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Two experiments employed a combination of item method and list method directed forgetting methodologies (Bjork, LaBerge, & Legrand, 1968). Participants studied two lists of items, half of which were subsequently cued to-be-forgotten (TBF) or to-be-remembered (TBR). After the first study list, half of the participants were told to forget the entire list, whereas the remaining participants were told to remember it for a later test (e.g., list-method). The list-method forgetting instruction impaired recall of List 1 TBF and TBR items to the same extent. However, it enhanced recall of List 2 TBR items, but not TBF items. These results were found only among participants who reported engaging in effortful forgetting, whereas participants who reported doing nothing showed no effects of list-method directed forgetting. In Experiment 2, along with receiving a mid-list forget instruction, participants were given specific types of forgetting strategies that were most frequently reported in Experiment 1. The results showed that some strategies produced greater forgetting of List 1 items than others. Taken together, these findings highlight the role of effort required to achieve intentional forgetting. Implications for directed forgetting theories are discussed.

INDIVIDUAL DIFFERENCES IN FORGETTING STRATEGIES

by

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CHAPTER I

INTRODUCTION

Forgetting is often viewed strictly as a memory flaw. Many times this is the case – important information often escapes us right when we need it most. However, consider a situation where you accidentally write the zip code of a *previous* residence on the return address portion of the envelope. This is a case where your memory for outdated information mistakenly perseveres. Being able to forget the old zip code in favor of your new, relevant zip code is a very beneficial cognitive process. Bjork (1989) described this form of forgetting as the updating of memory, implying that forgetting could play a functional role. In the laboratory, this form of forgetting has been studied using the directed forgetting procedure, invented by Bjork, LeBerge, and LeGrande (1968). There are two primary directed forgetting methods: the item method and the list method. In the item method, participants study a list of items. After each item, they are cued to either forget that particular item or to remember it for a later test. Typical results show that memory for the to-be-forgotten items is impaired compared to that of to-be-remembered items (see MacLeod, 1998, for a review). Participants in the list-method procedure study a list of items and are either told that all of those words were just for practice and that they can forget them, or that they should be remembered for a later test. Then, all participants study a second list. Therefore, in the list method, the cue to forget or remember appears only once: between List 1 and List 2 presentation. Participants instructed to forget List 1 items show poorer recall for those items than do participants

instructed to remember List 1 items – an effect known as the *costs* of directed forgetting. Additionally, List 2 recall is better for forget than for remember participants – an effect known as the *benefits* of directed forgetting (see MacLeod, 1998, for a review of the relevant findings).

Directed Forgetting Mechanisms

Forgetting that occurs in the item method of directed forgetting is thought to be due to encoding processes (e.g., Woodward & Bjork, 1971; Woodward, Bjork, & Jongeward, 1973). It is believed that participants begin rehearsing all items. Participants continue to rehearse items that are cued to-be-remembered, whereas they stop rehearsal for items that are cued to-be-forgotten. Therefore, due to insufficient rehearsal, the to-be-forgotten items are not encoded into long-term memory to the same extent as to-be-remembered items. This process results in a lower recall (Bjork & Woodward, 1973) and recognition (Woodward, Bjork, & Jongeward, 1973) for the to-be-forgotten items compared to the to-be-remembered items. Recently, Taylor (2005) combined an inhibition of return (IOR) paradigm with the item-method directed forgetting procedure. Inhibition of return is the tendency for participant to inhibit the orienting of attention to locations that were just attended (Posner, Rafal, Choate, & Vaughan, 1985). Taylor (2005) found that participants took longer to respond to targets located in the same peripheral location as preceding TBF items compared to when the targets were in different locations. There was no response time difference, however, between the same and different locations when the preceding item was cued to-be-remembered. Taylor (2005) interpreted these results by invoking an inhibitory explanation, suggesting that

forgetting in the item-method procedure is due to an inhibitory process that acts on the spatial representation of the item.

There have been several proposed mechanisms for the directed forgetting effect using the list-method procedure. These mechanisms fall into one of two categories: single-process and dual-process accounts. Single-process accounts attribute both the costs and benefits of directed forgetting to one mechanism, whereas dual-process accounts posit separate mechanisms for the costs and benefits.

One of the single-process accounts is the set differentiation and selective rehearsal theory first proposed by Bjork (1970). Bjork argued that upon receiving the forget instructions, participants segregate the forget and remember items in memory and rehearse only the remember items. In contrast, participants receiving the remember instructions do not segregate the list and continue to rehearse all of the List 1 items in addition to List 2 items. Because forget group participants stop rehearsing List 1 items, the memory for these items is poor (leading to the costs). However, the forget group shows higher recall for List 2 items compared to the remember group because they rehearse only a single list. In contrast, the remember group has twice as many items to rehearse and therefore List 2 recall suffers.

A study by Geiselman, Bjork, and Fishman (1983) demonstrated that selective rehearsal, however, is not sufficient enough to explain their data. In their experiment, participants were presented with words in a list. Half of the items were to be studied for a later test and the other half judged for pleasantness. Participants were told that the task of judging the pleasantness of these items was for another study and that they would not

be tested on these items. The aim was to mix intentionally learned items with incidentally encoded items on the same list. The results showed that participants in the forget condition had impaired memory for both the intentionally learned items and the incidentally learned items. If participants respond to the forget instruction by terminating the rehearsal process, memory for the incidental items should not have declined because there was no reason participants should be rehearsing these items. This finding prompted researchers to propose the retrieval inhibition mechanism, which operates at the retrieval stage and inhibits or reduces access to List 1 items (Geiselman et al., 1983; Bjork, 1989). Retrieval inhibition is also a single-process account because it explains the costs and the benefits by invoking an inhibitory process. According to this account, directed forgetting benefits arise because of a reduced level of proactive interference in the forget group (Bjork, 1970). That is, inhibited List 1 items do not interfere with list 2 items producing an elevated list 2 recall in the forget group compared to the remember group. Despite impaired recall of List 1, recognition memory for List 1 items remains intact (Bjork, 1972; Bjork & Bjork, 1996; Geiselman, et al, 1983; Sahakyan & Delaney, 2005) suggesting that List 1 items are available in memory at full strength but are just inaccessible for free recall.

Recently, Sahakyan and Kelley (2002) proposed the context change account of directed forgetting. Past research on context and memory has shown that participants encode both item information and context information. Context information consists of the physical environment in which the participant learns the information, was well as mood, physiological and mental states of the participant. Research has shown that people

use context cues to initiate recall (Gillund & Shiffrin, 1984), and that when context cues change between study and test, recall suffers (Smith & Vela, 2001). Sahakyan and Kelley hypothesized that the forget instruction in the list method of directed forgetting produces a change in the participant's mental context. According to this view, there should be a mismatch between the testing context and the List 1 encoding context for the forget group. The remember group, however, should not have changed their mental context and should therefore have the same contextual cues available at retrieval as for List 1. Consistent with this hypothesis, Sahakyan and Kelley (2002) obtained costs and benefits by instructing remember participants to imagine the inside of their parents' house or to imagine that they are invisible. This "mental change of context" instruction appeared after List 1 presentation and produced an equivalent amount of List 1 costs and List 2 benefits to that of the forget participants. Sahakyan and Kelley (2002) argued that the costs were due to the contextual mismatch between List 1 learning and retrieval, and the benefits occurred because of the reduction in proactive interference arising from the changes in mental context between the lists. Because the context change is responsible for producing both the costs and the benefits, Sahakyan and Kelley's (2002) context change hypothesis is also a single-process account of directed forgetting.

Despite the parsimonious nature and experimental support of single-process accounts, there have been many studies showing costs without benefits (e.g., Conway, Harries, Noyes, Racsma'ny, & Frankish, 2000; Sahakyan & Delaney, 2003) and benefits without costs (e.g., Macrae, Bodenhausen, Milne, & Ford, 1997). In fact, some researchers have suggested that the costs and benefits arise from two different processes

(e.g., Sahakyan & Delaney, 2005). It has been shown that forget and remember participants use different strategies to encode List 1 compared to List 2 (Sahakyan & Delaney, 2003). Sahakyan and Delaney (2003) analyzed the retrospectively reported encoding strategies of participants in prior directed forgetting experiments and found that a larger percentage of forget participants, compared to remember participants, tended to switch encoding strategies from shallow strategies for List 1 to deeper strategies for List 2 – a process that should produce enhanced List 2 memory for the forget group. Based on these analyses, Sahakyan and Delaney (2003) proposed the hypothesis that strategy change between the lists is responsible for the benefits of directed forgetting. In one of their experiments, they instructed participants to study both lists using the same encoding strategy on each list. Half of the participants were instructed to use a shallow strategy (i.e., rote rehearsal), whereas the other half were instructed to use a deep strategy (i.e., form a story). This manipulation prevented participants from spontaneously switching encoding strategies between lists. Results showed that neither group accrued benefits, despite significant forgetting of List 1. In another study, Sahakyan and Delaney (2003) asked all participants to change encoding strategies between the lists (from shallow strategy on List 1 to deep strategy on List 2), and found that despite significant costs there were no relative benefits for the forget group because the remember group also benefited from better study strategy on List 2. Based on these findings and several other dissociations between the costs and the benefits, Sahakyan and Delaney (2005) argued for the dual-process account of directed forgetting. They argued for the context-based

explanation of directed forgetting costs, and the strategy-based explanation for the benefits of directed forgetting.

