List Method Directed Forgetting: Return of the Selective Rehearsal Account

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Summary. Explanations of directed forgetting—the poorer memory for information that we are instructed to forget (F items) than for information that we are instructed to remember (R items)—have featured two classes of accounts: rehearsal and retrieval. Under the rehearsal account, the argument has consistently been that R items are selectively rehearsed more than F items. Retrieval accounts have been more varied, but the concept of retrieval inhibition has become prevalent, the idea being that F items are suppressed following a forget instruction. For the last 10-15 years, these two explanations have been attached to the two most common procedures in directed forgetting studies: selective rehearsal to the item method, where individual items are randomly assigned instructions, and retrieval inhibition to the list method, where half the list is designated as to-be-forgotten. We report serial position and test warning effects that demonstrate clear selective rehearsal effects in the list procedure. We argue that a separate retrieval inhibition account of the list method is not parsimonious; rather, a selective rehearsal explanation can readily accommodate the principal results obtained under both procedures.

Key words. Directed forgetting, rehearsal, selective rehearsal, inhibition.

Introduction

"Every time I learn something new, it pushes some old stuff out of my brain. Remember when I took that home winemaking course, and I forgot how to drive?"—Homer Simpson, *The Simpsons* (Daniels & Baeza, 1994)

The importance of forgetting is widely undervalued; indeed, people often profess the desire to banish forgetting entirely. This distaste for forgetting can be seen from the earliest views on memory. The ancient Greeks

had two goddesses to represent the importance of remembering and forgetting, both daughters of Uranus (heaven) and Gaea (earth). Titaness Mnemosyne was the goddess of memory and the muse of remembering; her sister Lesmosyne presided over forgetting. Yet Mnemosyne was revered as by far the more important of the two. In part, this "higher profile" derived from her children with Zeus: Their nine daughters, the Muses, played a central role in memory mythology because cultural memories were preserved and shared through literature, art, song, poetry, dance, and theatre. Thus, Mnemosyne presided over memory and her children provided the means of preserving those memories.

In Greek mythology, the importance of remembering is emphasized, with forgetting viewed as the negative result of an inability to remember. Even Lesmosyne herself appeared to discount the importance of forgetting, stating, "that Memory should bear 'forgetfulness' is an oxymoron and almost a pun" (Caldwell, 1987). Unfortunately, little is known about Mnemosyne, who is featured in few myths. Ironically, however, even less is known about Lesmosyne, who is all but forgotten. Undeniably, the tradition of discounting the importance of forgetting in light of the importance of remembering is one of long standing.

In modern times, as illustrated in the opening quote, Homer Simpson's never-ending battle with his feeble memory is highlighted in many episodes of the popular cartoon. Like the Ancient Greeks and most of his non-fictional contemporaries, Homer views his memory loss as a problem, neglecting the benefits associated with "failures to remember." Indeed, forgetting is almost universally perceived as negative, often described using such loaded terms as memory "failure," "loss," or "impairment," all terms that emphasize the apparently detrimental aspects of forgetting. Who would not want a perfect memory?

Certainly the benefits of remembering are more apparent than are those of forgetting. Our ability to remember is clearly important not only for normal day-to-day functioning, but also for the development and maintenance of a sense of self (see, for example, Kihlstrom, Beer, & Klein, 2003). We rely heavily on this ability, admiring those, like top *Jeopardy* contestants, with exceptional memories. Yet the importance of forgetting should not be underestimated. It is axiomatic that to remember important information without confusion we need to forget extraneous and no longer relevant information. Old information can interfere with memory for new information, like remembering where you parked each day when you leave work: To find your car, you must forget where you parked on previous trips and remember today's location. Moreover, we often want to or need to forget, as in the case of a particularly embarrassing, sad, or traumatic incident. A world without forgetting would not be nearly as idyllic as many

believe. Perhaps the most compelling example is the true story of the mnemonist Shereshevsky (Luria, 1968), a man with an extraordinary memory who became overwhelmed and imprisoned by the sheer volume of detail that he remembered. It seems that a memory not decluttered by forgetting interferes with normal functioning. In the words of William James (1890), "in the practical use of our intellect, forgetting is as important as recollecting."

We certainly agree with James that successful remembering is related to our ability to forget information that should be forgotten. Forgetting is especially important in memory updating (see Bjork, 1978; 1989)—replacing old information with new information to eliminate problems resulting from interference between old and new. Information can be forgotten unintentionally through the normal processes of forgetting or it can be forgotten intentionally by actively trying to suppress information or by following directions or instructions to forget. This chapter will focus on the second of these possibilities—intentional forgetting as a function of directions or instructions to forget.

Intentional forgetting is important at the individual level; for instance, we might want to suppress a personal memory of a loss or trauma that is particularly painful (Freud, 1900, 1938). It is also important at a more social level; for instance, when a judge orders that inappropriately presented information must be ignored or forgotten by a jury. In fact, in these and many other cases, it is not easy to forget despite the desire to do so (e.g., Wegner, 1994; see also Golding & Long, 1998). Nevertheless, under some conditions, people can intentionally forget, and this effect can be quite robust.

The paradigm that most successfully captures intentional forgetting in the laboratory is the *directed forgetting paradigm*. Using a simple word list learning procedure, during which the participants are instructed to forget a subset of the newly acquired information, numerous studies over the past 35 years have shown that to-be-forgotten information is quite easily forgotten, often to the benefit of the to-be-remembered information (for reviews, see Golding & Long, 1998; Johnson, 1994; MacLeod, 1998). Contrary to the prevalent belief that telling someone to forget something will actually make it even more memorable, the research shows that information can be successfully forgotten upon instruction.

Directed Forgetting Methods and Terminology

There are two primary variations of the directed forgetting paradigm which differ in how the memory instructions are presented. Under both methods, the participant is instructed to forget some items, the to-be-forgotten (F) items, and to remember other items, the to-be-remembered (R) items. In the *item method*, there are multiple apparently random R and F cues, one instruction immediately following each individual list item (e.g., MacLeod, 1975). In contrast, in the *list method*, two cues are typically presented, one at the middle (usually the forget instruction) and one at the end of the list (e.g., Elmes, Adams, & Roediger, 1970), although other list method variations have been introduced (e.g., MacLeod, 1975).

Following the study phase, in which the participant is told to remember or to forget subsets of the items, there is a free recall task in which the participant is asked to retrieve both the R items and the F items, despite having been told at the outset of the study that they would not be tested on the F items. Both list method and item method directing forgetting paradigms reveal that R words are advantaged compared to F words, although the difference apparent under the item method is attenuated under the list method (see, e.g., MacLeod, 1999). The usually observed recall advantage for the R items over the F items has been dubbed the *directed forgetting effect*.

The directed forgetting effect can be measured in two different ways. The first measure emphasizes the R items, employing a cost-benefit analysis of the differences in recall accuracy among three conditions: (a) the standard directed forgetting condition with an equal mix of R and F items (the entire list), (b) a condition with the R items only—half of the list, and (c) a condition with the entire list composed of R items (see MacLeod, 1998, for further details). The *directed forgetting benefit* is the recall advantage for the R items when coupled with an equal number of F items (condition a) as opposed to an equal number of R items (condition c). How much does the replacement of some R items with F items help the recall of the remaining R items? In contrast, the *directed forgetting cost* is the recall disadvantage for the R items when coupled with an equal number of F items (condition a) compared to a condition in which the list is half as long and made up of R items only (condition b). How much does adding F items to the list hurt recall of the R items?

The second measure emphasizes the F items, in contrast to the R items. This measure is simply the difference in recall between the R items and the F items (the *remember-forget difference*). Under the list method, this measure can be taken in two ways: as the difference between sub-list 1 (F) and sub-list 2 (R) in a within-subjects design, or as the difference between

sub-list 1 (F) in a F-R instruction ordering condition and sub-list 1 (R) in a R-R instruction ordering condition. We see the latter measure as a more accurate calculation of the remember-forget difference in list method directed forgetting because the control condition removes the list order confound inherent in the within-subjects design (see Anderson, this volume, for further discussion on this point). Interestingly, however, the former measure is quite common in the literature. We should also highlight that the remember-forget difference measure is more commonly reported in the literature than is the cost-benefit technique as the preferred index of directed forgetting.

