lower recall of to-be-forgotten items than to-be-remembered items. Most authors attribute item method directed forgetting to selective rehearsal of to-be-remembered items at the expense of to-be-forgotten items (e.g., R. A. Bjork, 1989). Both recognition testing and free-recall testing produce similar results, consistent with an encoding-based explanation of item method directed forgetting.

The mechanisms underlying list method directed forgetting are more complicated. A typical list method study presents participants with two lists. Half of the participants are told after List 1 to try to forget it, while the rest are told to keep remembering List 1. After studying the second list, participants are asked to recall all the items, including any items they were earlier instructed to forget (if applicable). The remember group is assumed to reflect participants' typical behaviour, and so the results are labelled according to how the forget group differs from the remember group. The two effects that emerge using word lists are called the costs and benefits of directed forgetting. *Costs* refers to poorer List 1 memory in the forget group than in the remember group, and *benefits* refers to better List 2 memory in the forget group than in the remember group.

Unlike the item method results, selective rehearsal appears insufficient to explain findings associated with use of the list method (see Geiselman, Bjork & Fishman, 1983; Sahakyan & Delaney, 2005). Robust costs occur following incidental learning (Geiselman et al., 1983; Sahakyan & Delaney, 2005; Sahakyan, Delaney, & Waldum, 2008), which is difficult to explain from a selective rehearsal perspective as participants are not supposed to rehearse in incidental learning. Additionally, re-presenting a portion of the to-be-forgotten items as a recognition test just before a recall test eliminates the costs for explicitly but not implicitly encoded items (e.g., E. L. Bjork & Bjork, 1996). Taken together, these results seemed to imply inhibition at retrieval.

Recently, Sahakyan and Kelley (2002) proposed that the apparent inhibition occurs because the forget cue prompts some participants to think of something unrelated to List 1 learning, which changes mental context between the lists. Changing mental context causes a mismatch between the List 1 study context and the test context, resulting in forgetting of List 1. Tasks designed to change mental context mimic the effect of the forget instruction, producing the costs of directed forgetting (e.g., Delaney & Sahakyan, 2007; Sahakyan, 2004; Sahakyan & Kelley, 2002), and instructions to mentally reconstruct the original learning context benefit the forget group more than the remember group (Sahakyan & Kelley, 2002).

The earliest attempts to obtain selective forgetting came not from directed forgetting per se, but from a related method known as the *only method*. Epstein's (1969) only method involved asking participants to study two short lists of items from different categories, such as a short list of words followed by a short list of numbers. They were then asked to recall either words then numbers or numbers then words, or to recall only one of the sets—only words or only numbers. Surprisingly, recalling only one set of items produced better memory than recalling the same set of items with the knowledge that another list would be tested afterwards. The expectation that another set of items would need to be recalled after the first set was sufficient to suppress recall, a finding called the *only effect*. Epstein's later experiments showed that mixing the items on the list eliminated the only effect, suggesting that blocked presentation by category was necessary to obtain it. However, in these only effect studies, the to-be-excluded items are never tested, so it is impossible to know whether they are forgotten or not.

In list method directed forgetting, the forget instruction is applied to all precue items. However, a few studies have asked participants to try to forget only some of the items they studied. Studies generally suggest that directed forgetting cannot be targeted at some items that precede the cue without also targeting all of the other items that precede the cue. For example, Geiselman et al. (1983) had participants study some words intentionally and others incidentally. Participants then received an instruction to forget the intentionally learned items. The results showed that both intentionally and incidentally encoded items were forgotten, suggesting that directed forgetting applied to all items that preceded the forget cue. Similarly, Sahakyan (2004) had participants study three lists and then delivered a forget cue after the second list, with explicit instructions to forget only the second list. She found that the first list was also forgotten—even when each list came from a different semantic category (e.g., animals and fruits). Taken together, the results of these studies suggest that people cannot selectively forget some previously studied items without forgetting some to-be-remembered items as well.

