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# CUED FORGETTING IN SHORT-TERM MEMORY: RESPONSE SELECTION [1]

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Four experiments used a running paired-associate task to investigate the effects of cueing *S*s to forget items presented prior to a critical pair and to determine how *S*s forget irrelevant information. Cueing *S*s to forget prior information was effective when the list presentation times were equivalent for cued and noncued *S*s. The *S*s cued to forget prior items were less likely to use those items as response intrusions than were *S*s who were not cued to forget the same items. In a postlist recognition task, cued and noncued *S*s recognized the to-be-forgotten items with equal facility.

When we carry on conversations, perform intricate mathematical operations, and solve complex problems, we demonstrate the remarkable facility that humans possess for holding, utilizing, and ignoring information over short intervals of time. Nearly all short-term memory studies have focussed on the determinants of storage and retrieval while only a very small number of experiments have been concerned with the factors involved in ignoring or setting aside information that is no longer relevant (Bjork, 1970; Bjork, LaBerge, & Legrand, 1968; Elmes, 1968, 1969a, 1969b; Turvey & Wittlinger, 1969; Weiner, 1968; Weiner & Reed, 1969).

This small interest in the setting aside or forgetting of irrelevant information is incongruous since the operation of such processes seems vital to insure accurate performance in a variety of learning and memory situations. For example, it is well known that the less an individual has to keep track of at any given point in time, the better is his short-term retention (e.g., Elmes, 1969c). Also, retention improves when *S*s come to recognize that they are no longer responsible for certain items of information (Elmes, 1969b). One would expect, therefore, that efficient storage and retrieval would be dependent, in part, on forgetting irrelevant information. It also appears likely that an understanding of the way(s) in which information is ignored would aid in the understanding of short-term storage and retrieval processes.

The general strategy used to investigate the setting aside of irrelevant information in the present series of experiments is as follows: An *S* is cued to forget some items he has just seen in a running paired-associate list, and the effect of this instruction to forget on the retention of later items in the series is assessed. What this cue to forget presumably should do is to reduce the number of items that *S* needs to retain. Thus, *S*'s storage load for a particular pair should be smaller following a cue to forget than when no cue is presented, and the cue should improve subsequent retention.

In an earlier experiment in which this technique was used (Elmes, 1969b, Exp. II), improved retention following a cue to forget prior items was not observed.[4] Subsequently, however, it has been shown that cueing *S*s to forget can modify retention in the running paired-associate task (Elmes, 1969a). Since previous experiments conducted in the Washington and Lee Labora-

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[4] Such a result reminds one of the unsuccessful alchemist who could not convert lead into gold because his formula required him to stir lead for one hour without thinking of elephants.

TABLE 1

SAMPLE LISTS ILLUSTRATING THE TASK AND MATERIALS

| Cue condition | | No-cue condition | |
|---|---|---|---|
| train | most | train | most |
| full | silk | full | silk |
| bell | met[a] | bell | met |
| full | | full | |
| charm | owner[a] | charm | owner |
| train | | train | |
| rush | wet[a] | rush | wet |
| (cue to forget) | | | |
| volume | aunt | volume | aunt |
| volume | | volume | |
| leg | grand[b] | leg | grand[b] |
| heat | bone | heat | bone |
| tip | great | tip | great |
| pick | devil | pick | devil |
| tip | | tip | |
| leg[c] | | leg[c] | |
| pick | | pick | |
| heat | | heat | |
| | | bell | |
| | | charm | |
| | | rush | |

[a] To-be-forgotten pairs.
[b] Critical item presentation.
[c] Critical item recall point.

tory did not always demonstrate improved retention following a cue to forget, one of the purposes of the present research was to specify the conditions under which cueing to forget enhances retention. In order to better understand how irrelevant information is set aside, a second purpose of the present studies was to determine, if possible, how information is ignored and what happens to that information after it is set aside.

## METHOD

*General procedure.*—The lists shown in Table 1 illustrate the general nature of the running paired-associate task and the kinds of materials used. The *S*s attempt to recall a response when its stimulus is presented alone, and each pair is presented and tested once. The lists contain from 8–14 pairs of common English words, and the pairs and stimuli alone are presented by an automatic slide projector at a 2-sec. rate. During an experiment, a single *S* is presented with several lists each of which contains different stimuli and responses. Between each list there is a 30-sec. rest. The cue to forget has taken several different forms and its presence or absence has been a between-*S*s variable.

In the cue condition shown in Table 1, note that three pairs have not been tested for retention when the cue to forget is presented. These are the pairs that the cued *S*s are supposed to forget, and, of course, the cued *S*s are not tested for retention of these items. The *S*s who do not receive a cue to forget are tested for retention of these pairs at the end of the list.

