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The effects of list-method directed forgetting on recognition memory

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It is an almost universally accepted claim that the list-method procedure of inducing directed forgetting does not affect recognition. However, previous studies have omitted a critical comparison in reaching this conclusion. This article reports evidence that recognition of material learned *after* cue presentation is superior for conditions in which the material that preceded cue presentation was designated as to-be-forgotten. Because the absence of an effect of directed-forgetting instructions on recognition is the linchpin of the theoretical claim that retrieval inhibition and not selective rehearsal underlies that effect, the present results call into question the need to postulate a role for inhibition in directed forgetting.

The directed-forgetting methodology, in which the effects of experimental instructions to forget a subset of studied material are examined, has undergone somewhat of a renaissance in the recent literature. This renewed interest probably derives in part from an influential and fascinating recently edited volume by Golding and MacLeod (1998), in which parallels are drawn between the basic experimental procedure and widely ranging phenomena of clinical, legal, and social interest. In the 7 years prior to the publication of that book, PsycINFO reports there were 37 entries that used the term *directed forgetting*; in the 7 years following its publication, there were 109. Some of the attention probably owes to the claim that directed forgetting involves memory inhibition, a claim that invites comparison with arguments about memory repression (Freud, 1915).

The central empirical finding that has been used to support the claim of memory inhibition in directed forgetting is that the list-method procedure—in which a cue to *remember* or *forget* the preceding material is placed in the middle of a list of studied items—appears to affect recall (see, e.g., R. A. Bjork, LaBerge, & Legrand, 1968) but not recognition (Block, 1971; Elmes, Adams, & Roediger, 1970) performance. This apparent dissociation contrasts with results from experiments that have used the item-method procedure, in which individual items are cued as to-be-remembered or to-be-forgotten immediately following their presentation. In that paradigm, to-be-forgotten items have been more poorly recalled and recognized (see, e.g., Davis & Okada, 1971; MacLeod, 1975). For recall, it has generally been accepted that selective rehearsal accounts well for the pattern of results (B. H. Basden, D. R. Basden, & Gargano, 1993).

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In a comprehensive review of the work on directed forgetting, MacLeod (1998) listed the finding that list-method directed forgetting leads to a null effect on recognition as one of the 12 most important findings in the field to date. However, there have actually been very few studies that directly assessed recognition memory using the list-method procedure, and they all shared an odd characteristic: They failed to report performance for all of the conditions relevant to the basic directed-forgetting effect. Early studies (Block, 1971; Elmes et al., 1970) reported recognition performance only for precue items, for which hit rates did not differ between cue conditions. B. H. Basden et al. (1993) tested both pre- and postcue items, but only for a group that received a forget cue: They did not include a control condition in which subjects received a remember cue between list halves. Performance did not differ between conditions in that experiment. Instead, a null effect was evident between pre- and postcue items in the group that received the forget instruction.

The purpose of the present study is to examine the full set of conditions relevant to the assessment of the directed-forgetting effect. Two canonical findings are a sine qua non of that effect: (1) A forget instruction leads to poorer memory for the targeted material than does a remember instruction, and (2) a forget instruction leads to superior memory for materials learned following that instruction. Taken together, these results have usually revealed an ordinal interaction in which memory performance decreased across list halves for the group given the remember instruction, but increased across list halves for the group given the forget instruction. The crux of the directed-forgetting effect—namely, this ordinal interaction in memory performance between list half and cue type—has not previously been assessed, and it is the focal analysis of this article. The critical simple effect in that interaction—which has previously remained unexamined—is the effect of orienting instruction on memory for materials learned following that cue. This oversight is understandable, insofar as the

term *directed forgetting* tacitly emphasizes the *forgetting* component of the effect—see finding (1), above. The advantage in memory for postcue material has usually been attributed to a decrease in proactive interference (a decrease that owes to that forgetting); thus, the absence of any obvious forgetting of precue material might be seen as obviating the need for further exploration. However, there are reasons why a difference between groups might reveal itself on postcue but not precue performance under the unique combination of conditions afforded by recognition testing and the list-method encoding procedure. To understand this explanation, I will consider, in turn, (1) the differences between the list method and the item method, and (2) the differences between recall and recognition.