CHAPTER II

EXPERIMENT 1

The proposed mechanisms of directed forgetting imply that different forgetting strategies may be recruited in response to the forget cue. For example, the selective rehearsal account (Bjork, 1970) implies that forgetting may be accomplished by stopping the rehearsal process. On the other hand, participants might engage in a diversionary thought between the lists in order to distract themselves from remembering List 1 items. This is the hypothesized mechanism behind the context change account of Sahakyan and Kelley (2002). Finally, participants might use a strategy that actively inhibits or pushes List 1 items out of awareness, as implied by the retrieval inhibition account of directed forgetting (Bjork, 1989).

The purpose of the Experiment 1 was two-fold. The first goal was to obtain a distribution of forgetting strategies that participants use to forget List 1 items. After the recall phase, I asked forget group participants to report what they did in order to forget List 1 items. Different forgetting strategies might lead to different degrees of list-method directed forgetting, which could be informative in evaluating the underlying mechanisms of the list-method directed forgetting phenomenon.

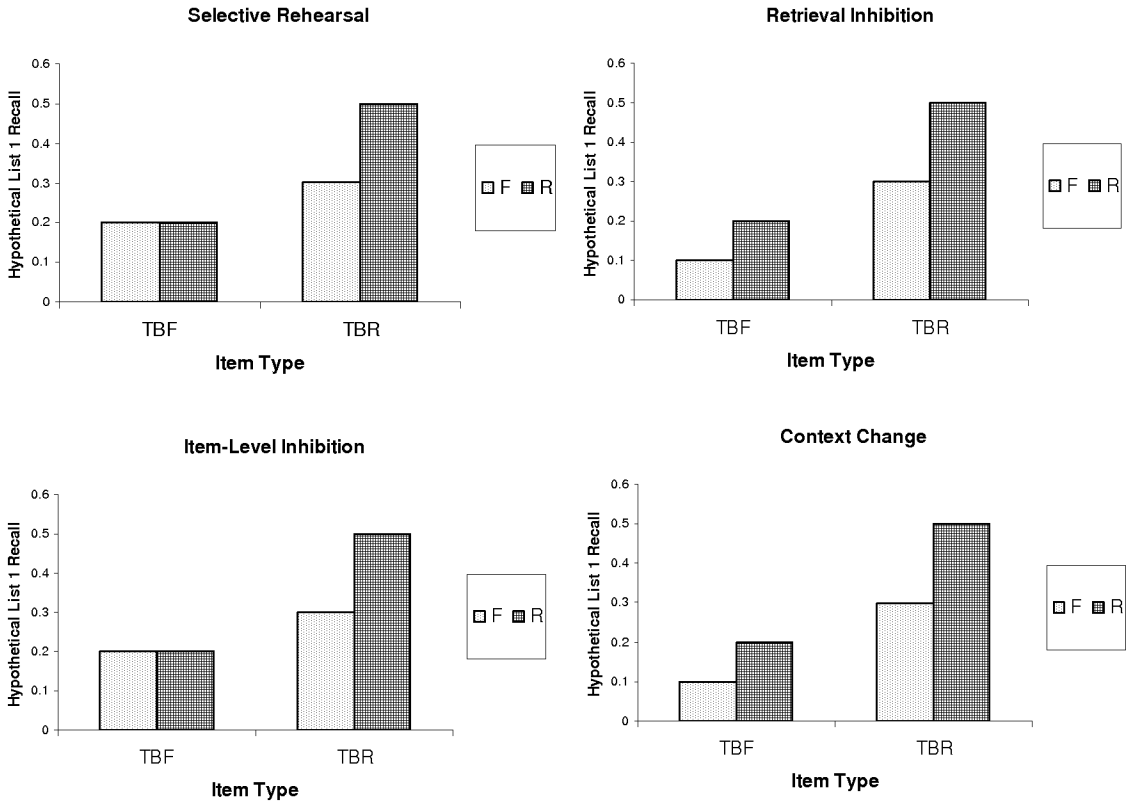
The second goal of Experiment 1 was to test the existing theories of list-method directed forgetting by combining a list-method directed forgetting manipulation with an item method forgetting manipulation embedded within each list. Thus, there were two types of items intermixed on each study list – items that were cued to-be-remembered

(TBR) or to-be-forgotten (TBF), signaled via change in the font color. This was done in order to vary the amount of rehearsal that each item receives. To-be-remembered items should be rehearsed more than TBF items (but see Taylor (2005). Importantly, deliberate forgetting by the way of terminating rehearsal should lead to significant list method directed forgetting only on items that were being rehearsed (i.e., TBR items within each list), but should not produce forgetting of items that were not rehearsed (i.e., TBF items within each list). In other words, if selective rehearsal is the underlying mechanism of list-method directed forgetting, then we would expect to find directed forgetting costs and benefits on TBR items, but not on TBF items.

On the other hand, if the context change is the mechanism of directed forgetting, the between-list forget cue should impair recall of TBR and TBF items within List 1 to the same extent. Because participants encode equivalent amount of contextual information when they initially encode the items (e.g., Malmberg & Shiffrin, 2005), any shift in mental context should impair recall of TBF and TBR items to the same extent because it should render the context cues of List 1 inaccessible. The retrieval inhibition theory makes the same prediction as the context account if we assume that inhibition is targeted at the representation of entire list rather than individual items (e.g., Bjork, 1989; Bjork & Bjork, 1996). In other words, the between-list forget cue should equally impair recall of TBR and TBF items within that list. However, alternative interpretations of inhibition account were also made, which propose that inhibition is invoked at the item level in order to overcome interference (e.g., Conway & Fthenaki, 2003). According to this position, there should be greater list-method directed forgetting of TBR items than

TBF items, because the former are more likely to interfere with List 2 items than TBF items, and hence should be more inhibited. Figure 1 summarizes theoretical predictions of different directed forgetting theories.

Figure 1: Theoretical predictions of directed forgetting theories



CHAPTER III

EXPERIMENT 1 METHODS

Participants

One-hundred twelve undergraduate psychology students at the University of North Carolina at Greensboro participated to fulfill course credit. Participants were tested individually and each session took approximately 20 minutes.

Design

The study was a 2 (Orienting Task: animacy judgment vs. pleasantness judgment) x 2 (Within-list Item Type: TBF vs. TBR) x 2 (Between-list Cue: implied forget vs. implied remember) mixed-factorial design. Orienting Task was varied between-subjects and involved making either animacy or pleasantness judgments on all items during encoding. Within-list Item Type was varied within-subjects and involved presenting participants with TBF or TBR items cued via change in the word color. Finally, Between-list Cue was varied between-subjects and involved instructing participants to remember or forget List 1 items by way of an implied remember/forget instruction (see *Procedure* section for details).

Materials

Thirty-two English nouns were organized into two lists of 16 words each. Half of the items in each list were further segregated into subgroups of eight TBR items and eight TBF items. Each item on each list served equally often as a TBR or TBF item. Word concreteness, imagibility, and number of syllables was equated across each subgroup.

The presentation order of the two lists was counterbalanced across all participants, whereas the presentation order of the words within each list was fixed.

Procedure

After giving consent, participants were told that they were going to study two lists of words, but they would only be tested on one of the lists and would not be told in advance which list would later be tested. Immediately after presentation of List 1, participants in the forget condition were told that they would not be tested on the list they just studied and would only be tested on the next list. Because the forget group was never explicitly told to forget List 1, the cue is thought to be *implicit* and will be referred to as the implicit forget cue. The purpose of the implicit forge cue was to circumvent suspicions that arose when we delivered the standard forget instruction in past experiments: that List 1 was just for practice and they should forget the List 1 words because they will not be tested on them. We were also interested in the efficacy of a more subtle forget instruction. If an implicit instruction is just as effective as an explicit one, future directed forgetting research can begin to use these subtle forget cues more regularly. The number of participants that are excluded because they are suspicious of the forget cue might be reduced as a result of implementing a more believable implicit forget cue. Participants in the remember condition on the other hand were simply told to continue studying List 2 words and that we would later tell them which list will be tested. After List 2 presentation, remember participants were informed that they would actually be tested on both lists.