Why might we still expect to observe selective forgetting after an intervening list under some circumstances? Radvansky (1999) proposed that memory for text is different from other kinds of memory because people attempt to integrate textual information into coherent situation models (an idea first proposed by van Dijk & Kintsch, 1983). Consequently, when events take place in a common location or around a common theme, they are integrated into a schema that produces little interference between the individual sentences. However, when unrelated sentences about the same person are presented, they are stored as competing (and mutually interfering) situations. Unsurprisingly, memory for thematic text is therefore much better than that for unrelated sentences (e.g., Radvansky, 1999).

During either study or retrieval, a variety of mechanisms might create selective forgetting. For example, if we studied sentences about Tom and sentences about Alex and were then told to forget the Tom sentences, we might try to retrieve the Alex sentences to ensure that we can mentally discriminate them from the to-be-

forgotten Tom sentences. This retrieval of Alex sentences—a kind of selective rehearsal—could reduce memory for Tom sentences. However, when all the sentences about both Tom and Alex can be integrated into a coherent situation model, less mutual interference should occur (Smith, Adams & Schorr, 1978). Less interference has been associated with reduced directed forgetting in several papers (e.g., R. A. Bjork, 1989; Pastötter & Bäuml, 2007; Sahakyan & Goodmon, 2007) and might also be true with selective directed forgetting.

EXPERIMENT

The experiment was a list method directed forgetting study, except that participants were asked to forget only some of the studied sentences. Participants studied sentences about two characters (Tom and Alex) as List 1. For half of the participants, it was possible to create a coherent mental picture about each character's typical activities and lifestyle, while for the remaining participants all of the sentences were thematically unrelated and should therefore be stored as separate schemas. After studying List 1, half of the participants were asked to forget only the sentences about Tom, while the other half were told to keep remembering both characters. Everyone then studied unrelated sentences about a new character (Joe) as List 2, before receiving a final recall test on all of the sentences. Sahakyan's (2004) results implied that we should not obtain selective forgetting under these circumstances.

Method

Participants

Participants were 128 undergraduate students who participated for course credit. We replaced 13 participants after they admitted in the postsession interview that they either made no effort to comply with the forget instruction or actively rehearsed forget items instead of remember items. One additional participant was replaced because he admitted that he never studied the words.

Materials

Participants studied two lists, which are provided in the Appendix. List 1 consisted of 8 sentences about Tom and 8 sentences about Alex, presented in alternating order. We counterbalanced whether the first sentence presented was about Tom or Alex. In the *thematic* condition, one of the characters was a writer who liked snow sports (e.g., “Tom writes in a study” and “Tom went skiing”). The other character was a lawyer who was family oriented (e.g., “Tom works late hours” and “Tom has two kids”). While participants were never explicitly told that there was a theme, virtually everyone mentioned that they noticed the themes. In the *random* condition, the sentences were unrelated action phrases (e.g., “Tom watched television” and “Alex brushed his teeth”). List 2 was always the same and consisted of 14 unrelated sentences about Joe (e.g., “Joe played video games” and “Joe woke up late”).

Procedure

Participants were told to study the sentences for a later memory test. Each sentence was presented for 7 s. Following List 1, participants in the *remember* condition were told to keep remembering the sentences while they studied a second list. Participants in the *forget* condition were told to try to forget the Tom sentences in order to remember the Alex sentences better. After a 90-s delay filled with multiplication problems, participants then studied List 2 (about Joe). After List 2, they again solved multiplication problems for 90 s.

The final recall test consisted of an instruction to recall as many sentences as possible from List 1—both the Tom sentences and the Alex sentences. Next, they were asked to recall as many sentences as they could from List 2 (about Joe). Participants had 120 s to recall each list.

After completing their recall, participants were asked whether they believed the forget cue and tried to forget, what they did in order to learn the sentences, and whether they had been confused by the instructions.

Results and discussion

Sentences were counted correct if participants recalled the gist of the sentence. Substitutions that did not substantively change the meaning were acceptable (e.g., "brushed his hair" for "combed his hair"). Substitutions that altered the meaning of the sentence were not accepted (e.g., "rented skis" for "rented a snowboard"). Two independent coders who were blind to the purpose of the experiment coded the data. Interrater agreement was 97.6%. Differences were resolved through discussion.