Although not yet directly compared empirically—work is in progress in our laboratory—there is also variability in the presentation of list method directed forgetting instructions. In the *simple cue paradigm* (e.g., Horton & Petruk, 1980), a single cue signifying "forget" (e.g., a color change, a symbol, or FFFFFF) is presented after the F sub-list without any explanation as to why these words should be forgotten. In the classic *deception paradigm* (e.g., Sahakyan & Kelley, 2002), following presentation of the F sub-list, the participants are told that the previous list was for practice and therefore that they can forget the items just presented (in a variation, the F sub-list is represented as a mistake, with participants told that the list can be forgotten). The subsequent R list is then presented as the real to-be-tested list. This discounting of the first sub-list and emphasis on the second sub-list effectively constitutes the directed forgetting instruction. Finally, in the *multiple cue training paradigm* (e.g., MacLeod, 1999) version of the task, participants are told from the outset that they will be presented with lists of words to learn, but that following each list they will be given an instruction to remember or to forget the previous list. Training trials prior to the experiment teach the participants the nature of the F-R cues, helping to solidify the belief that only the R items will have to be recalled at test. During the actual experiment, the first sub-list is given a F cue and the second sub-list a R cue, and the entire list is followed by an instruction to recall both the R and F items, countermanding previous instructions. We are currently exploring the differential effect of instructional type (simple cue, deception, multiple cue training) on the directed forgetting effect and more broadly on the underlying theoretical mechanisms.

In this chapter, we will center our attention on list method directed forgetting. Johnson (1994) argued that this is the only "true" directed forgetting, in that the instruction is given not during but after learning, thereby truly constituting a cue to forget rather than a cue not to learn. Although we believe that both methods have their value in helping us to understand forgetting, and we will ultimately argue that essentially the same mechanism is invoked by both methods, we will focus this chapter on the list

method because it is primarily here that the rehearsal/inhibition battle has been waged. To understand the importance of this debate, we now introduce the various explanations that have been offered for the directed forgetting effect.

Theoretical Accounts of Directed Forgetting

Until quite recently (Basden, Basden, & Gargano, 1993; Bjork, 1989), theoretical accounts of the directed forgetting effect did not distinguish between the list and item method directed forgetting paradigms. Instead, unified theories were presented to account for all directed forgetting findings, regardless of procedural differences. The first true directed forgetting experiment was conducted by Muther in 1965, although Bjork, LaBerge, and Legrand (1968) really ignited directed forgetting research and led us into the "The Golden Age" of directed forgetting research through the 1960s and 1970s (MacLeod, 1998). Speculation about the theoretical underpinnings began with these first experiments. Almost immediately, the *deletion/erasure hypothesis* was rejected (Bjork et al., 1968; Muther, 1965) because F items clearly were not entirely expunged from memory, as demonstrated by their intrusion in recall (Muther, 1965).

One of the other earliest theoretical accounts of directed forgetting was the *repression account*, influenced by the parallels with clinical ideas of repression. This view posited inhibition of F items to reduce the extent to which they interfered with R items (Weiner, 1968; Weiner & Reed, 1969). But this view also quickly was set aside in the early years, displaced by two other theoretical positions, one emphasizing encoding and the other retrieval. Under the *selective rehearsal account*, rehearsal favored the R items, leading to better encoding of the R items than of the F items (see Bjork, 1972, for a review). Under the *selective search account*, when it was time for retrieval, participants largely restricted their search to the set of R items, segregated during study from the F items (see Epstein, 1972, for a review).

Selective search relied on the idea that participants separated items in memory by actively tagging them as either R or F during study, creating two instructionally distinguished sets. At test, the F items were ignored to the extent possible and the R items were selected for retrieval. Early segregation and selective search ideas had an inhibitory aspect: The items tagged as F were somehow suppressed or inhibited at retrieval and only the R items were actively retrieved (e.g., Elmes et al., 1970; Epstein, 1969). Although the inhibitory element was not emphasized, this view clearly

represents one of the precursors to the current retrieval inhibition account. Epstein's early work did not unambiguously support the segregation and selective search account over the selective rehearsal account (e.g., Epstein, Massaro, & Wilder, 1972; Epstein & Wilder, 1972; Shebilske, Wilder, & Epstein, 1971), yet in his review Epstein (1972) emphasized the importance of selective search and rejected findings that differential rehearsal might have an effect on directed forgetting as uninteresting, similar to the position which Johnson (1994) later adopted in her review.

Selective rehearsal was not, however, without advocates. Although initially rejecting it (Bjork et al., 1968), Bjork soon came to prefer the selective rehearsal explanation. The selective rehearsal explanation simply proposes that items cued as R are rehearsed more than items cued as F, which may be rehearsed only minimally. At test, the items that received the most rehearsal during encoding are the most easily recalled, thus R items are retrieved more readily than are F items. Bjork (1970), like Elmes et al. (1970) and Epstein (1969), argued that participants use the F cue to segregate R and F items, but he further proposed that once the items were separated the participants selectively rehearsed only the R items, which served to strengthen the set differentiation. It is interesting to note that the specifics of the selective rehearsal account varied from an emphasis on the effect of selective rehearsal at encoding (Bjork, 1970) to retrieval (Woodward & Bjork, 1971) and back to encoding (Bjork & Woodward, 1973). Although the timing of the influence of selective rehearsal was not clear-cut, Bjork's explanation of the directed forgetting effect clearly emphasized two elements: the selective rehearsal of R items, and the segregation of R and F items in memory (Bjork, 1972). For most of the 1970s, the selective search and selective rehearsal theories of directed forgetting dominated the field.

By the late 1970s, however, an old idea was garnering new support. Retrieval inhibition, the account championed by Weiner in the 1960s (e.g., Weiner, 1968; Weiner & Reed, 1969) had fallen into disfavor after the very early years of directed forgetting. Weiner and colleagues had proposed that F and R items were not differentially learned, but that F items were harder to retrieve because they were repressed or inhibited. In the late 1970s, the inhibition view re-emerged, in large part as findings apparently inconsistent with a rehearsal explanation began to appear. In contrast to their earlier views, Bjork, Geiselman, and colleagues reported a series of studies, the findings of which could not easily be explained by selective rehearsal or selective retrieval accounts (e.g., Geiselman & Bagheri, 1985; Geiselman, Bjork, & Fishman, 1983). For instance, they observed directed forgetting under conditions in which selective rehearsal would appear to have been irrelevant or impossible.

Instead, Bjork, Geiselman, and colleagues (e.g., Geiselman & Bagheri, 1985; Geiselman, Bjork, & Fishman, 1983; Geiselman & Panting, 1985) argued that F items were inhibited during retrieval but could, under certain conditions (most notably re-presentation), be released from inhibition. The release from inhibition findings were seen as evidence against selective rehearsal: Clearly the items had been encoded if they could later be recalled, thus it was assumed that at the time of free recall the items were in memory but inaccessible. This revived inhibition account of directed forgetting has led to a continuing debate between encoding-based rehearsal views and retrieval-based inhibitory views of directed forgetting, as we have discussed elsewhere (MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003).

Early accounts of the directed forgetting effect were applied to differences obtained under both item method and list method directed forgetting. However, in 1989, Bjork suggested that different mechanisms could underlie the two methods. Bjork (1989) and Basden et al. (1993) proposed a simple dichotomy—that selective rehearsal underlies item method directed forgetting whereas retrieval inhibition underlies list method directed forgetting. Under item method instructions, the participant may delay rehearsal until an R or F cue is presented. Upon presentation of an R cue, the participant rehearses the item, but when an F cue is presented, the participant does not rehearse the item, likely using any available rehearsal time to rehearse earlier R items instead. The F items are not well rehearsed and therefore are not well encoded; as a result, F items are disadvantaged at test compared to R items. Even re-presentation of the item does not attenuate the effect (Basden et al., 1993).

In contrast, under the list method, the participant is not aware when (or even if) the F cue will be presented, therefore there is no motivation to delay rehearsal. Presumably all F items are rehearsed until the mid-list presentation of the F cue, at which point rehearsal of the F items ceases. Thus, under the list method, F items should be rehearsed and encoded to the same extent as R items. The theoretical consequence is that F-R recall differences at test cannot be attributed to selective rehearsal of R items, given that all items are rehearsed. Instead, Bjork (1989) proposed that list method directed forgetting effects resulted from inhibition. Upon presentation of the F cue, the F set is inhibited and these items consequently are disadvantaged at recall. Re-presenting the item at retrieval releases the inhibition such that the F items, which were encoded and are stored in memory, become accessible again (Basden et al., 1993).