The primary dependent measure is the number of so-called critical items correctly recalled by *S*s who have, and by *S*s who have not, been cued to forget pairs presented prior to the critical one. The length and composition of the retention interval of all critical items is equated for the cue and no-cue conditions. To minimize the possibility of isolation or emphasis of the critical pair by the cue, a pair is presented and tested between the presentation of the cue and the critical item. Note that from *S*'s point of view the critical pair is no different than any other pair in the list. Critical items are shifted from list to list so that they are presented to both cued and noncued *S*s in a variety of contexts. The time intervals in the lists presented to cued and noncued *S*s were equivalent in the present experiments unlike those in a previous study (Elmes, 1969a) in which the cue (a blank slide and buzzer occurring together) added 2 sec. between the items to-be-forgotten and the critical pair in the cue condition.

In the present experiments, length and composition of the critical item retention interval were varied in addition to the cue–no-cue variable. The additional variables were manipulated within *S*s and, therefore, added variety to the kinds of lists presented. Since the effects of retention interval length and composition are not of primary concern and do not interact with the cue–no-cue variable, they will not be discussed.

*Experiments I and II.*—Experiments I and II were essentially the same. In Exp. I all *S*s (15 each in the cue and no-cue conditions) saw the same 12 lists. The *S*s in the cue group heard a buzzer during the change time of the projector at a point analogous to the cue position shown in Table 1. These *S*s were told to forget pairs presented prior to the buzzer. The *S*s in the no-cue group did not hear the buzzer. Subsequent to the the end of the last list, *S*s were presented a sheet of paper which contained all the pairs from the terminal list interspersed among three times as many new pairs that they had not seen during the experiment. The *S*s were allowed as much time as needed to circle the pairs they thought had appeared in the final list. Experiment II differed from Exp. I in that there were 12 *S*s in each group instead of 15, and a recognition test was not administered after the last trial. In all other respects these experiments followed the general procedure previously outlined.

*Experiment III.*—The 12 *S*s in the cue group and the 12 *S*s in the no-cue group were presented the same 12 lists. A blank slide appeared in each list at a point similar to the cue position shown in Table 1. The noncued *S*s were told that the blank slide was necessary for programming the lists and was irrelevant to the task. In the cue condition a buzzer sounded when the blank slide appeared, and the cued *S*s were instructed to

forget the untested pairs presented prior to the blank slide and buzzer. Other procedural details were the same as those described previously.

*Experiment IV.*—At a point analogous to the cue position shown in Table 1, a blank slide appeared in all nine lists presented to the nine *S*s in each of four groups. One of these groups was told to forget pairs presented prior to the blank slide, while another group was instructed to ignore the blank slide. The second two groups heard a buzzer when the blank slide appeared in the lists. One of these two groups was told to ignore the blank slide and buzzer, while the final group was instructed to forget pairs presented prior to the blank slide and buzzer. Of the four groups, therefore, two received a cue to forget, and two groups received similar stimulation but without instructions to forget. Following the final list, *S*s were required to select the responses that appeared in the final list from a group of new words three times greater than the number of responses in the final list. Unlimited time was allowed for selection of responses. The remainder of the procedure followed that described previously.

## Results

*Critical item recall.*—The proportions of critical items correctly recalled in Exp. I and II appear in Table 2. In both experiments a greater proportion of critical items were recalled correctly by cued than by noncued *S*s; however, the difference is not very great in either study and both failed to reach statistical significance, $F$s $< 1$.

In Exp. III, *S*s in the cue group recalled .30 of the critical items correctly, while *S*s in the no-cue group recalled only .17 of the critical items correctly. The superiority of critical item recall in the cue condition is reliable, $F\ (1, 22) = 8.87$, $p < .01$.

The proportions of critical items correctly recalled in each group of Exp. IV are shown in Table 3. A significantly greater proportion of critical items was recalled correctly by *S*s in the cue groups than by *S*s in the no-cue groups, $t\ (34) = 4.11$, $p < .001$. The tendency toward better critical item recall by *S*s who received the blank slide and buzzer together than by *S*s who received the blank slide alone was not reliable, $t\ (34) = 1.04$, $p > .10$.

TABLE 2

PROPORTIONS OF CRITICAL ITEMS CORRECTLY RECALLED IN EXPERIMENTS I AND II

| Exp. | Cue group | No-cue group |
|---|---|---|
| I | .51 | .47 |
| II | .43 | .38 |
| $\bar{X}$ | .47 | .43 |

Note.—Cue to forget presented during an interstimulus interval.