Source confusions

Sentences recalled on the correct list but assigned to the wrong character were counted as correct, but were marked as *source confusions*. Although source confusions were infrequent, we conducted a 2 (list type: thematic vs. random) ×2 (cue: forget vs. remember) ×2 (character: Tom vs. Alex) analysis of variance (ANOVA) on the number of source confusions—that is, Tom or Alex sentences correctly recalled but assigned at recall to the other character. There was an unsurprising main effect of list type, $F(1, 124) = 12.01$, $p < .001$, $MSE = 0.27$, with fewer source confusions on the thematic lists (0.13) than on the random lists (0.35). All other effects were $F < 1$ except the Cue ×List Type interaction, $F(1, 124) = 2.41$, $p = .12$, $MSE = 0.27$.

List 2 Recall: Joe

We expected no directed forgetting benefits because benefits usually only emerge when a strategy change leads to differential strategy usage on List 2 across conditions (Sahakyan & Delaney, 2003, 2005). For sentence recall, the majority of our participants informally reported a "deep" encoding strategy of trying to form a story about the characters on both List 1 and List 2. A 2 list type (thematic vs. random) ×2 cue (forget vs. remember) ANOVA on List 2 recall revealed only a main effect of list type, $F(1, 124) = 3.96$, $p < .05$, $MSE = 0.39$, reflecting better recall following a thematic list (.45) than following a random list (.38), consistent with reduced proactive interference. All other effects were $F < 1$.

List 1 recall: Tom and Alex

The most important question of the current work was whether there would be selective forgetting. A 2 (list type: thematic vs. random) ×2 (cue: forget vs. remember) ×2 (character: Tom vs. Alex) ANOVA on the proportion of List 1 sentences recalled revealed a significant three-way interaction, $F(1, 124) = 4.04$, $p < .05$, $MSE = 0.023$. Recall rates and standard deviations are shown in Table 1.

Table 1. Proportion of sentences recalled by list type, cue, and character

		Thematic				Random			
		Forget		Remember		Forget		Remember	
Sentences		***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
List 1	Tom	.49	.23	.52	.26	.28	.19	.39	.18
	Alex	.52	.22	.55	.24	.37	.20	.32	.18
List 2	Joe	.45	.18	.45	.21	.38	.21	.36	.20

We followed up the interaction with separate ANOVAs for thematic and random lists. For thematic lists, we observed no effect of the forget cue, $F < 1$, and no main effect of character, $F(1, 62) = 1.17$, $MSE = 0.027$. The interaction was not significant, $F < 1$. For random lists, main effects were absent for cue and character, both Fs < 1. However, the Cue × Character interaction was significant, $F(1, 62) = 9.66$, $p < .01$, $MSE = 0.019$. There was lower recall of Tom sentences following the forget cue than following the remember cue, $t(62) = 2.31$, $p < .05$. For Alex sentences, the difference in proportion recalled in the forget condition and that in the remember condition was not significant, $t < 1$.

Clustering analyses

Clustered recall reflects greater integration of items of the same type during a test. To examine how participants organized their recall, a new research assistant calculated a measure of clustering by counting how many times participants shifted from one character to the other during recall and dividing by the total number of transitions. This *swaps score* is higher when participants tend to alternate more often between Tom and Alex and lower when Tom or Alex sentences are recalled as a group. A swaps score near 0 indicates perfect clustering, while a swaps score near 1 indicates perfect alternation.

For participants who organized their recall into two columns—one for Tom and one for Alex—we could not calculate a swaps score. Recalling in columns was roughly twice as common in the thematic group as in the random group (see Table 2). Participants who recalled two or fewer items or no items of one type were also excluded.

Table 2. Perfect clustering and perfect alternation by list type

	In columns	Perfect clustering	Perfect alternation
Note: In percentages. We did not include participants who recalled two or fewer items or zero items of a given type in the counts.			
Thematic	48	39	3
Random	25	21	18

For the remaining 77 participants, we subjected the swaps scores to a 2 (cue) × 2 (list type) ANOVA. We obtained a significant effect of list type, $F(1, 73) = 15.46$, $p < .001$, $MSE = 0.081$. Participants in the thematic condition tended to cluster their output (swaps score .39) while participants in the random condition were more likely to alternate (swaps score .65). There was no main effect of cue and no interaction, both $F < 1$. One way to visualize clustering is to ask what percentage of participants in each group showed perfect clustering (i.e., only switched from Tom to Alex once) and what percentage showed perfect alternation (i.e., always alternated between Tom and Alex). Table 2 shows these percentages—perfect clustering was approximately twice as likely for the thematic group, while perfect alternation was six times more common in the random group.