This account also nicely handles the "standard" finding that a directed forgetting effect is observed on a recognition test only for the item method. Under the item method, F items are poorly learned, which should be evident on any (explicit) memory test. But under the list method, the re-

presentation required to test recognition releases the inhibition, eliminating any effect on recognition. This is precisely what the data of numerous studies had demonstrated—that there was little if any directed forgetting effect on recognition using the list method (see MacLeod, 1998, for a review).

The release from inhibition distinction between list method and item method directed forgetting is crucial. This dichotomy provides the best evidence that different mechanisms underlie the two methods. If words can be retrieved under some test conditions (e.g., recognition), this implies that the items were encoded and learned; if the items cannot be retrieved under any test condition, this implies that the items were not encoded and learned. The idea that different mechanisms underlie list method and item method directed forgetting is now the most widely subscribed theoretical account of directed forgetting (MacLeod, 1998).

The role of selective rehearsal in item method directed forgetting is the commonly accepted and seemingly sufficient explanation of item method directed forgetting (Johnson, 1994; MacLeod, 1998). Recently, however, the inhibitory view of list method directed forgetting has begun to be challenged. Sahakyan and colleagues (e.g. Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002) and MacLeod, Sheard and colleagues (e.g., MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003; Sheard, Dodd, Wilson, & MacLeod, 2004; Sheard & MacLeod, 2002) have proposed alternatives to the inhibition-based explanation of list method directed forgetting.

Sahakyan and Kelley (2002) introduced a *context change account* of list method directed forgetting. Upon presentation of an F cue, participants actively try to forget the preceding items by changing their internal context (e.g., their state or mood) so that they are in a different internal context during presentation of the R list. At retrieval, they remain in this second context which facilitates recall of R items but impedes recall of F items because they were encoded under a different context. The mismatch between the encoding and retrieval contexts of F items results in impaired recall of F items, much like state dependency affects memory in drug studies (see, e.g., Eich, 1980). Their results were consistent with this view in that a context change even in the absence of an F cue impaired recall of the first sub-list, and reinstatement at test of a context consistent with the encoding context (for F items) reduced the overall directed forgetting effect (Sahakyan & Kelley, 2002).

The context change idea is reminiscent of the early set differentiation and selective search concepts (see Epstein, 1972; see also Bjork, 1972, for reviews), although context change does provide a more process-based mechanism for set differentiation. Under the context change account, each set—both the R items and the F items—is associated with a different inter-

nal context and thus the differing contexts serve to segregate the sets. Although the context change account does not rely on retrieval inhibition, it is not entirely incompatible with such a view: A change in context could form the basis for inhibition in that the context-mismatched items become the ones that are inhibited at retrieval.

Both context change and retrieval inhibition propose that directed forgetting is a phenomenon occurring at retrieval, which is where these mechanisms exert their influence. In contrast, we propose an account of list method directed forgetting that, like context change, does not rely on inhibitory mechanisms but, unlike context change and the dominant inhibition theory, emphasizes encoding over retrieval. Our proposal also is not new; rather, it seeks to re-establish selective rehearsal as the explanation for both list method and item method directed forgetting.

As part of ongoing research in our laboratory, our goal is to evaluate more thoroughly the role of selective rehearsal in list method directed forgetting. Bjork (1989) and Basden et al. (1993) provided what appeared to be compelling evidence that a two-mechanism explanation of directed forgetting most appropriately accounts for the divergent findings under list method and item method instructions. In so doing, they denied any influence of selective rehearsal in list method directed forgetting. We argue, however, that selective rehearsal plays a more dominant role in list method directed forgetting than is currently recognized. So, in contrast to the current two-theory explanations of the directed forgetting effect, we propose that a single explanation—selective rehearsal—can provide a unified theory for all directed forgetting effects.

Early Evidence for Selective Rehearsal

To fully understand the unified rehearsal explanation, we will begin by summarizing the early evidence for selective rehearsal. Interestingly, initial accounts of directed forgetting discounted selective rehearsal, in large part because it was thought that selective rehearsal could not operate under such rapid presentation conditions (Bjork et al., 1968; Brown, 1954; see also Geiselman & Bagheri, 1985). The tide soon shifted, however, and many early findings derived from both the item method and the list method were explained in terms of selective rehearsal, although selective search was a popular alternate explanation (MacLeod, 1998).

Woodward and Bjork (1971) provided early evidence for the role of selective rehearsal in item method directed forgetting. Even with a financial inducement to recall both the R and F items, participants still recalled

comparatively few F items (see also Reitman, Malin, Bjork, & Higman, 1973). Woodward and Bjork hypothesized that subjects waited for the R or F cue before processing the item and therefore that the F items were not rehearsed at study and consequently could not be recalled at test, despite the cash incentive. In contrast, upon presentation of the R cue, the R items were rehearsed and therefore were considerably better recalled at test. Although along the way Woodward and Bjork considered both encoding and retrieval loci for selective rehearsal effects (Bjork & Woodward, 1973; Woodward & Bjork, 1971; see MacLeod, 1998, for a discussion), the basic tenets of their selective rehearsal account remain in place today in the explanation of item method directed forgetting. Participants delay rehearsal until a cue is presented: If the cue is an F cue, no rehearsal follows, but if the cue is an R cue, then the participant selectively rehearses the R item. The dominant role of rehearsal in item method directed forgetting was, therefore, established early on. Intriguingly, so was the role of selective rehearsal in list method directed forgetting.

As mentioned, the role of rehearsal in item method directed forgetting is not terribly controversial: The evidence for selective rehearsal is solid and rarely has a researcher actively contested this claim. The evidence for selective rehearsal in list method directed forgetting is more controversial, however, and over the years the evidence for or against the role of selective rehearsal has been inconsistent. In her review, Johnson (1994) indicated that selective rehearsal (or post-instruction encoding) could not account solely for, but could contribute to, list method directed forgetting effects. In this section, we will highlight the studies that support a selective rehearsal account of list method directed forgetting. Although the current inhibitory view of list method directed forgetting rejects an influence of selective rehearsal, there is a long history of evidence that counters this claim. Early research using list method instructions yielded many results consistent with a selective rehearsal account.

In 1970, Bjork examined the effect of a cue to forget previously learned words. On recall tests, the number of precue forget pairs did not impact recall of the R pairs whereas in lists with a "non-designated" cue (specifying neither F nor R), precue pairs did interfere with postcue pairs, with postcue word pair recall declining as the number of precue word pairs increased. Furthermore, the F-cued items were not well recalled—the classic directed forgetting effect. Bjork proposed that participants used the cues to segregate the lists and that they then selectively rehearsed the R items. Segregation and rehearsal were seen as symbiotic, with segregation allowing for selective rehearsal, and selective rehearsal solidifying segregation. Timmins (1973) dissociated segregation and rehearsal by demonstrating that a repeated F item is better recalled than any other items (unrepeated F

items or R items). This finding is inconsistent with segregation: If the first occurrence of the to-be-repeated item is within the F set, then it should be segregated with the unrehearsed F items and recalled only as well as other F items. Therefore, the enhanced recall of repeated F items indicates that these items were not segregated with other F items and also that they benefited from additional rehearsal. Although the relation between segregation and rehearsal was not clear, the role of selective rehearsal in list method directed forgetting was becoming well established.

In the early directed forgetting literature, however, the teaming of segregation and selective search was often compared with the teaming of segregation and selective rehearsal. In comparing these two accounts, MacLeod's (1975) data also argued against a selective search mechanism. MacLeod found that the R-F difference persisted over long intervals (one and two weeks) because of R-F encoding differences at input. Presumably a selective search account would predict a diminishing directed forgetting effect over a long interval, as the set differentiation information is lost. Stability of the directed forgetting effect over time implies that the selective rehearsal of R items at encoding resulted in a long-term R-F advantage due to differential original learning.