Selective Rehearsal and the Orienting Cue

Consider the possibility that item-method and list-method directed forgetting induce the same strategic effect—differential rehearsal of material according to instructions—but differ in the degree to which they invite effective partitioning of items into to-be-rehearsed and to-be-excluded bins. Item-method procedures allow subjects to engage in rote rehearsal until the cue is given and then either "dump" the item or engage in more potent encoding techniques, as may be warranted (see, e.g., Benjamin & R. A. Bjork, 2000). List-method procedures require subjects to maintain a considerably larger set of items prior to making a strategic decision about their encoding fate; thus, subjects may later suffer from a considerably larger amount of confusion about which items are to be remembered and which are to be forgotten when making decisions about additional retrieval or rehearsal. If this interpretation is correct, then the effects in the list-method paradigm should follow the pattern of results elicited by the item-method procedure, even if those effects are muted by the imposition of other factors.

The mystery of list-method directed forgetting lies in the fact that it induces no difference in the recognition of precue items—the straightforward result that is very much at the heart of experiments that test recall. Several data bear on this question. But note that list-method directed forgetting elicits considerably smaller effects than does item-method directed forgetting (see, e.g., B. H. Basden et al., 1993). This result suggests that subjects in both paradigms attempt to continue rehearsal of precue items when given a remember cue and discontinue when given a forget cue, but they fail to do so as effectively under conditions in which partitioning is delayed and differentiation is difficult. However, the presence of precue differences on tests of recall—smaller effect size notwithstanding—reveals that this difference cannot be the whole story. The nature of the test needs to be considered as well.

Bases for the Recognition Judgment

Recall imposes a premium on the very aspects of memory encoding that are fostered by additional rehearsal (Woodward, R. A. Bjork, & Jongeward, 1973). Thus, it is not surprising that under conditions in which precue items benefit from additional retrieval and rehearsal (following a remember cue), a recall advantage ensues. It is instructive, therefore, to consider the ways in which recognition judgments can be made, because they may not value the same mnemonic characteristics. Of great heuristic value, but of currently debated theoretical significance, is the current distinction between familiarity-based and retrieval-based recognition (see, e.g., Jacoby, 1991; Mandler, 1980). Familiarity characterizes the sources of evidence that are context independent: Recently or frequently exposed stimuli generate generally greater *resonance* in memory upon reexposure. Thus, situations that require discrimination between recently seen and recently unseen stimuli of similar normative frequency encourage the use of such bases for recognition judgments. In contrast, retrieval involves using pattern-completion mechanisms to evoke memory for the specific context of a particular stimulus's earlier exposure. Retrieval-based recognition is necessary for discrimination among items that enjoy similar levels of familiarity due to recent exposure (Benjamin & Craik, 2001; Jacoby, 1999), high normative frequency (Arndt & Reder, 2002; McCormack & Swenson, 1972), or semantic or associative convergence (Benjamin, 2001; Roediger & McDermott, 1995).

One does not need to have intimate familiarity with the literature on directed forgetting to know that the situation in the typical experiment is conducive to familiarity-based recognition. It is entirely possible that retrieval-based recognition is impaired following a forget instruction, but that traditional experiments have created a situation in which familiarity-based recognition—which likely has a considerably less conceptual component (Jacoby, 1983; cf. Toth, 1996) and is thus relatively unaffected by deliberate strategic encoding—leads to quite acceptable performance. This interpretation is consistent with what is otherwise a somewhat conflicting and odd datum in the literature: Subjects are considerably worse at remembering the cue designation (forget or remember) of to-be-forgotten than of to-be-remembered items (Davis & Okada, 1971), as well as the temporal list position of those items (Tzeng, Lee, & Wetzel, 1979). Those judgments necessitate the use of that very component of recognition that is impaired but untapped in the traditional recognition task, as implemented in directed-forgetting paradigms. However, it is also the case that both list position and cue designation are perfectly confounded with recency, as well as with whether the cue is likely to have elicited encoding effort or not (by virtue of its cue designation); thus, those results are difficult to interpret. The present experiment assessed memory for context using a contextual manipulation that is orthogonal to cue designation and list position and thus provides an unbiased manner of assessing the retrieval component of recognition for forget and remember items.