Each word was presented for 4 s in black Arial font. After 4 s, the color of the word changed either to green or to red and remained on the screen for an additional 1 s. All participants were told in advance that when the word changed to green, they would need to remember it because their memory was going to be tested on it. For the words that changed to red, participants were told that they would not be tested on those words and that they could forget them. There was an additional 1 s inter-stimulus interval (ISI) separating all the words. To ensure that the participants processed each item before it changed its color into red or green, they were instructed to do one of two tasks with each item in both lists. Participants in the animacy judgment group were told to state whether the word represented something living or non-living. Participants in the pleasantness rating group were instructed to rate the pleasantness of the words on a scale from 1 (not at all pleasant) to 5 (extremely pleasant).

After participants studied both lists, they were given 90 s to recall as many words from List 1, including the TBF items from that list (i.e., red-colored items). Participants that received the implicit forget cue were encouraged to recall as many words from List 1 that they could remember, even though they were instructed earlier to forget those words. After recalling List 1 items participants were given an additional 90 s to recall List 2. Afterwards, participants receiving the implicit forget cue were asked to report the strategies they used to forget the words from List 1:

> "When you finished studying the first list and I told you that you would only have to remember the second list, what did you do, if anything, to forget the words from the first list? If you clearly remember what you did, please write that down. If you do not remember clearly, please do not make up anything at this point. If

you did not do anything in particular to forget the words, or if you specifically tried to remember them, please indicate this."

CHAPTER IV

EXPERIMENT 1 RESULTS

There was great variability in the verbal reports regarding the strategies people reported in order to forget List 1 items. Specifically, 55% of the forget group participants reported doing *something* to forget, while 41% reported doing *nothing*[1] (Table 1 shows specific strategy breakdowns of the participants that reported doing *something* to forget). It is worth noting that the percentage of forget participants who did *nothing* is much larger than in prior directed forgetting studies (e.g., Sahakyan, Delaney, & Goodmon, in press). This is probably due to the differences in the forget instructions; prior studies have used an explicit forget instructions, whereas in the current study the cue to forget was more implicit.

[1] Two of the forget participants, despite claiming that they did *something*, reported very vague strategies and were not included in the frequency analysis.

Table 1: Percentage of participants using specific forgetting strategies in Experiment 1.

Strategy	% of something participants using the strategy
Stop rehearsing words	22.6%
Stop thinking	22.6%
Focus on upcoming list/try harder	19.4%
Push words out of mind	16.1%
Clear mind	9.7%
Didn't try to remember	6.5%
Stare at screen	3.2%

I will first report analyses from the entire data set, and then report separate analyses evaluating the magnitude of directed forgetting effect for the participants that reported doing something to forget (further termed the *something* group*)* and participants reporting doing nothing to forget (termed the *nothing* group). To conclude this section, I will report the descriptive statistics for the four most frequently reported forgetting strategies.

Analyses of All Participants

To analyze the costs and the benefits of directed forgetting, I conducted separate analyses on the proportion of List 1 and List 2 recall. An item was counted towards recall regardless of whether it was recalled on the corresponding sheet of paper (that is, by ignoring source errors). In all analyses reported in this paper, I use the term Cue to denote

the between-list instruction (remember vs. implicit forget), and I use the term Item Type to denote the within-list items (TBF vs. TBR).

List 1 Costs. A mixed factorial analysis of variance (ANOVA) using Orienting Task (animacy judgment vs. pleasantness judgment), Item Type (TBF vs. TBR) and Cue (remember vs. implicit forget) was performed on the proportion List 1 recall. The results are displayed in the top portion of Table 2. There was a main effect for the Orienting Task, $F(1,108)=5.26$, $MSE= .027$, $p<.05$, with participants in the pleasantness judgment group remembering more List 1 items (.27) than in the animacy group (.21). There was also a main effect of Item Type, $F(1,108)=34.60$, $MSE= .028$, $p<.001$, indicating item-method directed forgetting effect (.31 for TBR items vs. .17 for TBF items). The main effect of the Cue was also significant, $F(1,108)=7.30$, $MSE= .027$, $p<.01$, with participants recalling fewer items (.21) with a forget instruction than remember instruction (.27). Thus, both the item-method and the list-method directed forgetting manipulations were effective. In addition to the main effects, there was a significant Item Type x Orienting Task interaction, $F(1,108)=8.80$, $MSE=.028$, $p<.01$. Follow-up analyses showed that there was a larger item-method directed forgetting effect in the animacy group (.12 for TBF and .31 for TBR, $t(55)= 6.70$, $p<.001$) than in the pleasantness group (.23 for TBF vs .30 for TBR, $t(58)= 2.11$, $p<.05$).

Table 2: Proportion of List 1 and List 2 recall by Orienting Task, Item Type, and Cue in Experiment 1. Values in parentheses represent SE.

		List 1 Costs	
Item Type	*Orienting Task*	*Between-List Cue*	
		Forget	**Remember**
TBR	**animacy**	.25 (.03)	.38 (.03)
	pleasantness	.26 (.03)	.33 (.03)
TBF	**animacy**	.10 (.03)	.13 (.03)
	pleasantness	.23 (.03)	.24 (.03)
		List 2 Benefits	
		Forget	**Remember**
TBR	**animacy**	.46 (.04)	.32 (.04)
	pleasantness	.48 (.04)	.43 (.04)
TBF	**animacy**	.21 (.03)	.22 (.03)
	pleasantness	.28 (.03)	.32 (.03)

The Item Type x Cue interaction approached but did not reach significance, $F(1,108)=2.75$, $MSE=.028$, $p=.10$. Separate analyses of TBR and TBF item recall revealed directed forgetting costs for TBR items ($t(119)= 2.73$, $p<.01$), but not for TBF items ($t<1$). Neither the Orienting Task x Cue nor the 3-way interactions were significant, Fs < 1.

List 2 Benefits. The above reported analyses were performed also on List 2 recall, and the results are displayed in the bottom section of Table 2. There was a significant main effect of Orienting Task, $F(1,108)=10.38$, $MSE=.028$, $p<.01$, with the pleasantness

group recalling more List 2 items (.38) than the animacy group (.30). There was also a significant main effect of the Item Type, $F(1,108)=41.78$, $MSE=.036$, $p<.001$, indicating item-method directed forgetting effect (.42 for TBR items vs. .26 for TBF items). There was no main effect of Cue, $F(1,108)=2.28$, $MSE=.028$, $p=.13$. However, there was a significant Item Type x Cue interaction, $F(1,108)=5.30$, $MSE=.036$, $p< .05$. Follow-up tests showed that the directed forgetting benefits were observed for TBR items (.47 for the forget vs. .38 for remember, $t(110)=2.38$, $p<.05$), but not for TBF items (.25 for the forget vs .27 for the remember group, $t < 1$). Thus, participants that received an implicit forget instruction had better memory for List 2 items compared to remember participants, but this was true only for the TBR items. None of the remaining interactions were significant, Fs<1.

To summarize, the cue to forget produced impaired recall of List 1 items and an enhanced recall of List 2 items – that is, significant directed forgetting costs and benefits were obtained. These effects, however, depended on the item type. For the TBF items, there were neither costs nor benefits, whereas for the TBR items both effects were significant.

Analyses Comparing Something and Nothing Groups

As stated earlier, some of the forget group participants reported doing something to forget List 1 items, whereas others reported doing nothing. In this section, I compare the magnitude of list-method directed forgetting across *something* and *nothing* groups to evaluate whether the size of the effect varied as a function of deliberate effort to forget.

If directed forgetting requires effort, the forget-something group should show significant costs whereas the forget-nothing group should not.

List 1 Costs. A mixed ANOVA on List 1 recall was performed, using Orienting Task (animacy vs. pleasantness) x Item Type (TBR vs. TBF) x Group (remember vs. forget-nothing vs. forget-something). The results are displayed in the top portion of Table 3.

Table 3: Proportion of List 1 and List 2 recall by Orienting Task, Item Type, and Group in Experiment 1. Values in parentheses represent SE.