This stability of the effect is important because, in an earlier review, Epstein (1972) asserted that selective search was key, even though some of his own work indicated that selective rehearsal was an important component of list method directed forgetting. For instance, Epstein and Wilder (1972) found that the directed forgetting effect was larger for unfilled intervals (which offered rehearsal opportunities) than for filled intervals. They acknowledged briefly that selective rehearsal might operate to enhance the selective search process, but selective rehearsal alone was not viewed as a crucial mechanism. Certainly, typical results reveal that tasks designed to prevent rehearsal have minimal to no impact on the directed forgetting effect (see Johnson, 1994, for a review), the implication being that if rehearsal opportunity does not influence recall then selective rehearsal is not a viable mechanism. The findings of Spector, Laughery, and Finkelman (1973), however, contest this claim: When the R or F cue preceded the rehearsal interval, the directed forgetting effect was obtained, but when the cue followed the rehearsal interval, the directed forgetting effect vanished. Again we see that selective rehearsal findings in list method directed forgetting are not consistent.

By the late 1970s, support for the rehearsal account seemed to be losing ground (MacLeod, 1998). In early sentence-based item method work, Geiselman's results supported a selective rehearsal view (e.g., Geiselman, 1974; 1975); indeed subjective reports of rehearsal by participants further supported the rehearsal account (Geiselman, 1974). But a subsequent se-

ries of studies by Geiselman and colleagues (e.g., Geiselman, 1974; Geiselman & Bagheri, 1985) seemed to counter a rehearsal account. The crucial study in shifting the emphasis from encoding to retrieval was Bjork and Geiselman's (1978) modified item method study. By forcing retrieval of F items during recall ("What was that item you were told to forget?"), the directed forgetting effect was reduced in recall and eliminated in recognition, a finding seen as inconsistent with an encoding/rehearsal account of directed forgetting. Converging evidence came from a study by Geiselman, Bjork, and Fishman (1983) using a modified list method procedure. The R-F difference persisted for both intentionally and incidentally learned items, despite the fact that under a rehearsal account incidentally learned items should have no real advantage regardless of instruction because even given an R cue the incidentally learned words should not be rehearsed.

As an interesting aside, one of the seminal studies in propelling the inhibition view actually used the item method, now closely linked to selective rehearsal, the very mechanism that this study helped to undermine. Using the item method, Geiselman and Bagheri (1985) showed that item repetition benefited F items to a greater extent than R items; indeed, even unrepeated F items from a partially repeated set benefited from repetition. The hypothesis was that repeating some F items released the inhibition on previously unrecallable F items, much the same way that re-presentation is now thought to release the inhibition of F items. R items did not benefit as much from repeated presentation because they were never inhibited in the first place.

A series of follow-up studies (Geiselman & Panting, 1985; Geiselman, Rabow, Wachtel, & MacKinnon, 1985; for a review see MacLeod, 1998) led to a more general conclusion implicating both rehearsal and inhibition. This merged view suggested that selective rehearsal at encoding favored R items but that inhibition at retrieval impaired F items. It was the combined effect of these two different processes at two different sites that was responsible for the directed forgetting effect. Geiselman's two-process interpretation was later thought to be related to the as yet unidentified differences between list method and item method directed forgetting, however it is possible that his encoding-retrieval dual mechanism unified view might still be plausible.

The rehearsal-inhibition controversy continued until Bjork (1989) and Basden et al. (1993) seemingly solved the theoretical riddle. A selective rehearsal account evidently best accounts for the item method results, whereas a retrieval inhibition account evidently provides the best explanation of list method results. In particular, the presence of an effect on recognition under the item method and its absence under the list method

seems diagnostic: Recognition is sensitive to reduced rehearsal (item method) but the re-presentation of the items required by a recognition test "disinhibits" F items, restoring their equivalence to R items (list method). Indeed, in many instances, list method results seem incompatible with a selective rehearsal account and item method results seem incompatible with an inhibition account.

It may be, however, that the two explanations have become too polarized over the past decade. Specifically, it is not clear that inhibition is the only or best explanation of list method directed forgetting (see MacLeod et al., 2003) or that a selective rehearsal account cannot provide a successful account of list method directed forgetting. Although the two methods-two mechanisms idea is appealing, we think that a selective rehearsal account of list method directed forgetting may have been abandoned prematurely. Certainly, in the vein of Geiselman, it seems reasonable that at the very least both inhibition and selective retrieval operate in list method directed forgetting but, to reach further, it is possible that selective rehearsal alone can account for list method directed forgetting findings. If so, the principle of parsimony would be well-served by having a unified account of directed forgetting.

New Evidence For a Rehearsal Account of List Method Directed Forgetting

We have already sketched our argument that an inhibitory account of list method directed forgetting may not be necessary or appropriate, and that a selective rehearsal explanation may be entirely satisfactory (see MacLeod et al., 2003). Ongoing list method research in our laboratory certainly suggests that rehearsal does play a role in list method directed forgetting, implying that longstanding and well defined memory operations can account for the directed forgetting effect without reliance on what we see as less well defined notions of inhibition. In the first series of experiments, we show that rehearsal opportunities during a pretest delay greatly impact the directed forgetting effect, implying that rehearsal is a factor in list method directed forgetting, at least under delay conditions. In the second series of experiments, we dissect the recall pattern of a typical directed forgetting study using a serial position analysis. Clear—and quite classic—rehearsal patterns emerge. Taken together, these results indicate to us that rehearsal does play a role—a substantial role—in list method directed forgetting.

The Delayed Recall Project

In the first series of studies (Sheard, Dodd, Wilson, & MacLeod, 2004) we investigated selective rehearsal in list method directed forgetting using a delay variant of the paradigm. Basden and Basden (1998; see also Gilliland, McLaughlin, Wright, Basden, & Basden, 1996) developed a paradigm to investigate the effects of a pre-delay recall warning on directed forgetting. They reported that a pre-delay warning telling the participant that in fact both R and F items will have to be recalled eliminates the directed forgetting effect under list method conditions (but not under the item method). Their explanation is that under the list method participants normally adopt a retrieval strategy that inhibits the F items and emphasizes the R items, but that a warning prior to a delay provides an opportunity for the participants to switch retrieval strategies and more equally emphasize R and F items (see MacLeod et al., 2003, for a critique of the inhibition explanation). However, the delay results are not incompatible with a selective rehearsal account. Clearly, the delay also provides an opportunity for selective rehearsal and, following a warning, participants might simply switch rehearsal strategies to emphasize the previously neglected F items. We sought to evaluate this possibility.

Under a selective rehearsal assumption, if a delay is preceded by a warning that the participants will have to recall both the F and the R items (the *delay-warning* condition), then the interval could be used to selectively rehearse F items, a shift in emphasis presumed to reflect the perceived difficulty that will be experienced in trying to recall the F items after all. Consequently, R items will not be as well rehearsed as they would be if the delay were not preceded by a warning (the *delay–no warning* condition), where participants would presumably focus rehearsal on the R items, assuming (consistent with initial instructions) that only the R items will be tested. Because it is also likely that rehearsal strategies would differ between participants, we divided the participants into high and low memory groups based on overall memory performance. High memory participants probably utilize better rehearsal strategies than do low memory participants, and so the warning manipulation should differentially affect the two groups. All results were compared to a standard directed forgetting condition in which there was no delay between the study and test sessions (the *no delay* condition).

Figure 1 shows the data from the first experiment in this project. The delay-warning and delay-no warning low memory groups showed equivalent directed forgetting. Apparently, low memory participants did not use the delay to strategically rehearse either R or F items. Indeed, a comparison between the delay conditions and the no delay condition is telling:

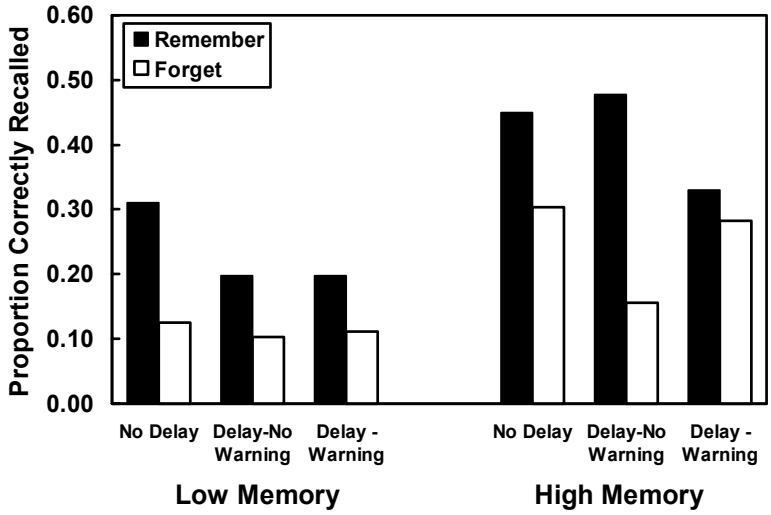

Fig. 1. The effect of a pre-delay warning that both R and F items are to be recalled (delay – warning), no pre-delay warning regarding recall (delay – no warning), or no delay (no delay) on directed forgetting, for both high and low memory participants.

