DOCUMENT RESUME

ED 069 403 PS 006 130

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TITLE	The List-Length Effect on Long-Term Memory: Forgetting or Lack of Original Storage?
PUB DATE	Sep 72
NOTE	14p.; paper presented at the Annual Convention of the American Psychological Association (80th, Honolulu, Hawaii, Sept. 3-7, 1972)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Bibliographies; Cognitive Processes; College Students; *Educational Research; *Learning Processes; *Memory; *Recall (Psychological); *Research Methodology; Retention; Retention Studies; Speeches; Technical Reports
IDENTIFIERS	Shiffrins Procedure

ABSTRACT

In a recent study by Shiffrin (1970) where list N was not recalled until after list N+1 had been studied, the length of List N was considered to be a variable that affected forgetting from long-term memory (LTM). However, due to a confounding in Shiffrin's design, recall failures could have been due either to forgetting from LTM or to lack of original storage in LTM. Using a modification of Shiffrin's procedure, the present study showed that the primary effect of list length is on original storage in LTM rather than on forgetting from LTM. (Author)

APA, 1972

ED 069403

The List-Length Effect on Long-Term Memory: Forgetting or Lack of Original Storage?

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Abstract

In a recent study by Shiffrin (1970) where list N was not recalled until after list N+1 had been studied, the length of list N was considered to be a variable that affected forgetting from long-term memory (LTM). However, due to a confounding in Shiffrin's design, recall failures could have been due either to forgetting from LTM or to lack of original storage in LTM. Using a modification of Shiffrin's procedure, the present study showed that the primary effect of list length is on original storage in LTM rather than on forgetting from LTM.

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The frame of reference used here comes from two-state memory models (Atkinson & Shiffrin, 1968) where the two memory states are short-term memory (STM) and long-term memory (LTM). The assumption is made that all attended items enter enter STM; thereafter, they will be forgotten from STM within 30 seconds of the time that rehearsal ceases (Peterson & Peterson, 1959). While in STM, they *may* be transferred, or copied, into LTM (Hebb, 1961) and items stored in LTM will eventually be forgotten. As used here, "learning" refers to the transferral of items from STM to LTM, and "forgetting" can be interpreted either as an actual loss of information (trace erosion) or as a loss of access to information still in memory (retrieval failure). The critical argument is that recall errors occurring after the duration of STM can reflect *either* lack of original storage in LTM *or* forgetting from LTM. This view is applied to a study by Shiffrin (1970a) and also to some new data collected in a modification of Shiffrin's paradigm.

The stated aim of Shiffrin's study (1970a) was to differentially test two theories of forgetting: trace erosion and retrieval failure. He used a delayed free-recall paradigm where S studied and recalled a number of different free-recall lists. The interesting innovation was that S always recalled list N after seeing list N+1 (i.e., S always recalled the list prior to the one just presented). Shiffrin found that (a) the proportion of items recalled was independent of the size (5 vs. 20 items) of the list intervening between presentation and test of a given list and (b) the proportion recalled was higher when the tested list was 5 (as opposed to 20) items in length. The interpretation of these results was that the size of the tested list, but not the size of the intervening list, determines the amount of *forgetting* from LTM. This will be referred to as the forgetting interpretation. The forgetting interpretation implicitly assumes that all of the to-be-recalled items were initially stored in LTM during item presentation. However, such an assumption is debatable when one considers Shiffrin's rapid 1 sec/item presentation rate, i.e., it seems doubtful that all of the items were, in fact, ever stored in LTM.

Without knowing how many items were stored in LTM prior to presentation of the intervening list, it is impossible to know how many were forgotten during the presentation of the intervening list. Therefore, one can not rule out the following interpretation, which will be called the lack-of-storage interpretation. The main assumptions are: (a) the proportion of items <u>stored in LTM</u> is lower for 20-item lists than for 5-item lists; (b) the 5- vs 20-item intervening list was not long enough to produce forgetting, much less differential forgetting, of the items in the test list; (c) the proportion of items forgotten from LTM is the same whether an item was a member of a 5-item or 20-item list.