TABLE 3

PROPORTIONS OF CRITICAL ITEMS CORRECTLY RECALLED IN EXPERIMENT IV

| Group | Blank alone | Blank + buzzer | $\bar{X}$ |
|---|---|---|---|
| Cue | .42 | .51 | .47 |
| No cue | .23 | .27 | .25 |
| $\bar{X}$ | .33 | .39 | |

*Critical item errors.*—If *S*s are effectively setting aside or forgetting the to-be-forgotten items, then it would be expected that those items would appear less often as intrusion errors on the critical items for the cued than for the noncued *S*s. In Exp. I–III the mean proportion of intrusion errors on the critical items that came from the to-be-forgotten pairs was .14 for the cued *S*s while the proportion of critical item errors from the corresponding items was .21 in the no-cue groups. Although this difference is in the expected direction, it is not very large. It should be remembered, however, that the cue failed to enhance critical item retention in two of those studies.

In Exp. IV the cue to forget was effective, and in this experiment .08 of the cued *S*s' critical item intrusions came from prior items in the list while .25 of the noncued *S*s' critical item intrusions came from corresponding items. This difference is significant beyond the .05 level, $t\ (34) = 2.02$.

*Posttask recognition.*—In Exp. I the recognition test required *S*s to select pairs of items from the final list that were intermixed with three times as many new pairs. It will be remembered that the cue occurring during an interstimulus interval in Exp. I had only a slight effect on critical item retention. The results of the recognition test following the final list showed the same trend: of the pairs correctly recognized, 52% occurred before the cue in the cue group, while in the no-cue group the corresponding value was 56%.

In Exp. IV the cue had a significant effect on critical item retention. In this experi-

ment the recognition test required *S*s to select the responses that appeared in the final list from a group of new words three times greater than the number of responses in the terminal list. Of the responses correctly recognized by *S*s in the cue groups, .24 were the items to-be-forgotten. The corresponding value in the no-cue groups was .26. In this experiment, therefore, even though the cue had an effect on critical item recall the to-be-forgotten items were recognized about as often by cued as by noncued *S*s.

## Discussion

The purpose of the present research was twofold: (*a*) to determine under what conditions *S*s can be cued to forget prior information in the running paired-associate task; and (*b*) to try to specify how cueing to forget operates.

With respect to the first purpose, it appears that perhaps a lengthy and distinctive cue is necessary for retention to be modified in the present task. It should be noted that the present results demonstrate that cueing to forget operates when the time intervals in cued and noncued lists are equivalent; thus, earlier results (Elmes, 1969a) from an experiment in which there were different intervals in cued and noncued lists are interpretable in terms of cued forgetting.

One of the most famous psychologists in the United States today, Joyce Brothers, has recently admonished her readers to forget the irrelevant because successful retention is dependent upon not cluttering "up your mind with unimportant things (Brothers & Egan, 1967, p. 64)." Brothers is correct as the present and other data indicate, but the question remains: How do *S*s forget the irrelevant?

There seem to be at least four possibilities as to the fate of items that *S*s are to forget (cf. Bjork, 1970). In the first place it could be that *S*s can actively dump information from their short-term storage, actually destroying information that is no longer needed. However, as demonstrated in the present and other research (e.g., Bjork, 1970), *S*s can recognize or recall the to-be-forgetten items, indicating that some information still remains or still is available about the irrelevant information. This same result would also be contrary to the idea that *S*s cease rehearsal of the to-be-forgotten items, and then these items decay from memory (Elmes, 1969a). Another possibility is that *S*s repress irrelevant information. Weiner and Reed (1969) report that some *S*s, called repressers, could not verbalize any difference in the way they handled items to be forgotten and items to be remembered, while other *S*s, called suppressers, reported that they rehearsed the forget items less often than they rehearsed the remember items. Suppressers and repressers had similar patterns of recall. Although this interpretation fits nicely with some clinical hypotheses, the use of verbalization and nonverbalization as indicators of awareness and unconscious thought is controversial, and the repressed items seem available in the sterile nontherapeutic atmosphere of the laboratory.

The preferred explanation of the present results is that *S*s organize their recall and suppress irrelevant information. As Miller (1956) suggested, *S*s organize their short-term memory—in the present instance along a dimension of to-be-rememberedness (or relevance) from to be remembered to to be forgotten. Responses from one set, the remember one, are selected and used, while responses from the other set, the forget set, are set aside or suppressed. Thus, forget or irrelevant items are less likely to appear as intrusions, but *S*s can recognize or recall the items in the irrelevant set when necessary (cf. Bjork, 1970).

Admittedly, the ideas of organized recall and response selection from different sets of items are not well specified. Nevertheless, these ideas provide a reasonable account of the present and other data, and similar notions are in current favor as interpretations of free recall phenomena and the processes involved in the proactive inhibition of long-term memory (e.g., Postman, 1969). In addition, the present results and formulation would seem congenial with the findings of Wickens and associates (e.g., Wickens, Born, & Allen, 1963) that changes in the class of to-be-remembered items can result in a dramatic attenuation of proactive inhibition in short-term memory.

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