Under the no delay condition, participants recalled significantly more R items than under either delay condition, but the groups did not differ at all in recall of the F items. The loss of R items over the delay suggests that the low memory participants were not rehearsing at all during the study-test interval, and that they simply forgot some of the R items over the delay.

In contrast, the high memory participants did show a marked effect of warning. In the standard no delay condition, a significant directed forgetting effect was found. Under the delay-no warning condition, however, the size of the directed forgetting effect increased substantially due to increased recall of R items and decreased recall of F items, relative to the no delay condition. This pattern implies that, without a warning, high memory participants were actively rehearsing the R items during the delay, to the detriment of the F items. Rehearsing R items is a strategic way of maximizing recall given that the participant believes that only R items will be tested. The pattern reversed for the delay-warning condition: The directed forgetting effect disappeared, the result of decreased recall of R items and stable recall of F items over the delay interval. Again, the results are consistent with a rehearsal-based explanation. When warned,

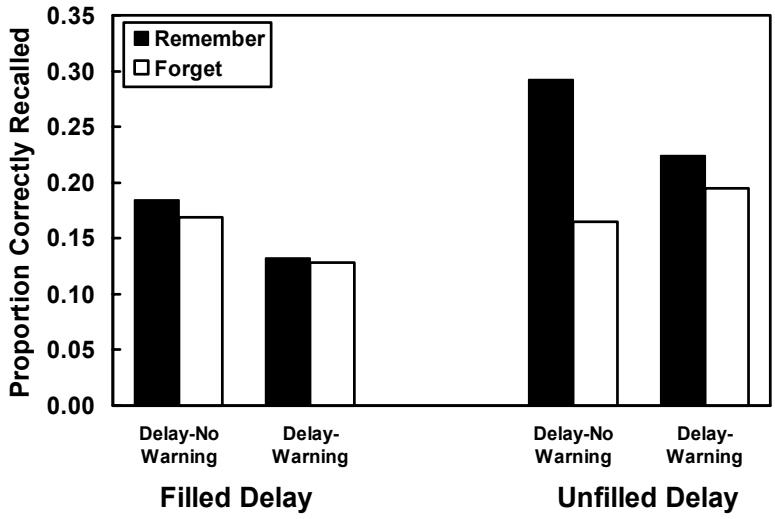

Fig. 2. The effect of a filled versus unfilled delay as a function of warning on directed forgetting.

high memory participants strategically rehearsed F items over the delay, successfully maintaining their level of recall (which had suffered with no warning). But this benefit for F items came at the cost of a significant reduction in the recall of R items, attributable to emphasis on the F items, which were seen as in greater need of rehearsal.

In Experiment 2, we further explored the role of selective rehearsal in the warning effect paradigm. To focus on the differences between "rehearsers" vs "non-rehearsers," we directly manipulated rehearsal opportunities during the delay. In the *filled delay* condition, the participants were engaged in an effortful spatial task designed to prevent rehearsal. In the *unfilled delay* condition, we provided motivation to rehearse, telling participants prior to the delay that they would receive payment for each item correctly recalled. We expected performance in the filled delay condition to mirror that of the low memory participants from Experiment 1 and performance in the rehearsal condition to mirror that of the high memory participants.

The findings supported the predictions (see Figure 2). The filled groups did not show an effect of the warning manipulation nor was there a significant directed forgetting effect. Inability to rehearse over the delay resulted in a loss of R; recall of the F items was too poor to demonstrate any significant loss over the delay. The unfilled groups, who had the chance (and

incentive) to rehearse, revealed a significant directed forgetting effect in the delay-no warning condition, but no directed forgetting effect in the delay-warning condition. The difference stemmed from recall of R items: The delay-no warning group recalled more R items than did the delay-warning group. With no warning that F items must also be recalled, the delay was used for continued rehearsal of the R items, resulting in a larger than normal directed forgetting effect.

In combination, these results provide support for the role of selective rehearsal in list method directed forgetting, at least under delay conditions. Is it also reasonable to assume that participants might utilize rehearsal strategies under typical no delay conditions as well? That was the goal of the next series of experiments (Sheard & MacLeod, 2002), in which we provide evidence of selective rehearsal under standard no delay list method directed forgetting conditions.

The Serial Position Project

In a second series of ongoing studies (Sheard & MacLeod, 2002; a preliminary sketch of the studies was reported in MacLeod et al., 2003), we further investigated the possible role of selective rehearsal in list method directed forgetting by analyzing the serial position curves for the R and F sub-lists. Serial position differences are the hallmark of rehearsal effects in recall (Rundus, 1971; Rundus & Atkinson, 1970), and thereby clearly expected under a rehearsal explanation. If rehearsal does play a central role in list method directed forgetting, then recall differences in F and R might reasonably be expected to vary by serial position. Our basic idea is that the directed forgetting effect stems not from the poorer overall recall of the F items that would be anticipated based on the idea that all F items are inhibited (see Geiselman et al., 1983), but rather from the differential recall of R and F items located in the primacy and recency portions of the two sub-lists. If, as the inhibition account would have it, the F sub-list is rehearsed to the same extent as the R sub-list but is then subsequently inhibited, we see no reason not to expect consistent R and F patterns for serial position. Nothing in the current inhibition account would seem to provide a principled basis for serial position differences between the F and R items, unlike the case of selective rehearsal.

In our first study (Sheard & MacLeod, 2002), we replicated the within-subject list method design, comparing recall of the initial F sub-list (List 1) to that of the subsequent R sub-list (List 2), following what has become common practice in the literature. We obtained the typical directed forgetting effect: Recall of the R sub-list was significantly better than recall of

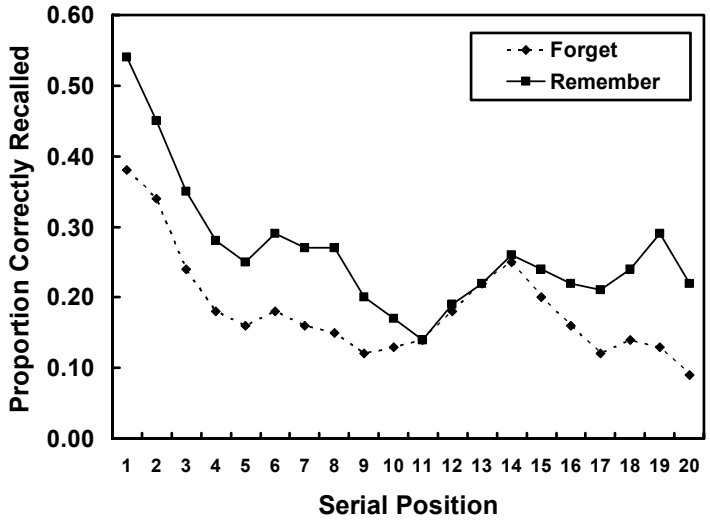

Fig. 3. Serial position effects for Forget (list one) versus Remember (list two). The differences in recall stem from differences in the primacy and recency portions of the curve: The Remember list shows a marked primacy and recency effect compared to the Forget list, which shows only a modest primacy and no recency effect. All curves shown are smoothed by using an algorithm that averages the data point with the two adjacent data points (e.g., position 15 represents an average of position 14, 15, and 16).

the F sub-list. But the serial position analysis revealed an interesting pattern underlying this R-F difference. It was not recall of the entire F list that was reduced in comparison to the R list, contrary to what might be anticipated from an unadorned inhibition explanation. Rather, the differences in recall were restricted to the primacy and recency portions of the curve, with the R list showing a marked primacy and recency effect compared to the F list, which showed a more modest primacy effect and no recency effect. This pattern is displayed in Figure 3.