It seems inappropriate to apply the terms "retrieval failure" or "trace erosion" to a retention-test error if the item may not have been stored in LTM in the first place (cf. Underwood, 1964). Although the assumption is tenable that all attended information enters short-term memory (STM), it is not necessarily true that all attended information enters LTM (cf. Cohen & Johansson, 1967; Nelson, 1971). In order to obtain an estimate of forgetting from LTM--whether it be retrieval failure or trace erosion--perhaps one should examine the probability of a retention-test error given that the item could be recalled from LTM prior to the retention interval. And to insure that original recall comes from LTM rather than from STM, a short period of rehearsal-preventing activity could be interpolated between item presentation and original test; this would eliminate recall from STM but leave recall from LTM unaffected (Glanzer & Cunitz, 1966; Postman & Phillips, 1965).

Some data recently collected bear on the above issues. Each of 32 Stanford undergraduates saw a long series of 5-

or 20-item lists, presented at a rate of 1 sec/item. Each list contained items from a single category (e.g., FRUITS)--Shiffrin's lists were not categorized--to focus on individual items within the list rather than on the entire list itself (i.e., category cues could be given to insure that at all times S was recalling items from the correct list as opposed to an irrelevant list). After each list was presented, S counted backwards by threes for 30 seconds to eliminate recall from STM, and then recalled as many items as he could from the list just seen. This original test (OT) provides a measure of the number of items that originally were stored in LTM. Periodically S received a second test--delayed test (DT)--on a previous list, e.g., after the OT on the current list WEAPONS, S saw a card that read "Second test, category FRUITS". At the end of the entire series of 36 lists, S received a final test (FT) where he was asked to recall all of the items in the experiment, first without the aid of category cues and then with the category names provided. The data relevant to the present issue come from two sources.

First, consider those lists that had a DT with one list intervening between OT and DT--as in Shiffrin's study, the size of the intervening list (5 or 20 items) and the size of the DT list (5 or 20 items) were factorially combined in a within-S design. The results are shown in Figure 1. As in Shiffrin's study the unconditional probability of correct recall on DT was greater ($p < .01$) for 5-item DT lists than for

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Insert Figure 1 about here

20-item DT lists, and was unaffected by the size of the intervening list (left panel of Figure 1). The question is, are the nonrecalled items missed because they were forgotten from LTM or because they were never stored in ~~the~~ LTM? Notice that these unconditional DT probabilities are nearly identical to those from OT for the same lists (middle panel of Figure 1). This correspondence between the OT and DT data support the notion that the size of the DT list affects storage in LTM rather than forgetting from LTM. As the right panel of Figure 1 shows, there was extremely little forgetting from LTM during the trial on the intervening list, regardless of the size of the DT list or the size of the intervening list. Therefore, even if 5-item <u>intervening</u> lists do produce less forgetting than 20-item intervening lists, the difference would not be apparent because of the floor effect on the absolute amounts of forgetting.[1]

Second, even when forgetting from LTM does occur, it does not differ as a function of list size. Figure 2 shows the proportion of items from intervening lists (which did not have any DT) that were missed in cued FT but had been correctly recalled on OT.[2] Even when appreciable forgetting occurs--approximately 50% for the majority of lists--the probability of being forgotten is no greater for items in 20-item lists than for those in 5-item lists. However, one might argue

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Insert Figure 2 about here

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that the OT in some way eliminated the effect of test-list size on subsequent forgetting. Note first of all, that very few (less than 8%) of the items missed on OT were subsequently recalled. Therefore, when using the forgetting-as-a-function-of-list-size notion, one might want to re-define the "effective" test-list size in terms of the number of items stored in LTM at the time of OT (see middle panel of Figure 1). These derived list-sizes would then be: for the original 5-item list, 5 x .75 = 3.75 items; for the original 20-item list, 20 x .52 = 10.40 items. Thus, even with these derived estimates of effective list size, the forgetting interpretation (Shiffrin, 1970a; Shiffrin, 1970b, p. 418) would predict differential forgetting as a function of test-list size, but this did not occur (see Figure 2).

Taken together these data support the lack-of-storage interpretation rather than the forgetting interpretation, and suggest that (a) the intervening-list sizes employed were not large enough to produce forgetting from LTM during the trial on the intervening list--this floor effect logically prohibits the comparison of the amounts of forgetting produced by 5-item vs 20-item intervening lists--and (b) test-list size affects storage in LTM more than forgetting from LTM in the delayed free-recall paradigm. The general implication seems clear: Failure to recall on a delayed test can reflect either lack of original storage in LTM (as in Figure 1) or forgetting from LTM (as in Figure 2). Recall failures should not be construed theoretically as instances of forgetting from LTM unless the possibility can be eliminated that they represent lack of original storage in LTM.