Output interference

Why did our study show selective directed forgetting when earlier studies did not? Perhaps output order may have varied across conditions, resulting in more output interference on Tom sentences in the forget condition than in the remember condition. If participants in the forget group began with Alex more often than did participants in the remember group, it would lead to lower recall of the Tom sentences in the forget group, because output interference would decrease the likelihood of recalling Tom sentences.

To test for unequal output interference, we used a procedure developed by R. A. Bjork and Whitten (1974) to calculate output position percentiles. For each participant, the output percentile was calculated for each character (Tom and Alex) as the average nominal output position of sentences recalled from that character

divided by the total number of sentences recalled by that participant. Thus, higher numbers indicate later output. We calculated output scores for every participant that had a swaps score (see above).

Planned comparisons were conducted separately for Tom and Alex sentences to provide maximum power to detect output order differences, but neither comparison yielded evidence of differential output bias across cue conditions in the thematic condition (both ts < 1). In the random condition, there was no output order difference in the remember group, $t < 1$. However, in the forget group, Tom sentences were output earlier ($M = .52$) than Alex sentences ($M = .65$), $t(23) = 2.12$, $p < .05$. This is the reverse of what one would expect if output interference were responsible for our results. In fact, the results suggest that forgetting could be larger if we controlled output order.

GENERAL DISCUSSION

The present study is, to our knowledge, the first to demonstrate selective directed forgetting. Sahakyan (2004) showed that when participants were instructed to forget a list, all precue items showed forgetting, consistent with Sahakyan and Kelley's (2002) context change explanation of list method directed forgetting. We created a situation where participants could organize the material into two separate sets (one about Tom and one about Alex). The results suggested that when information can be integrated into a thematically organized schema, participants could not selectively forget sentences about one character. However, when participants studied unrelated sentences about the two characters, they were able to forget the sentences pertaining to one without forgetting the sentences pertaining to the other. This *selective directed forgetting effect* is different from the only effect (Epstein, 1969), because it results in actual forgetting and not just better memory for some items.

One potential explanation is that our results reflect a mechanism akin to the selective rehearsal mechanism seen in item method directed forgetting. R. A. Bjork (1970) originally proposed that selective rehearsal could explain directed forgetting in both the list method and the item method, but abandoned selective rehearsal as a mechanism because Geiselman et al. (1983) demonstrated forgetting of incidentally learned items in the absence of any rehearsal—a result replicated by Sahakyan and Delaney (2005) and Sahakyan et al. (2008). A great deal of research suggests that the item method primarily relies on selective rehearsal of to-be-remembered items at the expense of to-be-forgotten items. Evidence that selective forgetting is possible in the list method is consistent with a renewed role for selective rehearsal. The most direct evidence for selective rehearsal would be better memory for Alex sentences when Tom sentences were forgotten. Although Table 1 shows a 5% recall advantage for Alex sentences in the forget condition compared to the remember condition, this difference was not reliable. Thus, the current results are consistent with a selective rehearsal explanation but do not provide strong evidence for such an interpretation. Another reason to be suspicious of a rehearsal account is that it cannot immediately explain why selective directed forgetting occurs only in the random condition and not in the thematic condition. Perhaps in the thematic condition, the study material was sufficiently well organized and encoded that changes in rehearsal frequency had little impact on recall, whereas in the random condition, rehearsal was much more important for fostering organization. Finally, if selective rehearsal created a selective directed forgetting effect in our study, why did it not occur in Sahakyan's (2004) experiments? The two categories of items in her Experiment 2 were quite distinctive and could have been rehearsed separately.