This serial position pattern is inconsistent with the classic inhibition view that the entire F list is inhibited at retrieval (e.g., Basden & Basden, 1998). To explain our serial position pattern, one must argue that inhibition is selective and that items are inhibited to varying degrees—in a pattern consistent with a rehearsal account (see MacLeod et al., 2003). Indeed the findings are much more consistent with a selective rehearsal account. Upon presentation of the F cue, the participant devotes extra attention to the first few words of the subsequent remember list, resulting in a marked primacy effect for the R sub-list (List 2). Add to this the ex-

pected recency effect for the second sub-list, and we see an overall difference in recall favoring the R sub-list over the F sub-list. But the resulting "directed forgetting effect" is an illusion: The F sub-list was not forgotten, rather the R sub-list was better remembered because of privileged rehearsal of the first few items and working memory access of the last few items.

In Experiment 2 we removed the within-subject design order confound in which the F sub-list precedes the R sub-list to which it is compared. We added two control conditions. The first was the standard R-R control condition, which would permit us to compare F recall and R recall for the first sub-list between subjects, avoiding the order confound that is intrinsic to the within-subject design. The second additional control condition was a variation of the standard R-R control condition where the participant was explicitly instructed to stop rehearsing the first R sub-list following the cue. This was intended to more closely mimic the F-R condition, at least according to the selective rehearsal account. The idea is that, upon receipt of a F cue, the participant presumably discontinues rehearsal of the first (F) sub-list; however, if the first sub-list is followed by a R cue, the participant may be inclined to continue rehearsing that first sub-list. To properly compare a F List 1 to a R List 1, then, we incorporated a R List 1 condition in which participants were also encouraged to stop rehearsal upon receipt of the cue, analogous to the forget condition. As it turned out, these two control groups did not differ, so we will describe only the results from the standard R-R group.

In comparing List 1 (F) from the F-R group to List 1 (R) from the R-R group, we found no reliable differences. Both overall recall and the serial position curves were comparable, as can be seen in Figure 4. An inhibitory account would predict that recall of the F List 1 should be reduced compared to recall of the R List 1, but it was not—there was no directed forgetting effect. This may seem surprising, given that previous studies have reported such a difference (e.g. Liu, Bjork, & Wickens, 1999; Reitman et al., 1973; Sahakyan & Kelley, 2002). Only using the order-confounded within-subject comparison was a directed forgetting effect present; using the more appropriate between subjects design, there was no such effect.

Further analysis of List 2 (R) from the F-R group vs List 2 (R) from the R-R group was also quite informative. On List 2 (the R sub-list), the F-R group revealed a marked primacy effect, in contrast to the R-R group, which showed no primacy effect at all. This pattern is clearly evident in Figure 5. When a R sub-list follows a F sub-list, there is a dramatic influence on primacy; however, a R sub-list following a R sub-list displays no primacy advantage at all. It follows, then, that a mid-list F instruction influences the participant's subsequent behavior. Specifically, as noted in

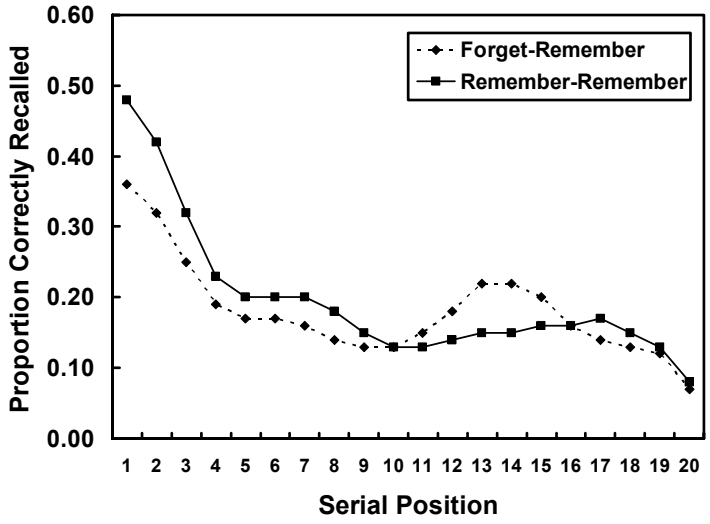

Fig. 4. Forget (list one) from a Forget-Remember condition versus Remember (list one) from a standard Remember-Remember condition. There were no significant differences between groups in recall of list one—that is, using this measure, there was no directed forgetting effect.

Experiment 1, participants actively rehearse the initial items of the R sub-list. This behavior is not a general List 2 phenomenon because when a R sub-list follows another R sub-list, there is no extra rehearsal of the second sub-list. More likely, following a mid-list R instruction for the preceding sub-list, the participants continue to rehearse the first sub-list to the detriment of the first few items on the second sub-list, but to the overall advantage of List 1 compared to List 2. Indeed, with the continued rehearsal of List 1, we would expect better overall recall of a R List 1 compared to a R List 2. As it happens, this finding is both typical in the literature (Bjork, 1970; Liu et al., 1999; Sahakyan & Kelley, 2002) and replicated in this study.

The serial position analyses indicate that participants adopt a different rehearsal strategy for List 2 following a F cue than following a R cue. The difference in recall in a within-subject comparison results from the effect of the F cue on the subsequent R sub-list and not from inhibition of the initial F sub-list. Again, we see that there is a highly probable role for a selective rehearsal strategy in list method directed forgetting.

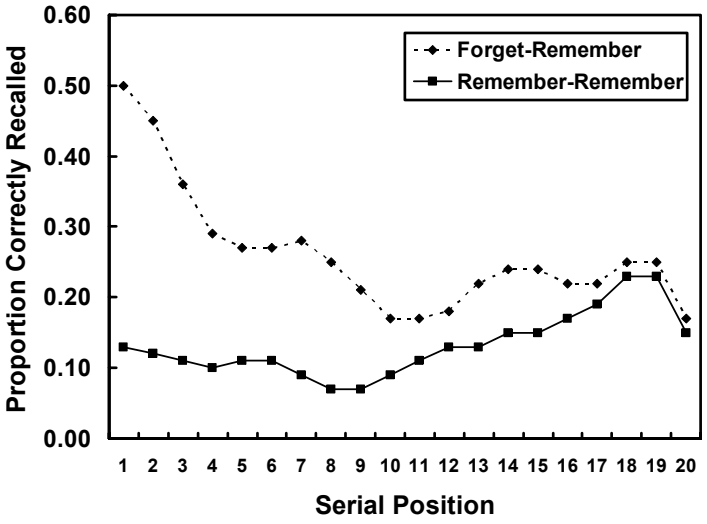

Fig. 5. Remember (list two) from a Forget-Remember condition versus Remember (list two) from a standard Remember-Remember condition. There is a marked difference in recall of list two—when list two follows a forget instruction, it benefits from a strong primacy effect not found when list two follows another remember list.

Although we see these results as compelling, the astute reader might note that we have yet to explain the absence of a list method directed forgetting effect on a recognition test, in contrast to the clear directed forgetting effect in recognition under item method instructions. Although we have not yet tested our hypotheses empirically, we offer two possible reasons. First, we speculate (see MacLeod et al., 2003) that at least part of the method difference in recognition hinges on the initial differences in effect size. The directed forgetting effect on recall ordinarily is considerably larger under the item method than the list method (see, e.g., Basden, et al., 1993; MacLeod, 1999). Under the item method, to the extent that one can compare recall and recognition directly, the directed forgetting effect diminishes from recall to recognition. If the effect also diminishes from recall to recognition under the list method, it may actually disappear. Put simply, the effect disappears under the list method because the starting effect size is so much smaller that it reaches the floor.

Our second possibility for why there is no directed forgetting effect on recognition under the list method relates to our serial position findings. There is evidence that recognition may not show serial position effects as strongly as recall (see, e.g., Cohen, 1970; Kintsch, 1968), therefore if the

list method directed forgetting effects in recall are serial position effects they may not be observable in recognition. Note that under neither of these speculated mechanisms is it necessary to posit an inhibitory mechanism to account for the "release from inhibition" finding of no directed forgetting in recognition under the list method. One focus of current research in our laboratory is investigating conditions under which representation does and does not result in the "release from inhibition" pattern. We also intend to test the floor effect possibility by finding ways to increase the size of the directed forgetting effect in list method recall; if we are right, this might then leave room for a directed forgetting effect to be observed in a corresponding list method recognition test.