List 1 Costs

		Group		
Item Type	*Orienting Task*	**F-Something**	**F-Nothing**	**Remember**
TBR	**animacy**	.26 (.04)	.24 (.05)	.38 (.03)
	pleasantness	.28 (.03)	.24 (.05)	.33 (.03)
TBF	**animacy**	.06 (.04)	.15 (.05)	.13 (.03)
	pleasantness	.18 (.03)	.30 (.05)	.24 (.03)

List 2 Benefits

		Group		
Item Type	*Orienting Task*	**F-Something**	**F-Nothing**	**Remember**
TBR	**animacy**	.50 (.05)	.40 (.06)	.32 (.04)
	pleasantness	.50 (.05)	.46 (.06)	.43 (.04)
TBF	**animacy**	.20 (.04)	.23 (.04)	.23 (.03)
	pleasantness	.24 (.04)	.33 (.04)	.32 (.03)

The results for the Item Type variable and the Orienting Task variable were the same as found in the overall analysis of all participants. Importantly, there was a Group x Item type interaction, $F(2,106)=3.44$, $MSE = .027$, $p<.05$. To follow-up this interaction, I conducted separate ANOVAs on TBF and TBR item recall, using Group as the between-subjects factor.

There were significant differences in recall of TBR items among the three groups, ($F(2,109)=4.31$, $MSE=.031$, $p<.05$), with remember group recalling more (.35) than either the forget-something group (.27), $t(87)=2.19$, $p<.05$, or the forget-nothing group (.24), $t(77)=2.65$, $p<.05$. In other words, there were significant directed forgetting costs for TBR items in both the forget-nothing and the forget-something conditions. The difference between the two forget groups was not significant, $t < 1$.

There were marginally significant group differences in the recall of TBF items, $F(2,109)=2.56$, $MSE=.025$, $p=.08$. There was no difference between the forget-nothing group (.22) and the remember group (.19), $t<1$, implying no directed forgetting costs. However, the difference between the forget-something (.13) and remember group approached significance, $t(87)=1.92$, $p=.06$, implying a trend towards the directed forgetting costs. The forget-something group also had significantly lower recall than the forget-nothing group, $t(54)=2.0$, $p=.05$.

List 2 Benefits. A mixed ANOVA on List 2 recall was performed, using Orienting Task (animacy vs. pleasantness) x Item Type (TBR vs. TBF) x Group (remember vs. forget-nothing vs. forget-something). The results are displayed in the

bottom portion of Table 3. There was a main effect of Orienting Task, $F(1,106)=7.54$, $MSE=.028$, $p<.01$, as well as a main effect of Item Type ($F(1,106)=42.52$, $MSE=.035$, $p<.001$). Although there was no main effect of Group ($F(2,106)=1.19$, $p=.31$) there was a significant Group x Item Type interaction, $F(2,106)=4.24$, MSE=.035, $p<.05$. Neither the Orienting Task x Item Type nor the 3-way interactions were significant (both Fs<1). To follow up the Group x Item Type interaction, separate factorial ANOVAs were conducted for the TBF and TBR items with Group as the between-subjects factor.

For TBF item recall, there was no differences between the groups ($F<1$), implying no directed forgetting benefits. There were, however, significant differences between the groups for the TBR item recall, $F(2,106)=3.78$, $MSE=.041$, $p<.05$. The forget-something group (.50) recalled significantly more TBR items than did the remember group (.38), $t(87)=2.82$, $p<.01$, implying the directed forgetting benefits. There was no difference between the forget-nothing group (.43) and the remember group, $t<1$, implying no directed forgetting benefits. There was also no difference between the two forget groups, $t(54)=1.26$, $p=.21$.

Summary. Participants who reported doing *something* to forget List 1 items showed directed forgetting costs for both TBR and TBF items. In addition, they showed significant benefits for TBR items, but not TBF items.

Participants who report doing *nothing* to forget showed impaired recall of List 1 TBR items, but no directed forgetting benefits for either the TBF or TBR items. Lower recall of List 1 TBR items in the forget-nothing group (compared to the remember group) is less likely to be a true instance of directed forgetting, but rather reflects the inability to

maintain TBR items in memory. Two findings provide support this hypothesis. First, there is no item-method directed forgetting effect in the forget-nothing group (TBR=.24 vs. TBF=.22, $t<1$). Because item-method directed forgetting is attributed to processes that take place during encoding, the lack of difference between the recall of TBR and TBF items suggests that participants in the forget-nothing group were not putting effort into maintaining TBR items in memory. In contrast, the item-method directed forgetting effect was significant in the forget-something group (TBR=.27 vs. TBF=.13, $t(32)=3.73$, $p<.01$) and in the remember group (TBR=.35 vs. TBF=.19, $t(22) = 5.47$, $p<.001$). Second, and most importantly, the recall of TBR items in the forget-nothing group (.24) is not significantly different from the TBF item recall in the remember group (.19), $t(77)=1.36$, $p=.18$. Thus, the forget-nothing group remembers as much from the TBR items as the remember group does from the TBF items, which they are attempting to forget (presumably by stopping rehearsal). In other words, the forget-nothing group is not putting any effort to maintain the TBR items, which they were told to remember. Overall, it is unlikely that the forget-nothing group is selectively forgetting TBR, but not TBF items. The more likely interpretation is that the forget-nothing group is doing nothing to forget the TBF items, and in addition is doing nothing to remember the TBR items. That is, the forget-nothing group is not encoding TBR items to their full extent. Overall, the forget-nothing group showed no list-method directed forgetting – neither the costs, nor the benefits were significant for either item type.

Recall as a Function of Different Forgetting Strategies

The analyses of the forget-something and the forget-nothing groups suggests that deliberate effort is required to observe the list-method directed forgetting effect. Without effortful process, neither the costs, nor the benefits are apparent. In the next step, I split the forget-something group further into different subgroups based on the participants' reported strategies to evaluate the recall for each subgroup. I only report the four most frequently used and the most theoretically relevant strategies – *stop rehearsing words, stop thinking, focus on upcoming list / try harder,* and *push words out of mind* (see Table 1).

Recall as a function of forgetting strategies is displayed in Figure 2 (for List 1 recall) and in Figure 3 (for List 2 recall). Although no statistical analyses were performed on these data due to limited number of observations, on a descriptive level, the results suggest that some forgetting strategies are more effective than others, and that the magnitude of directed forgetting varied based on the strategy used to forget List 1. Therefore, in the next experiment, I experimentally controlled the forgetting strategies indicated in the retrospective verbal reports in order to see which strategy is the most effective and also to see how each strategy affects TBR and TBF recall.