Release From Inhibition?

It has been claimed that exposure to items that were cued to be forgotten "releases" the hold of inhibition on those items and returns them to a level of accessibility comparable to what they would be following a remember instruction (E. L. Bjork & R. A. Bjork, 1996). By the cur-

rent reasoning, however, inhibition plays no role in the directed-forgetting effect and, consequently, there should be no means of "releasing" it. What determines whether a directed-forgetting effect obtains is whether or not a particular memory decision requires retrieval, not whether like-fated items have been previously reexposed. Thus, it is expected that we will see quite a healthy directed-forgetting effect on memory, despite the fact that the relevant items have been reexposed in the course of the test.

Effects of a Forget Cue on Encoding Strategy

There is an alternative but related theoretical basis on which to expect differences in post- but not precue recognition in the list-method procedure. Sahakyan and colleagues (Sahakyan & Delaney, 2003; Sahakyan & Kelley, 2002) have proposed that a forget instruction induces a change in encoding strategy, so that items learned following the instruction are learned well not by virtue of the absence of interfering memory traces, but rather because they are protected from interference by distinctive encoding. In other words, precue items are learned equivalently between groups and are never forgotten or inhibited. They are, however, recalled more poorly because the contextual change persists into the testing period. Because the test context matches the encoding context for postcue items but mismatches the context for precue items, and because the change in encoding context reduces interference across the orienting cue, this theory explains both major directed-forgetting effects discussed earlier. However, recognition testing takes advantage of only one of these differences: Although the reduction in proactive interference is still thought to increase access to postcue items, the effects of contextual match/mismatch are likely to be negated in recognition (Smith, Glenberg, & R. A. Bjork, 1978). Thus, the change-in-encoding theory also provides a basis for predicting differences in postcue but not precue item recognition.

The Present Experiment

In the present experiment, I measured two aspects of recognition memory in a list-method directed-forgetting task. First, *yes*/*no* recognition was assessed for both pre- and postcue items, for both remember and forget groups, and I hypothesized that there would be a directed-forgetting effect but no reliable difference in recognition of precue items. As noted before, this interaction was the critical test in determining whether the directed-forgetting effect obtains.

METHOD

Subjects

Forty-six students participated in exchange for partial fulfillment of course requirements. The data from one subject were excluded because of the subject's failure to perform at an above-chance level on the recognition test.

Design

The experiment employed a 2×2 mixed design, in which all subjects viewed both pre- and postcue words. Cue designation (forget or remember) was manipulated between subjects. The dependent measures were the proportion of studied items endorsed on the later test (hit rate), the proportion of unstudied items incorrectly endorsed (false alarm rate), and the proportion of trials on which the correct presentation color was selected.

Materials

One hundred sixty nouns ranging from four to eight letters long were used in the experiment. Each subject studied a randomly selected half of these items. These 80 items were randomly assigned to either a precue or a postcue position, and one half of the pre- and postcue items were randomly assigned to be studied in red (and the others in green). The two colors were approximately equiluminant, and the background was black. The test consisted of all 160 items presented in random order.

Procedure

Prior to study, the subjects were informed that they would be studying a long list of words and that they should try to remember as many of the words and their colors as possible. They then cycled through the 40 precue items at a rate of 2 sec per word with an 800-msec interstimulus interval. After the cue and further instructions (described below), subjects studied the additional postcue words at the same rate.

The forget cue indicated to subjects that they would not be tested on the items that they had just completed studying, but that they would need to study another set of items that they would be tested on. The remember instruction was similarly worded, but indicated that they would be tested on the precue items in addition to the upcoming (postcue) items.

On the test, subjects were presented with individual words presented in white on a black background. Subjects first made a *yes*/*no* judgment about the prior occurrence of that word in the study list and then they made a forced-choice judgment about the color of its presentation. It was emphasized to subjects that they should endorse *all* previously seen items, regardless of any instructions they had been given about forgetting or remembering. Color judgments were made regardless of the response to the recognition query, and the test was self-paced.