Inhibition, as the term is currently used, is a very broad and flexible concept, as we have discussed elsewhere (MacLeod et al., 2003), and as Anderson (this volume) clearly illustrates. It would therefore quite likely be possible to construct a version of an inhibition account that could handle the results that we have just presented, but we believe that such an account would involve what would essentially be selective rehearsal mechanisms in disguise. We can think of no way to definitively refute the idea that inhibition is involved in list method directed forgetting, at least not without a better specified inhibition theory. What we can say is that there now appears to be converging evidence from our laboratory that selective rehearsal plays a central role in list method directed forgetting.

Other Evidence Supporting a Selective Rehearsal Account

There is evidence favoring a selective rehearsal account of list method directed forgetting from other laboratories as well. We will cite two other relevant projects. Kimball and Metcalfe (2001) pursued the approach introduced by Geiselman et al. (1983). In that study, participants were to learn one set of alternating words intentionally, with the other set of alternating words being learned incidentally (pleasantness judgment). Because there should have been no reason to rehearse the incidentally studied words, selective rehearsal should not have operated on these items. Therefore, directed forgetting should have occurred only for the intentionally learned items. But Geiselman et al. found directed forgetting for both sets of items, a pattern that they saw as inconsistent with selective rehearsal but consistent with intentional suppression of the entire F sub-list, which they assumed to be a single episode.

The Geiselman et al. (1983) study is one of the key early pieces of evidence cited as favoring an inhibition account of list method directed forgetting. Kimball and Metcalfe (2001) replicated this study with five modifications aimed at minimizing possible formation of associations between the intentional and incidental items, and at reducing the likelihood of such pre-experimental associations being used at the time of recall. What they observed was very different from what Geiselman et al. (1983) had found: There was a directed forgetting effect on recall for the intentional condition but not for the incidental condition. Consequently, following the logic of Geiselman et al., Kimball and Metcalfe's results supported the selective rehearsal account, not the retrieval inhibition account.

Recently, Golding and Gottlob (in press) explored the effect of recall order on list method directed forgetting, a factor which Geiselman et al. (1983) had claimed was not influential. In Experiment 1, Golding and Gottlob first demonstrated that, left to their own devices, participants tended to recall the R (second) sub-list before the F (first) sub-list. When Golding and Gottlob then forced the order to be either R then F or F then R in Experiments 2 and 3, they found a directed forgetting effect only for the R-then-F order, consistent with the preference pattern in Experiment 1. They saw this pattern as inconsistent with an inhibition account, and more consistent with a retrieval strategy favoring priority in recall of the more recent R items. We simply note that it is possible that this preference results from subjects recalling first what they are currently rehearsing, which would help to mesh the Golding and Gottlob finding with a selective rehearsal explanation.

There is other recent research to support the selective rehearsal explanation of list method directed forgetting. Using a post-experimental questionnaire, Whetstone, Cross, and Whetstone (1996) found that considerably more of the participants in the R condition reported selective rehearsal in terms of thinking about List 1 while studying List 2 than did F participants. Conway, Harries, Noyes, Racsma'ny, and Frankish (2000) found that the directed forgetting effect was reduced and could even be eliminated with a sufficient memory load during List 2 processing. This is consistent with a selective rehearsal account if we assume, quite reasonably, that the higher memory load prevented rehearsal. They also showed that the directed forgetting effect was eliminated if there was sufficient semantic relatedness between the F and R sub-lists. Similar to the argument of Kimball and Metcalfe (2001), semantic associations between the two sublists could lead participants to rehearse items across the two sub-lists rather than selectively rehearsing List 2 items.

Conclusions

In this chapter, we have considered the various accounts that have been provided over the past 35 years or so for the phenomenon of directed forgetting, which provides an experimental analogue to the everyday updating of memory. Two rise above all others: selective rehearsal and retrieval inhibition. It is clear to virtually all investigators (see MacLeod, 1998, for a review) that, for the item method of directed forgetting where each item receives its own instruction, selective rehearsal is the mechanism that underlies the advantage of R items over F items. Participants hold each item in abeyance until its instruction appears, and then they only rehearse R items. The theoretical debate, then, concerns the list method, where one sub-list is designated F and the other sub-list is designated R, such that multiple items receive the same instruction simultaneously.

The retrieval inhibition account is presently the dominant explanation of list method directed forgetting (see discussion in MacLeod, 1998; MacLeod et al., 2003), maintaining that the entire F sub-list is suppressed, and hence less likely to be retrieved at the time of test. Consistent with our broader concern regarding inhibitory mechanisms in attention and memory (see MacLeod et al., 2003), we have questioned whether list method directed forgetting might also be successfully explained using a selective rehearsal account. Toward that end, we have presented evidence from two lines of work in our laboratory as well as additional work from other laboratories that is inconsistent with an inhibition explanation and quite consistent with a selective rehearsal explanation.

The implications of a unified selective rehearsal account are interesting. Johnson (1994) argued that item method directed forgetting is not directed forgetting at all, but merely directed—hence selective—rehearsal or learning. She further argued that list method directed forgetting is true directed forgetting because the information is learned before the instruction, such that impaired recall reflects true forgetting and not just differences in learning. Based on Johnson's criterion, our proposal that list method directed forgetting is also due to selective rehearsal implies that there is no true directed forgetting! We see this as the wrong conclusion, however, and believe that both methods of delivering instructions to forget can be informative about how we update our memories. That this updating appears to rely heavily on selective rehearsal does not surprise or disappoint us—it is indeed reminiscent of the argument that "flashbulb" memories are well remembered not because of their special emotional nature but because they are rehearsed more often (see, e.g., McCloskey, 1992; Shum, 1998). Se-

lective rehearsal is undoubtedly among our most fundamental memory abilities.

Author notes

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References

Basden, B. H., & Basden, D. R. (1998). Directed forgetting: A contrast of methods and interpretations. In J. M. Golding and C. M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 139-172). Mahwah, NJ: Lawrence Erlbaum Associates.

Basden, B. H., Basden, D. R., & Gargano, G. J. (1993). Directed forgetting in implicit and explicit memory tests: A comparison of methods. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 603-616.

Bjork, R. A. (1970). Positive forgetting: The noninterference of items intentionally forgotten. *Journal of Verbal Learning and Verbal Behavior, 9*, 255-268.

Bjork, R. A. (1972). Theoretical implications of directed forgetting. In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory* (pp. 217-235). Washington, DC: Winston.

Bjork, R. A. (1978). The updating of human memory. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 12, pp. 235-259). New York: Academic Press.

Bjork, R. A. (1989). Retrieval inhibition as an adaptive mechanism in human memory. In H. L. Roediger, III & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving* (pp. 309-330). Hillsdale, NJ: Erlbaum.

Bjork, R. A., & Geiselman, R. E. (1978). Constituent processes in the differentiation of items in memory. *Journal of Experimental Psychology: Human Learning and Memory, 4*, 347-361.

Bjork, R. A., LaBerge, D., & Legrand, R. (1968). The modification of short-term memory through instructions to forget. *Psychonomic Science, 10*, 55-56.

Bjork, R. A., & Woodward, A. E., Jr. (1973). Directed forgetting of individual words in free recall. *Journal of Experimental Psychology, 99*, 22-27.

Brown, J. (1954). The nature of set-to-learn and of intra-material interference in immediate memory. *Quarterly Journal of Experimental Psychology, 6*, 141-148.

Caldwell, R. S. (1987). *Hesiod's Theogony*. Newburyport, MA: Focus.

Cohen, R. (1970). Recency effects in long-term recall and recognition. *Journal of Verbal Learning and Verbal Behavior, 9*, 672-678.

Conway, M. A., Harries, K., Noyes, J., Racsma'ny, M., & Frankish, C. R. (2000). The disruption and dissolution of directed forgetting: Inhibitory control of memory. *Journal of Memory & Language, 43*, 409-430.