Figure 2: List 1 Recall as a function of forgetting strategy

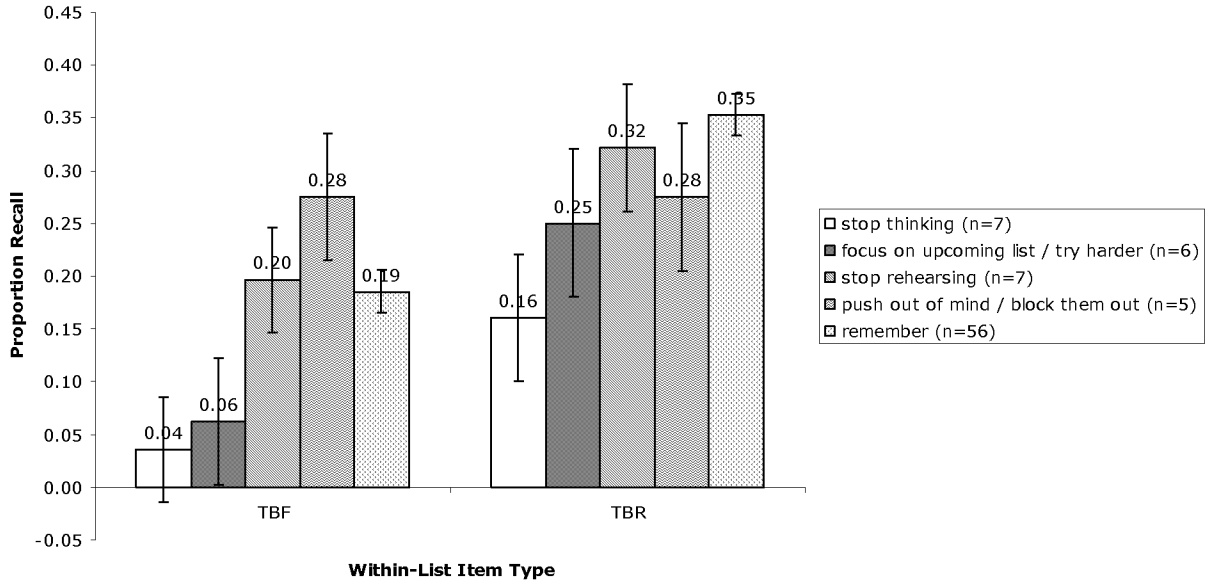
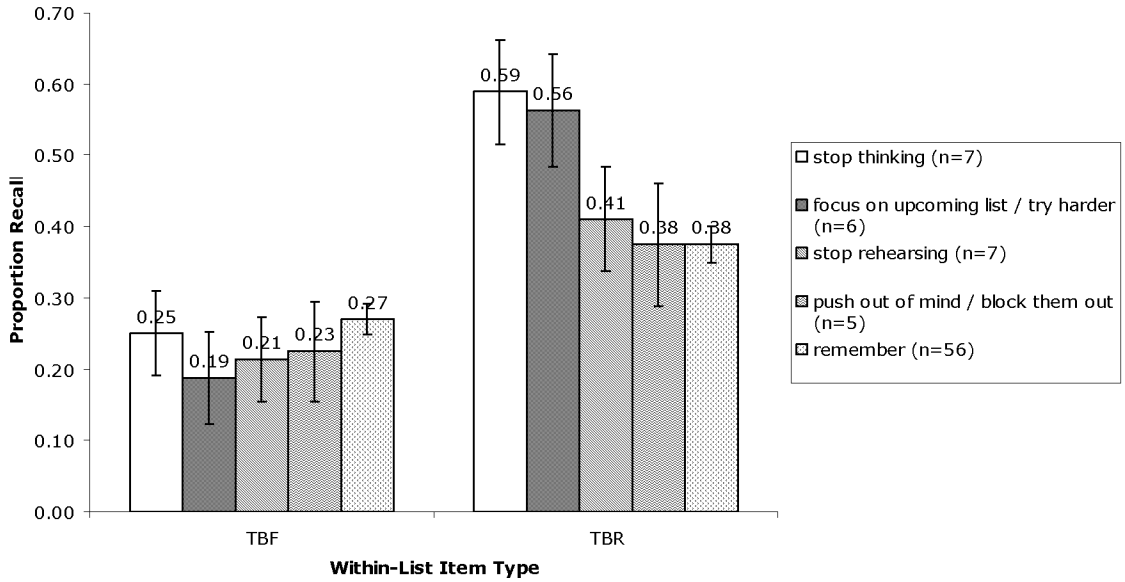


Figure 3: List 2 Recall as a function of forgetting strategy



CHAPTER V

EXPERIMENT 2

The most frequently reported forgetting strategies from Experiment 1 are strikingly similar to the mechanisms proposed by the theories of directed forgetting: the *stop rehearsing* and *push words out of mind* strategies mirror the selective rehearsal and the inhibition processes respectively. The *focus on upcoming list / try harder* and the *stop thinking*, on the other hand, are strategies thought to reflect underlying context change processes. Because the *stop rehearsing*, *stop thinking, focus on upcoming list / try harder,* and *push words out of mind* strategies are the most theoretically relevant and the most frequently reported strategies, participants were randomly assigned to these groups and were instructed to use one of these pre-specified strategies in efforts to forget List 1. In addition, the item-method directed forgetting manipulation was embedded within each list akin to Experiment 1.

The *stop thinking* strategy provided by participants in Experiment 1 was replaced with a *diversionary thought* strategy in Experiment 2 (see *Procedures*). This was done because it is unclear whether *stop thinking* means that the participant stopped rehearsing the items, or whether they stopped thinking about the list in general and distracted themselves with an unrelated thought while waiting for List 2 presentation to begin. The former hypothesis seems unlikely because the *stop thinking* group in Experiment 1 forgot both TBF and TBR items (see Figure 2), and this is unlikely to be the case if participants terminated rehearsal, which should affect only TBR items. Because in the

current experiment, we included a terminate-rehearsal condition, I chose to convert the *stop thinking* strategy to a *diversionary thought* strategy, which would allow evaluating the consequences of engaging in distracting thoughts for recall of TBR and TBF items. According to the context-change account, both item types should suffer if participants distract themselves with thoughts unrelated to the experiment.

CHAPTER VI

EXPERIMENT 2 METHODS

Participants

One-hundred and forty-five University of North Carolina at Greensboro psychology students participated in the experiment. Participants were randomly assigned to one of five conditions: forget-terminate rehearsal (F-T; n = 28), forget-diversionary thought (F-DT; n = 29), forget-focus on upcoming list / try harder (F-UL; n = 29), forget-push words out of mind (F-PW; n = 29), and remember (R; n = 30).

Procedure

The procedure were same as Experiment 1 with a few critical differences. First, all participants made living / non-living judgments on the list items. Second, participants in the forget condition were split into four groups: *stop rehearsal*, *diversionary thinking, focus on upcoming list*, and *push words out of mind*. Each group received a different forget instruction. Participants in the *stop rehearsing* group were told the following:

> "In order to forget the words from List 1, I want you to stop repeating them to yourself and that is all. Do not do anything else. Just stop repeating the words to yourself."

Participants in the *diversionary thinking* group were told the following:

> "In order to forget the words from List, I want you to stop thinking of these words and think of something else instead. Please try to think of something other than the List 1 words."

Participants in the *focus on upcoming list* group were told the following:

> "In order to forget the words from List 1, I want you to focus on the list that you are about to study and to put more effort into it. Do not do anything else to forget. Just think about studying the next list and focus more on it."

Participants in the *push words out of mind* group were told the following:

> "In order to forget the words from List 1, I want you to push the words out of your mind. Do not do anything else to forget. Just push the words out of your mind and do not let them enter your consciousness."

Participants in the remember group were told the following:

> "That was the first half of the list. Please remember those words because you will be tested on them."

After the recall phase, participants in the four forget groups were asked to provide retrospective verbal reports of the strategies that they used to forget List 1 items. This allowed us to verify if participants followed our forget strategy instruction.

Materials

Because participants were told to make living / non-living judgments on the words, the new items were chosen such that half of the items described living things, and the remaining half were non-living.

CHAPTER VII

EXPERIMENT 2 RESULTS

Although participants were specifically instructed on how to forget List 1 items, some participants did not follow the instructions and instead engaged in different strategies. Table 4 shows the percentage of participants in each of the forget groups that either followed the instructions, did something else to forget, did nothing to forget, or provided an unclear response according to their retrospective verbal reports.

Table 4: Percentage of participants who reported following instructions, doing something else to forget, doing nothing to forget, or provided an unclear response in Experiment 2.

Between-list Cue	Followed instructions	Did something else to forget	Did nothing to forget	unclear
F-T (28)	50% (n=14)	43% (n=12)	4% (n=1)	4% (n=1)
F-DT (29)	62% (n=19)	21% (n=6)	10% (n=3)	3% (n=1)
F-UL (29)	66% (n=19)	17% (n=5)	10% (n=3)	7% (n=2)
F-PW (29)	66% (n=19)	24% (n=7)	7% (n=2)	3% (n=1)

Overall, across all forget groups, 21% of participants reported doing something else to forget and 6% reported doing nothing to forget. I will first analyze List 1 and List 2 recall for the participants who followed the instructions (further termed the *compliant* group). The same analysis will be performed on participants categorized into groups

according to what they reported doing in order to forget List 1 rather than what they were told to do. Finally, to allow cross-experimental comparisons, analyses will be performed on the participants who reported doing *nothing* to forget.

Compliant Group Analysis

Participants included in this analysis are those who reported following the forget instructions assigned to them. The costs and the benefits of directed forgetting were analyzed by evaluating the proportion of List 1 and List 2 recall. An item was counted towards recall regardless of whether it was recalled on the corresponding sheet of paper (that is, by ignoring source errors).

List 1 Costs. A mixed ANOVA on the proportion of List 1 recall was performed, using Item Type (TBF vs. TBR) and Cue (F-T vs. F-DT vs. F-UL vs. F-PW vs. Remember) as the factors. The results are summarized in Table 5. There was a significant main effect of Item Type, $F(1,96)=42.10$, $MSE=.024$, $p<.001$, with higher recall of TBR items (.30) than TBF items (.15). Neither the main effect of Cue nor the Item Type x Cue interaction reached significance, $F(4,96)=1.54$, $MSE=.030$, $p=.20$, and $F(4,96)=1.44$, $MSE=.024$, $p=.23$, respectively. Although the interaction was not significant, I separately examined TBF and TBR recall as a function of Cue using one-way ANOVAs. There was no significant effect of Cue on the TBF item recall ($F<1$), and a marginally significant effect on the TBR item recall, $F(4,96)=1.96$, $MSE=.033$, $p=.11$. Planned comparisons showed that the F-UL and the F-PW groups remembered fewer TBR items than did the remember group, $t(47)=2.18$, $p<.05$, and $t(47)=2.10$, $p<.05$, respectively. However, The F-UL and F-PW groups did not differ significantly from

each other, $t<1$. The F-DT and F-T groups did not differ significantly from the remember group ($ts<1$), implying no directed forgetting costs in either of these groups.