RESULTS

All results reported here are reliable at the $\alpha < .05$ level, unless otherwise noted. For continuity, all inference regions were computed using Student's t distribution, including those for interactions, in which the test was based on a between-subjects comparison of within-subjects differences.

For recognition (see Figure 1) there was a reliable interaction between cue and list half [$t(43) = 2.84$]. Recognition of precue items did not reliably differ between groups, but recognition of postcue items did [$t(43) = 2.39$]. The mean false alarm rates were .24 and .25 for the remember and forget groups, respectively.

Color recognition was scored as the proportion of trials on which the correct color was chosen, and is shown in Figure 2. Again, there was a reliable interaction between cue and list half [$t(43) = 2.57$]. Color recognition of precue items did not reliably differ between groups, but color recognition for postcue items did [$t(43) = 2.16$].

DISCUSSION

For both *yes*/*no* recognition and forced-choice color recognition, the traditional interaction that indicates directed-forgetting effects was evident. The cue to remem-

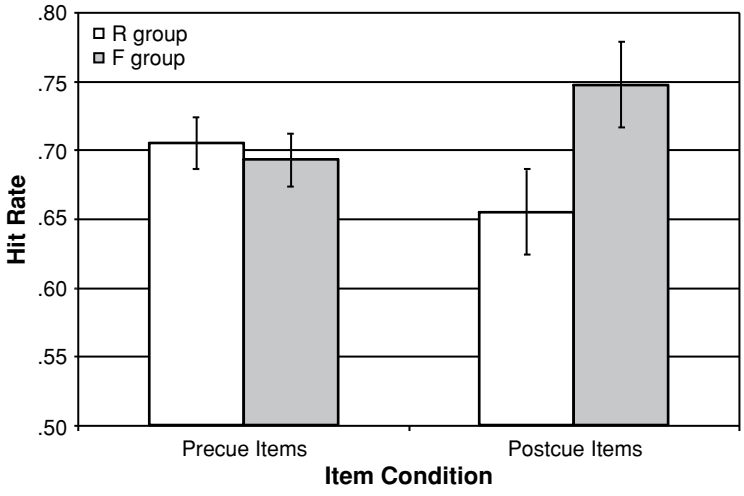

Figure 1. Mean hit rates as a function of cue condition and list half. Error bars represent standard errors of the difference scores between list halves.

ber the previous list half led to poorer memory for items that followed that cue, but a cue to forget the previous items eliminated this effect and, indeed, led to a slight increase in performance across list halves. This result indicates a removal of interference under the forget instruction, and supports the view that recognition is affected by directed forgetting. It is noteworthy that this experiment nonetheless replicated the two previously reported null effects—that which compared precue items for the R and F groups (Davis & Okada, 1971; Elmes et al., 1970) and that which compared pre- and postcue items for a group given a cue to forget (B. H. Basden et al., 1993). Critical for present purposes, the difference between groups was manifest only for postcue items.

The color recognition test revealed an analogous pattern: Color identification dropped markedly in the absence of a forget instruction but rose slightly—though nonsignificantly—when subjects were instructed to forget the precue items. Because color recognition was hypothesized to track retrievability, it is somewhat surprising that a precue difference did not obtain between groups. Although this failure does not change the substantive conclusions of this report, it is surprising nonetheless and suggests that the current theoretical rationale may be in need of subtle revision.

These results are wholly inconsistent with the claim that recognition is unaffected by list-method directed forgetting. They are also, by extension, incompatible with

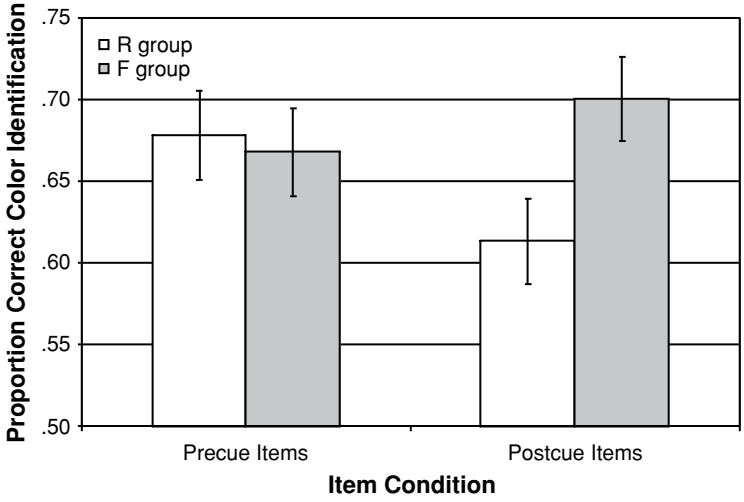

Figure 2. Mean correct color recognition as a function of cue condition and list half. Error bars represent standard errors of the difference scores between list halves.