Daniels, G. (Writer) & Baeza, C. (Director). (1994). Secrets of a successful marriage [Television series episode]. In M. Groening (Producer), *The Simpsons*. Beverly Hills, CA: Twentieth Century Fox Film Corporation.

Eich, J. E. (1980). The cue-dependent nature of state-dependent retrieval. *Memory & Cognition, 8*, 157-173.

Elmes, D. G., Adams, C. A., III, & Roediger, H. L., III (1970). Cued forgetting in short-term memory: Response selection. *Journal of Experimental Psychology, 86*, 103-107.

Epstein, W. (1969). Poststimulus output specification and differential retrieval from short-term memory. *Journal of Experimental Psychology, 82*, 168-174.

Epstein, W. (1972). Mechanisms of directed forgetting. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 6, pp. 147-191). New York: Academic Press.

Epstein, W., Massaro, D. W., & Wilder, L. (1972). Selective search in directed forgetting. *Journal of Experimental Psychology, 94*, 18-24.

Epstein, W., & Wilder, L. (1972). Searching for to-be-forgotten material in a directed forgetting task. *Journal of Experimental Psychology, 95*, 349-357.

Freud, S. (1900/1964). *The interpretation of dreams*. New York: Basic Books.

Freud, S. (1938). *Basic writings*. New York: Modern Library.

Geiselman, R. E. (1974). Positive forgetting of sentence material. *Memory & Cognition, 2*, 677-682.

Geiselman, R. E. (1975). Semantic positive forgetting: Another cocktail party phenomenon. *Journal of Verbal Learning and Verbal Behavior, 14*, 73-81.

Geiselman, R. E., & Bagheri, B. (1985). Repetition effects in directed forgetting: Evidence for retrieval inhibition. *Memory & Cognition, 13*, 57-62.

Geiselman, R. E., Bjork, R. A., & Fishman, D. L. (1983). Disrupted retrieval in directed forgetting: A link with posthypnotic amnesia. *Journal of Experimental Psychology: General, 112*, 58-72.

Geiselman, R. E., & Panting, T. M. (1985). Personality correlates of retrieval processes in intentional and unintentional forgetting. *Personality and Individual Differences, 6*, 685-691.

Geiselman, R. E., Rabow, V. E., Wachtel, S. L., & MacKinnon, D. P. (1985). Strategy control in intentional forgetting. *Human Learning, 4*, 169-178.

Gilliland, T. R., McLaughlin, K., Wright, M., Basden, B. H., & Basden, D. R. (1996). *The "warning effect" in directed forgetting.* Poster presented at the annual convention of the Western Psychological Association, San Jose, CA.

Golding, J. M., & Gottlob, L. R. (in press). Recall order affects the magnitude of directed forgetting in the within-participants list method. *Memory & Cognition*.

Golding, J. M., & Long, D. L. (1998). There's more to intentional forgetting than directed forgetting: An integrative review. In J. M. Golding and C. M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 59-102). Mahwah, NJ: Lawrence Erlbaum Associates.

Golding, J. M., & MacLeod, C. M. (Eds.). (1998). *Intentional forgetting: Interdisciplinary approaches*. Mahwah, NJ: Lawrence Erlbaum Associates.

Horton, K. D., & Petruk, R. (1980). Set differentiation and depth of processing in the directed forgetting paradigm. *Journal of Experimental Psychology, 6*, 599-610.

James, W. (1890/1981). *The principles of psychology* (Vol. 1). Cambridge, MA: Harvard University Press.

Johnson, H. M. (1994). Processes of successful intentional forgetting. *Psychological Bulletin, 116*, 274-292.

Kihlstrom, J. F., Beer, J. S., & Klein, S. B. (2003). Self and identity as memory. In J. Price (Ed.), *Handbook of self and identity* (pp. 68-90). New York: Guilford Press.

Kimball, D. R., & Metcalfe, J. (2001). *Directed forgetting: Evidence against a suppression mechanism*. Poster presented at the annual meeting of the Psychonomic Society, Orlando, FL.

Kintsch, W. (1968). Recognition and free recall of organized lists. *Journal of Experimental Psychology, 78*, 481-487.

Liu, X., Bjork, R. A., & Wickens, T. D. (1999). *List method directed forgetting: Costs and benefits analyses.* Poster session presented at the annual meeting of the Psychonomic Society, Los Angeles, CA.

Luria, A. R. (1968). *The mind of a mnemonist: A little book about a vast memory*. (Translated by L. Solotaroff). Cambridge: Harvard University Press.

MacLeod, C. M. (1975). Long-term recognition and recall following directed forgetting. *Journal of Experimental Psychology: Human Learning and Memory, 1*, 271-279.

MacLeod, C. M. (1998). Directed forgetting. In J. M. Golding and C. M. MacLeod (Eds.), *Intentional forgetting: Interdisciplinary approaches* (pp. 1-57). Mahwah, NJ: Lawrence Erlbaum Associates.

MacLeod, C. M. (1999). The item and list methods of directed forgetting: Test differences and the role of demand characteristics. *Psychonomic Bulletin & Review, 6*, 123-129.

MacLeod, C. M., Dodd, M. D., Sheard, E. D., Wilson, D. E., & Bibi, U. (2003). In opposition to inhibition. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 43, pp. 163-214). San Diego, CA: Academic Press.

McCloskey, M. (1992). Special versus ordinary memory mechanisms in the genesis of flashbulb memories. In E. Winograd & U. Neisser (Eds.), *Affect and*

accuracy in recall: Studies of "flashbulb" memories (pp. 227-235). New York: Cambridge University Press.

Muther, W. S. (1965). Erasure or portioning in short-term memory. *Psychonomic Science, 3*, 429-430.

Reitman, W., Malin, J. T., Bjork, R. A., & Higman, B. (1973). Strategy control and directed forgetting. *Journal of Verbal Learning and Verbal Behavior, 12*, 140-149.

Rundus, D. (1971). Analysis of rehearsal processes in free recall. *Journal of Experimental Psychology, 89*, 63-77.

Rundus, D., & Atkinson, R. C. (1970). Rehearsal processes in free recall: A procedure for direct observation. *Journal of Verbal Learning and Verbal Behavior, 9*, 99-105.

Sahakyan, L., & Delaney, P. F. (2003). Can encoding differences explain the benefits of directed forgetting in the list method paradigm? *Journal of Memory and Language, 48*, 195-206.

Sahakyan, L., & Kelley, C. M. (2002). A contextual change account of the directed forgetting effect. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 28*, 1064-1072.

Sheard, E. D., Dodd, M .D., Wilson, D. E., & MacLeod, C. M. (2004). *Strategic rehearsal and the directed forgetting warning effect*. Manuscript submitted for publication.

Sheard, E. D., & MacLeod, C. M. (2002). *Serial position effects in list-method directed forgetting: Evidence of selective rehearsal*. Poster presented at the annual meeting of the Psychonomic Society, Kansas City, MO.

Shebilske, W., Wilder, L., & Epstein, W. (1971). Forget instructions: Effect of selective rehearsal and categorical distinctiveness. *Journal of Experimental Psychology, 89*, 372-378.

Shum, M. S. (1998). The role of temporal landmarks in autobiographical memory processes. *Psychological Bulletin, 124*, 423-442.

Spector, A., Laughery, K. R., & Finkelman, D. G. (1973). Rehearsal and organization in intentional forgetting. *Journal of Experimental Psychology, 98*, 169-174.

Timmins, W. K. (1973). Repetition of intentionally forgotten items. *Journal of Verbal Learning and Verbal Behavior, 12*, 168-173.

Wegner, D. M. (1994). Ironic processes of mental control. *Psychological Review, 101*, 34-52.

Weiner, B. (1968). Motivated forgetting and the study of repression. *Journal of Personality, 36*, 213-234.

Weiner, B., & Reed, H. (1969). Effects of the instructional sets to remember and to forget on short-term retention: Studies of rehearsal control and retrieval inhibition (repression). *Journal of Experimental Psychology, 79*, 226-232.

Whetstone, T., Cross, M., & Whetstone, L. (1996). Inhibition, contextual segregation, and subject strategies in list method directed forgetting. *Consciousness & Cognition, 5*, 395-417.

Woodward, A. E., Jr., & Bjork, R.A. (1971). Forgetting and remembering in free recall: Intentional and unintentional. *Journal of Experimental Psychology, 89*, 109-116.