Table 5: List 1 and List 2 recall for participants who followed forgetting instructions in Experiment 2. Values listed represent proportion correct recall. The values in brackets represent p-values comparing each Forget condition with the Remember condition.

List 1 Costs		
Assigned Forgetting Strategies	*Item Type*	
	TBF	**TBR**
Remember	.18	.35
F-T	.18 [$t<1$]	.31 [$t<1$]
F-DT	.12 [$p=.19$]	.35 [$t<1$]
F-UL	.17 [$t<1$]	**.24 [$p<.05$]**
F-PW	.13 [$t<1$]	**.24 [$p<.05$]**

List 2 Benefits		
Assigned Forgetting Strategies	*Item Type*	
	TBF	**TBR**
Remember	.26	.40
F-T	.26 [$t<1$]	**.56 [$p<.01$]**
F-DT	.20 [$p=.16$]	**.64 [$p<.01$]**
F-UL	.25 [$t<1$]	.47 [$p=.19$]
F-PW	.25 [$t<1$]	**.56 [$p<.01$]**

List 2 Benefits. List 2 was analyzed the same way as List 1 (see Table 5, bottom section). There was a significant main effect for Item Type, $F(1,96)=113.45$, $MSE=.033$, $p<.001$, signifying item-method directed forgetting (.53 for TBR vs. .24 for TBF). There was also a significant main effect of Cue ($F(4,96)=2.60$, $MSE=.027$, $p<.05$), which was qualified by a significant Item Type x Cue interaction, $F(4,96)=4.57$, $MSE=.033$, $p<.01$. To follow-up the interaction, one-way ANOVAs were performed on List 2 TBF and TBR item recall. There were no differences between the groups in the recall of TBF items ($F<1$), but there were significant differences between the groups in the recall of TBR items, $F(4,96)=5.6$, $MSE=.037$, $p<.001$. Specifically, the remember group recalled fewer TBR items than did the F-T group ($t(42)=2.92$, $p<.01$), the F-DT group ($t(47)=4.21$, $p<.001$), and the F-PW group ($t(47)=2.8$, $p<.01$). In order to see which group benefited the most, List 2 TBR recall for the F-T, F-DT, and F-PW were further compared. None of the forget groups differed significantly from each other (for F-T vs. F-DT, $t(31)=1.13$, $p=.27$; for F-T vs. F-PW, $t<1$; for F-DT vs. F-PW , $t(36)=1.13$, $p=.27$).

Overall, there was significant item-method directed forgetting effect for both List 1 and List 2 items. Separate analyses of TBF and TBR items showed no directed forgetting costs for TBF items for any of the forget groups; however, participants instructed to push the words out of mind or to focus on the upcoming list showed the costs for the TBR items. Directed forgetting benefits occurred only for the F-T, F-DT, and F-PW groups but only in the recall of TBR items. There were no benefits for the TBF items in either of these groups.

Reported Forgetting Strategy Group Analysis

In the next set of analyses, participants were categorized into forget groups according to the strategy they reported using in order to forget, rather than according to what they were told to use. This was done because a large percentage of participants in each of the assigned strategy groups did not follow the instructions and engaged in different forgetting strategies according to their post-experimental verbal reports. Thus, if participants in the F-DT group reported stopping rehearsal as their forgetting strategy (rather than engaging in diversionary thought), then they were combined along with the F-T group's compliant participants, who reported terminating rehearsal. Table 6 shows the percentage of participants by the actual forgetting strategy used. Participants who reported thinking of a distracting thought in order to forget but did not include the specific distracting thought in their verbal reports were labeled *think of a distracting thought (unspecified).* Some participants said they had thoughts involving things or ideas outside of the laboratory (e.g., thought about purchasing a camera, thought about penguins), whereas others thought of things located in the laboratory room (e.g., stared at the color of the computer screen, thought about the advertisement on their pen). These two groups were labeled *think of a distracting thought (OUTSIDE)* and *think of a distracting thought (INSIDE)*, respectively. This distinction was made because I hypothesized that distracting thoughts of things located outside of the experimental context will more likely lead to a change of context than thoughts of things inside. Research has shown that participant who think of events located further back in time

experience more context change compared to when the events are more recent (Kelley, Zimmerman, Delaney, & Sahakyan, 2007). If the same idea applies to physical distance, then the *think of a distracting thought (OUTSIDE)* group should show more forgetting than the *INSIDE* group. Furthermore, objects in the experimental context can easily reinstate the context at the time of test because they are in the same environment both during encoding and during retrieval. Reinstatement of context at the time of test was shown to reduce directed forgetting effect (Sahakyan & Kelley, 2002).

Table 6: Percentage of participants using specific forgetting strategies in Experiment 2.

strategy	Actual Strategy N	Actual Strategy %
Terminate rehearsal (F-T)	23	23%
Think of a distracting thought, unspecified (F-DT)	16	16%
Think of a distracting thought OUTSIDE of the room	7	7%
Think of a distracting thought INSIDE the room	10	10%
Try harder on List 2 (F-UL)	20	20%
Push words out of mind (F-PW)	22	22%
Praying	2	2 %

List 1 Costs: A mixed factorial ANOVAs using Item Type (TBF vs. TBR) and Group was performed on proportion of List 1 recall. Due to the small sample size, data from the *praying* group was not included in the Group variable; the remaining six forget

groups and the remember group were included in the Group variable. Table 7 shows the average List 1 recall for each group. A significant main effect of Item Type was observed, $F(1,121)=51.15$, $MSE=.024$, $p<.001$. There was neither a main effect of Group, $F(6,121)=1.26$, $MSE=.027$, $p=.28$, nor an Item Type x Group interaction, $F(6,121)=1.07$, $MSE=.024$, $p=.39$. Separate one-way ANOVAs performed on each item type confirmed no effect of Group on TBF item recall ($F<1$) or the TBR item recall, $F(6,121)=1.42$, $MSE=.031$, $p=.21$. Finally, I chose to evaluate the results using planned comparisons contrasting the recall of each forget group with the remember group for both item types. Table 7 lists the significance values of those comparisons. None of the forget groups differed from the remember group in TBF item recall. However, the *try harder* group showed significant costs and the *push words out of mind* group showed marginally significant costs in TBR item recall.

Table 7: List 1 recall for participants who used reported forgetting strategies in Experiment 2. Values listed represent proportion correct recall. The values in brackets represent p-values comparing each Forget condition with the Remember condition.

	List 1 Costs	
Reported Forgetting Strategies	*Item Type*	
	TBF	**TBR**
Remember	.18	.35
Terminate rehearsal	.20 [t<1]	.30 [p =.29]
Think of a distracting thought (unspecified)	.16 [t<1]	.35 [t<1]
Think of a distracting thought (OUTSIDE)	.11 [p =.28]	.38 [t<1]
Think of a distracting thought (INSIDE)	.16 [t<1]	.29 [p =.32]
Try harder on List 2	.16 [t<1]	**.24 [p < .05]**
Push words out of mind	.12 [p =.17]	**.26 [p =.07]**

List 2 Benefits: The same analysis reported above was performed on proportion List 2 recall. Means are reported in Table 8. There was a significant main effect of Item Type (F(1,121)=131.04, MSE=.036, p<.001), Group, (F(6,121)=2.91, MSE=.028, p<.05), and an Item Type x Group interaction, (F(1,121)=3.07, MSE=.036, p<.01). Separate one-way ANOVAs on TBF and TBR items revealed no differences between the groups in TBF item recall (F<1), but significant differences in the TBR item recall, F(6,121)=4.32, MSE=.040, p<.01. Follow-up tests showed that compared to the remember group, all forget groups showed the benefits except for the F-UL group (see Table 8, for specific significance values of these tests).

To summarize, there were no directed forgetting costs for List 1 TBF items in any of the forget groups. However, the *try harder* and the *push words out of mind* groups

showed the costs for the TBR items. Directed forgetting benefits emerged for the *terminate rehearsal*, *think of a distracting thought (unspecified, OUTSIDE, and INSIDE)*, and the *push words out of mind* groups but only for the TBR items. There were no benefits in any group for the TBF items.