Clustering analyses suggested that a major difference between the thematic and random conditions was the way participants clustered their recall. In the thematic condition, participants tended to recall Tom sentences with other Tom sentences and Alex sentences with other Alex sentences. This type of retrieval suggests that Tom and Alex sentences were successfully integrated into separate sets during study. Previous research in item method directed forgetting has shown that information that is easy to integrate with earlier to-be-remembered information produces less directed forgetting than information that is more difficult to integrate. For instance, Golding, Long, and MacLeod (1994) showed that participants were less able to intentionally forget the second

word of a pair (e.g., “leg”) when that word was predisposed to natural integration with a just presented to-be-remembered item (e.g., “crab”). Golding et al. explained that the high degree of integration between word pairs causes memory for the first word of the pair to cue memory for the highly integrated second word leading to decreased forgetting. Therefore, in the thematic condition, Alex sentences might have been integrated in such a way that memory for any Alex sentence at test prompted memory for other highly integrated Alex sentences.

In contrast to the clustered output of the thematic condition, participants in the random condition tended to rely on the original input order and alternated between Tom and Alex sentences. Additional rehearsal of Alex sentences may have created competing order cues at recall—one based on the original input order and the other based on the contents of the rehearsal buffer as participants rehearsed only the Alex sentences. If so, then recalling an Alex item might tend to cue another Alex item, thereby skipping the Tom item that was originally presented between them and triggering apparent forgetting of Tom items. Disrupted retrieval mechanisms have been proposed in the past to explain part-set cueing and collaborative recall deficits (e.g., Basden, Basden, & Henry, 2000).

A final possibility is that selective retrieval of the Alex sentences lowers memory for the Tom sentences, through either retrieval inhibition (e.g., Radvansky, 1999) or a list strength phenomenon (e.g., Sahakyan et al., 2008). In each of these phenomena, retrieval (or restudy) of some items on a list results in reduced recallability of competing items. However, on thematic lists, there would be less competition and correspondingly smaller inhibitory effects.

In sum, our study is the first to demonstrate selective directed forgetting. Further work is needed to identify the mechanisms underlying selective forgetting, but the results are intriguing in that they suggest a novel directed forgetting paradigm. Future studies should use recognition tests to determine whether forgotten items are available in memory but blocked from access, or if they are less well learned. The latter would be good evidence for selective rehearsal mechanisms, while the former would be more consistent with inhibitory mechanisms or disruptions of retrieval strategies.

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Appendix A

Materials

Thematic group: List 1 materials

Character 1	**Character 2**
< *Tom/Alex* > parks downtown	< *Tom/Alex* > writes in a study
< *Tom/Alex* > is married	< *Tom/Alex* > rented a snowboard
< *Tom/Alex* > works late hours	< *Tom/Alex* > is creative
< *Tom/Alex* > played catch	< *Tom/Alex* > went skiing
< *Tom/Alex* > went to law school	< *Tom/Alex* > has an English degree

Thematic group: List 1 materials

Character 1	Character 2
< *Tom/Alex* > has two kids	< *Tom/Alex* > visited Colorado
< *Tom/Alex* > makes an opening statement	< *Tom/Alex* > loves to type
< *Tom/Alex* > went to a family restaurant	< *Tom/Alex* > used a ski lift

Random group: List 1 materials

Character 1	Character 2
< *Tom/Alex* > took his medicine	< *Tom/Alex* > ate a sandwich
< *Tom/Alex* > watched television	< *Tom/Alex* > watered his garden
< *Tom/Alex* > listens to music	< *Tom/Alex* > did his laundry
< *Tom/Alex* > had a birthday party	< *Tom/Alex* > rented a car
< *Tom/Alex* > jogs every morning	< *Tom/Alex* > bought shoes
< *Tom/Alex* > flew a kite	< *Tom/Alex* > brushed his teeth
< *Tom/Alex* > watched a movie	< *Tom/Alex* > refueled his car
< *Tom/Alex* > ate breakfast	< *Tom/Alex* > went to a concert

List 2 materials

Joe sentences

Joe went online	Joe played video games
Joe rode a horse	Joe visited his family
Joe sat on the couch	Joe drew a picture
Joe planted a tree	Joe made an appointment
Joe played tennis	Joe woke up late
Joe went swimming	Joe brushed his hair
Joe took out the trash	Joe completed a puzzle

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