the claim that inhibition plays a role in directed forgetting. The latter claim can be most easily understood by considering the theoretical claims and evidence from the item-method procedure, in which selective rehearsal is widely considered the most appropriate explanation for the result that to-be-forgotten items are remembered more poorly and interfere less with additional learning. The list-method procedure differed specifically because—it has been thought—it selectively affected recall but not recognition, thus implying a different mechanism was at work.

The present results suggest that only very minor modifications to the theory of that putative mechanism are necessary. In both cases, to-be-forgotten items are devoted fewer mnemonic resources. In both the item-method and list-method directed-forgetting procedures, this selective reallocation leads to enhanced memory for additionally learned materials. However, the degree to which that withdrawal of resources from to-be-forgotten materials affects memory for those materials is clearly reduced in the list-method procedure. This is likely due to a combination of two factors. First, set differentiation is considerably more difficult in the list-method procedure, leading some to-be-forgotten items to mistakenly receive additional retrieval and rehearsal. Second, familiarity-based recognition minimizes the effects of any differential rehearsal of precue items. These two factors dramatically reduce the consequences of the reallocation of resources for to-be-forgotten items in the list-method procedure.

It must be noted that other extant data have been used to support the view that inhibition plays a role in producing directed-forgetting effects. However, those data are somewhat peripheral and must be reinterpreted in light of the present findings. For example, Geiselman, R. A. Bjork, and Fishman (1983) showed that incidentally learned items that were intermixed with to-be-remembered and to-be-forgotten list halves suffered the same mnemonic fate as their list-half counterparts. Because incidentally learned words should not be accorded the same selection in rehearsal distribution, this result is prima facie inconsistent with selective-rehearsal interpretations of directed forgetting.

However, to the degree that set differentiation is difficult in the basic list-method procedure, the discrimination of items within each list half, in which not even temporal cues are available, must be orders of magnitude greater in difficulty. The performance data in Geiselman et al.'s (1983) experiment are consistent with this interpretation. Although in their experiment incidentally learned words were more poorly recalled than intentionally learned words, the two classes were recognized about equally well, suggesting that some aspects of encoding were more or less equivalent for the two types of words.

Geiselman and Bagheri (1985; see also Geiselman & Panting, 1985) showed that words that were previously designated as to be forgotten gained more from an additional study event than did previously to-be-remembered words. This result was interpreted by the authors as a "release" of retrieval inhibition, but it is also open to alternative interpretation. Notably, performance at low levels (as effectuated by the forget cue) has considerably more scale range in which to show improvement than does performance at high levels. It is unreasonable to assume that probability scales, which are bounded—and consequently meaningfully nonlinear—can yield interpretable interactions across dramatically different baseline levels (.58 and .10 in Geiselman & Bagheri's [1985] Experiment 1). Indeed, the negatively accelerated form of learning functions reveals that it is unreasonable to apply linear assumptions to learning-based interactions.[1] Also, all of the experiments discussed in this section used the item-method procedure; thus, they have unclear implications for the contribution of inhibition using the list method, which is the case under examination in this article.

The present results raise serious questions about the contribution of inhibitory processes to the effects of list-method directed forgetting. The patterns seen in recognition are quite compatible with those seen using tests of recall, and also with the results from item-method directed forgetting. It is not my hope to remove consideration of inhibitory mechanisms from descriptions of basic memory processes, including those seen in directed-forgetting paradigms, but rather to encourage a rigorous reevaluation of the contribution of results from list-method directed forgetting to that debate.

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NOTE

1. It should be noted that this analytic awkwardness is hardly unique to the study in question. Indeed, it is omnipresent in much of psychology.

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