Table 8: List 2 recall for participants who used reported forgetting strategies in Experiment 2. Values listed represent proportion correct recall. The values in brackets represent p-values comparing each Forget condition with the Remember condition.

	List 2 Benefits	
Reported Forgetting Strategies	*Item Type*	
	TBF	**TBR**
Remember	.26	.40
Terminate rehearsal	.30 [t<1]	**.53 [p<.05]**
Think of a distracting thought (unspecified)	.20 [p=.21]	**.59 [p<.01]**
Think of a distracting thought (OUTSIDE)	.29 [t<1]	**.66 [p<.01]**
Think of a distracting thought (INSIDE)	.21 [t<1]	**.65 [p<.01]**
Try harder on List 2	.24 [t<1]	.45 [p =.32]
Push words out of mind	.25 [t<1]	**.59 [p<.01]**

Nothing Group Analyses

There were a number of participants (n=9) who reported doing nothing to forget. In the previous experiment, there was no list-method directed forgetting effect for these participants. Therefore, in the current experiment, List 1 and List 2 recall was analyzed for participants who did not put any effort into forgetting to evaluate if previous null findings can be replicated. The means for List 1 and List 2 recall are listed in Table 9.

List 1 Costs. A mixed ANOVA using Item Type (TBF vs. TBR) and Cue (remember vs. F-T vs. F-DT vs. F-UL vs. F-PW) was performed on the proportion of List 1 recall. There was a significant main effect of Item Type ($F(1,34)=5.82$, $MSE=.030$, $p<.05$), but no main effect of Cue, $F(4,34)=1.67$, $MSE=.020$, $p=.18$, and no Item Type x Cue interaction, $F<1$.

List 2 Benefits. The same analyses performed on List 2 recall revealed that none of the main effects or interaction were significant (Fs<1, except for Item Type, $F(1,34)=2.46$, $MSE=.030$, $p=.13$). These results confirmed that the *forget-nothing* group showed no list-method forgetting – neither the costs, nor the benefits were significant.

Table 9: List 1 and List 2 recall for participants who did nothing to forget in Experiment 2. Values listed represent proportion correct recall.

List 1 Costs		
Assigned Forgetting Strategies	*Item Type*	
	TBF	**TBR**
Remember	.18	.35
F-T	.13	.50
F-DT	.33	.38
F-UL	.21	.38
F-PW	.06	.19

List 2 Benefits		
Assigned Forgetting Strategies	*Item Type*	
	TBF	**TBR**
Remember	.26	.40
F-T	.50	.38
F-DT	.25	.42
F-UL	.21	.42
F-PW	.19	.38

CHAPTER VIII

GENERAL DISCUSSION

The primary goal of this research was to explore the type of strategies that participants naturally use when attempting to intentionally forget List 1 items. This was done because I speculated that many strategies can be directly mapped onto the theoretical underlying mechanisms of directed forgetting proposed in the literature, and therefore if participants use a certain strategy, then they should show the pattern of forgetting that is consistent with predictions made by their underlying mechanism. The second aim of this investigation was to evaluate the magnitude of directed forgetting across various strategies by experimentally controlling the strategies most frequently reported by participants in retrospective verbal reports. In the next sections, I first summarize the experimental findings across both experiments, and then I will review each theory of directed forgetting in the context of the results of the present studies.

Summary of findings

The most reliable finding replicated across Experiments 1 and 2 was that TBR items were recalled better than TBF items – that is, reliable item-method directed forgetting was observed in both studies. In terms of list-method directed forgetting, Experiment 1 and 2 participants showed costs and benefits only for TBR items but not for TBF items. There was one exception, however. In Experiment 1, when recall was compared across participants who engaged in forgetting strategies and those who did not engage in forgetting strategies, then there was an equivalent degree of forgetting for TBR

and TBF items in the forget-*something* group, but no directed forgetting in the forget-nothing group. When the *forget-nothing* group was included in the overall analysis, the costs for the TBF items were disguised, and only the costs for TBR items were evident. Benefits were observed only for the *something* group's recall of TBR items, whereas the *nothing* group showed no benefits for either item type. Thus, in Experiment 1, there was no overall list-method directed forgetting for the participants who did not attempt any forgetting strategy. In contrast, when participants put effort into forgetting, they showed equivalent forgetting of TBR and TBF items from List 1, but they showed benefits only for List 2 TBR items. For the remainder of the General Discussion, any reference to Experiment 1 directed forgetting findings will assume only the forget-something group unless otherwise specified.

In Experiment 2, participants were instructed to forget using specific strategies. Throughout all forget groups, there were no directed forgetting costs for TBF items. However, there were costs for TBR items, but only in the F-UL and the F-PW groups. These results were observed both in the *compliant* group analyses and in the *reported forgetting strategy* group analyses. The benefits emerged only in the recall of TBR items and they were present in all groups except in the *try harder* group. This was observed both in the *compliant* group analyses, and was replicated also in the *reported forgetting strategy* group analyses. There were no benefits for TBF items. The presence of benefits for TBR items but not for TBF items replicated the pattern of directed forgetting benefits observed in Experiment 1. Finally, participants who reported doing nothing in order to forget showed neither costs nor benefits in both experiments.

Theoretical Implications

Directed Forgetting and Effortful Strategies. In order to get directed forgetting costs, participants had to engage in effortful strategies. Participants who reported doing nothing to forget List 1 items showed no costs. These findings are consistent with prior research with older adults, who do not show spontaneous directed forgetting costs because they do not put any effort into forgetting (Sahakyan, Delaney, & Goodmon, in press). Older adults said they did not put effort into forgetting because the words were probably already forgotten. Younger adults may have opposite beliefs about their memory that prevent them from trying to forget. Sahakyan et al. have found that some younger adults believe once they've memorized something, they cannot forget it. Participants that report doing nothing to forget in Experiments 1 and 2 may be engaged in this type of metacognitive thinking.

These findings have important implications for other list method directed forgetting studies. It is possible that some forget subjects in the typical directed forgetting study are doing nothing to forget, thereby reducing the magnitude of the costs and benefits. In other words, without identifying the non-compliant forget group participants, researchers may be underestimating the magnitude of the directed forgetting effect. It is important to note that in Experiment 1, the cue to forget was implicit and 41% of participants reported doing nothing to forget, whereas in Sahakyan, Delaney, and Goodmon (in press) the cue to forget was explicit and the majority of participants reported using a strategy to forget. Future research should attempt to measure forget-cue compliance according to whether the cue is explicit or implicit.

Selective Rehearsal. The selective rehearsal account (Bjork, 1970) predicts that participant who were told to terminate rehearsal of List 1 items in order to forget (i.e., F-T group) should forget only TBR items. This is because only rehearsed items from List 1 (i.e., TBR items) should suffer from terminating rehearsal under the selective rehearsal account. This view attributes the benefits to the increased amount of rehearsal the forget group gives to List 2 compared to the remember group, who has to rehearse both List 1 and List 2.

Participants from Experiment 1 showed costs for both item types, and benefits for TBR items. This is inconsistent with the selective rehearsal account, which does not predict costs for TBF items. However, the forget-something group may be composed of participants who use all sorts of strategies, some of which affect both types of items. In Experiment 2, however, there were no costs for either item type in the *compliant* F-T and the *reported F-T strategy group* analyses. That is, when participants were instructed to forget by terminating their rehearsal, neither TBR nor TBF items were forgotten. The lack of costs in F-T group in Experiment 2 is also inconsistent with selective rehearsal. The F-T forgetting strategy assumes that participants are rehearsing List 1 items; if items are not being rehearsed in the first place, it is impossible to forget by terminating rehearsal. If the animacy orienting task primed participants to encode List 1 semantically, rather than by rehearsal, then the F-T strategy could not be useful. Despite the absence of costs, the F-T group showed benefits for TBR items. This is consistent with the selective rehearsal account because benefits are attributed to the forget group devoting rehearsal to List 2 items, a process that should only affect TBR items.

However, the selective rehearsal is a single-process account and does not predict the occurrence of benefits without costs. Nonetheless, the selective rehearsal account is supported partially because it handles the presence of benefits, but not the absence of costs.

Dual-Process Account. Sahakyan and Delaney (2005) proposed a dual-process account of directed forgetting which attributes the costs to a change of mental context (Sahakyan & Kelley, 2002) and the benefits to an encoding strategy change (Sahakyan & Delaney, 2003; Sahakyan & Delaney, 2005). Sahakyan and Kelley (2002) demonstrated that participants who underwent a change of mental context between List 1 and List 2 learning showed costs just like the forget participants, even though they were not instructed to forget anything. The change of context in their study consisted of engaging the participants in the generation of thoughts unrelated to the primary task of learning list items. In the present study we predicted that instructing participants to forget by thinking of a distracting thought should induce a mental context change. The consequence of such context change should be an equivalent degree of forgetting of both TBR and TBF items. This prediction is derived from formal theories of memory (e.g., Gillund & Shiffrin, 1984; Malmberg & Shiffrin, 2005; Shiffrin & Steyvers, 1997) according to which a fixed amount of context is stored during the encoding of each item. Furthermore, strengthening the items by the levels of processing manipulations or extra study time does not enhance the strength of the contextual information, but only enhances the strength of the item content, whereas spacing manipulations enhance both context strength and item content (Malmberg & Shiffrin, 2005). Indeed, Sahakyan, Delaney, and

Waldum (2008) have shown that in the list-method directed forgetting study, strengthening List 1 items via extra presentation time or by levels of processing manipulations leads to equivalent degree of directed forgetting of strong and weak items. However, strengthening items via spacing manipulations leads to larger directed forgetting for spaced items than for massed items.

Because the amount of rehearsal is the only thing that varied across the TBR and TBF items in the present experiment, these items should only differ on the amount of item content stored, whereas the amount of context information should be equal. Therefore, a change of context (presumably induced by the F-DT and F-UL instructions) should lead to equivalent forgetting of both TBF and TBR items. Benefits, under the dual-process account, result from the forget group switching from a shallow encoding strategy for List 1 to a deep encoding strategy for List 2 (Sahakyan & Delaney, 2003; Sahakyan & Delaney, 2005). This view predicts that any encoding strategy improvement should only affect TBR items because there is no reason why participants should apply their new strategy to TBF items.

The dual-factor account was partly supported in the present study. In particular, the strategy change component of the dual-factor account was overall supported by the findings of both experiments because only TBR items showed the benefits, but TBF items did not. The context change component of the dual factor found mixed support across the two experiments. In Experiment 1, there was equivalent forgetting of both TBR and TBF items, which is consistent with the context-change account. Experiment 2, however, failed to show this pattern of costs: the F-DT group showed no costs for either

item type. One explanation for the lack of costs could be that the F-DT instruction was not specific enough. Sahakyan and Kelley (2002) provided very specific instructions regarding their mental context change manipulation. In fact, looking at the verbal reports of the F-DT group shows that some participants chose to think of things *inside* the experiment room. Participants whose distracting thoughts were about the objects or events inside the experimental context may not experience as much of a mental context change because any temporary context change can be reinstated during the test by the cues in the environment. Research shows that reinstatement of context at the time of test reduces directed forgetting (Sahakyan & Kelley, 2002). Also, Kelley, Zimmerman, Delaney, and Sahakyan (2007) have shown that the further back in time participants mentally travel when engaging in diversionary thought, the greater the degree of forgetting arising from context change. Perhaps the same is also true about the spatial distance such that mentally traveling a farther distance from the experimental context may produce greater costs compared to mentally traveling only a short distance (i.e., thinking of things inside the room). However, even when the data from the participants who engaged in diversionary thoughts about the events inside of experimental room were removed from the analyses, there were still no costs for the group consisting of F-DT *unspecified* plus *F-DT- OUTSIDE* participants compared to the remember participants, $F<1$. A follow-up study might address this issue by refining the F-DT forget instruction to include a specific example of a distracting thought so that participants are not left to their own devices.

Experiment 2 results were slightly different for the F-UL instruction, which was predicted to also induce a mental change of context. When the strategy was given as a forget instruction in Experiment 2, F-UL participants only forgot TBR items. This finding was replicated in the *reported forgetting strategy group* analysis. It is unclear why costs were restricted only to TBR items. Perhaps focusing on studying the upcoming list does not initiate a change of context, but rather activates some inhibitory process that affects TBR items only (see next section). Another possibility is that the F-UL instruction may have caused participants to terminate List 1 rehearsal, which would have produced TBR costs and left TBF items unaffected. Of all the other forget groups from Experiment 2, the F-UL pattern of costs most resembles the F-PW group. Indeed, if a F-UL strategy activates inhibitory mechanisms, then costs should resemble that of the F-PW group.

No benefits were observed for the F-UL group. The absence of benefits is puzzling considering the nature of the F-UL instruction: Participants are instructed to focus on the list they are about to study and to try harder to learn it. This should lead to better encoding of List 2 for the F-UL group compared to the remember group. One reason for the absence of benefits could be due to the F-UL group not knowing how to try harder to learn List 2. Giving participants more specific encoding strategies like "make a story with the words" should produce benefits (e.g., Sahakyan & Delaney, 2003).

Inhibition. The last directed forgetting theory of interest is inhibition. There are two inhibitory accounts that make different predictions. Retrieval inhibition (Bjork, 1989; Geiselman, Bjork, & Fishman, 1983) states that costs arise from inhibited access to

the entire List 1-learning episode. This view predicts costs for both TBR and TBF items. The second account states that inhibition operates at the level of the item rather than the list (e.g., Conway & Fthenaki, 2003). Research on retrieval-induced forgetting has shown that items more strongly activated in memory are more susceptible to inhibition (Anderson, Bjork, & Bjork, 1994; Storm, Bjork, & Bjork, 2007). TBR items that are more strongly activated in memory should interfere more. Therefore, an F-PW instruction should lead to more forgetting of TBR items than of TBF items. These two accounts also make different predictions regarding the benefits. If inhibition operates at the list level, then everything on List 1 should be forgotten to the same extent, leading to benefits of all item types on List 2. If inhibition operates at the item level, then the costs and the benefits should be greater for TBR items than TBF items. That is, the inhibition of List 1 TBR items should reduce the amount of proactive interference on List 2 TBR items, leading to enhanced memory for these items. Because TBF items are not affected by item-level inhibition, they should not be forgotten and there should be no benefits for these items on List 2.

The Experiment 1 results are consistent with the inhibition account aimed at the list level representation because costs for both item types were observed. Experiment 1 benefits occurred only for TBR items, a result that is inconsistent with list-level inhibitory account. The F-PW group from Experiment 2 produced only TBR costs and corresponding TBR benefits. These results are consistent with the inhibition aimed at the item level representation. Perhaps the *push words out of mind* instruction therefore acts as an inhibitory mechanism, targets intruding items, and renders them more difficult to

retrieve at test. The forgetting of TBR items should then lead to a release from proactive interference of these items on List 2, leading to TBR benefits – a pattern consistent with the observed results.

One thing that requires further investigation is the way in which participants interpret and execute the *push words out of mind* instruction. Push words out of mind may mean different things to different people, and various strategies can be used that would nonetheless be perceived as pushing words out of mind. For example, the way the strategy is worded (i.e., push out of mind) may more forcefully emphasize the need to forget, and in order to comply with it, participants may engage in various strategies that may not necessarily be inhibitory in nature. A moderately-sized proportion of participants in Experiment 1 reported using the *push words out of mind* strategy (16.1%). However, in Experiment 2, despite being instructed to push the words out of mind, there were still 24% of participants in the F-PW group that reported doing something else to forget. The proportion of participants not following the F-PW instruction may be due in part to the strategy being unclear, leaving room to different interpretations. A few participants even told our experimenters that they did not know how to use the F-PW strategy. This suggests that a training session would have been desirable in order to familiarize participants with the strategy. A typical training session might consist of a few practice trials in which participants attempt to forget by pushing words out of mind. The push out of mind strategy itself might be specified as having the participant visualize the words being pushed from their heads, or perhaps a think/no-think approach used by Anderson and Green (2001) in which the participant is instructed to prevent the unwanted

item from entering consciousness. Following each practice trial, participants would provide retrospective verbal reports about the details of the forgetting on that trial and feedback would be given in order to dissuade participants from using other forgetting strategies like terminating rehearsal or thinking of distracting thoughts.

Concluding Remarks

The studies reported here have shown that people use a variety of strategies to forget information. When used by participants in a controlled, effortful manner, some strategies produce more forgetting than others. Furthermore, directed forgetting costs and benefits are absent when no attempt is made to forget. Future research should investigate why some participants do not engage in forgetting strategies, and whether the likelihood of doing nothing varies as a function of how forgetting instruction is worded (i.e., explicit versus implicit forget cue). To better examine the relationship between the different forgetting strategies and the magnitude of directed forgetting, participants should be trained on how to use a given forgetting strategy in order to improve the likelihood that they use a specific strategy as intended instead of diverting from it.

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