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Footnotes

[1]This same situation is suggested in Shiffrin's data. For example, the unconditional probability correct for a 20-item DT list after a 20-item intervening list was .12. When the same 20-item list was studied, followed by 20 seconds of arithmetic, and then recalled (i.e., no intervening list) the probability correct was .16 (Shiffrin, personal communication, 1970). The difference between these two probabilities (i.e., .16 - .12 = .04) is almost surely nonsignificant, suggesting that the 20-item intervening list produced a negligible amount of forgetting from LTM in Shiffrin's study. Therefore, even if the 5-item intervening list had produced less forgetting than the 20-item intervening list, the effect would not have been detectable because of the floor effect on the absolute amount of forgetting from LTM.

[2]In noncued FT, there was actually <u>less</u> forgetting of items from 20-item lists than from 5-item lists, due to the fact that the probability of forgetting the entire category was lower in the former than in the latter. Hence, the cued FT data are more appropriate for the present issue of forgetting of individual items.

Figure Captions

Fig. 1. Performance on the delayed test (DT) and original test (OT) as a function of test-list size and intervening-list size.

Fig. 2. Proportion of items missed (forgotten) on the cued final-recall test, given correct on the original test, as a function of list size and input order of list. (Note: data are from lists which had no DT.)

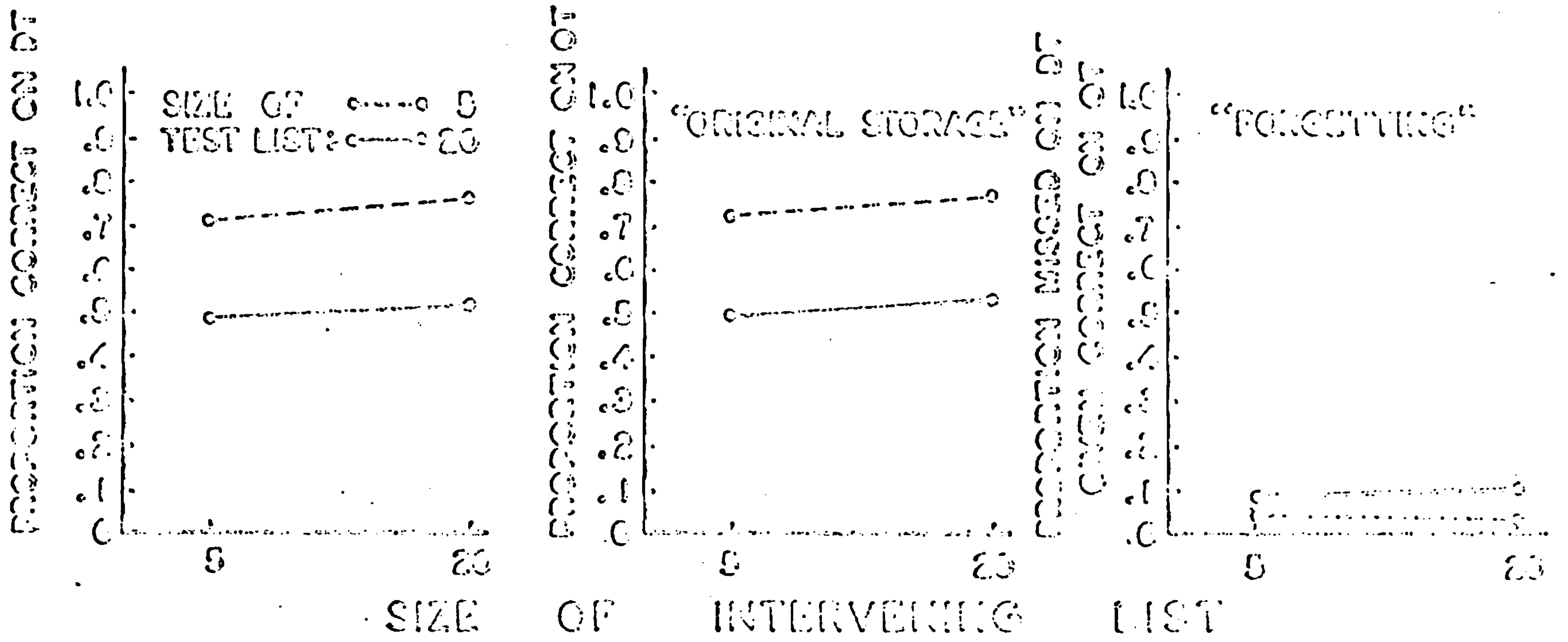
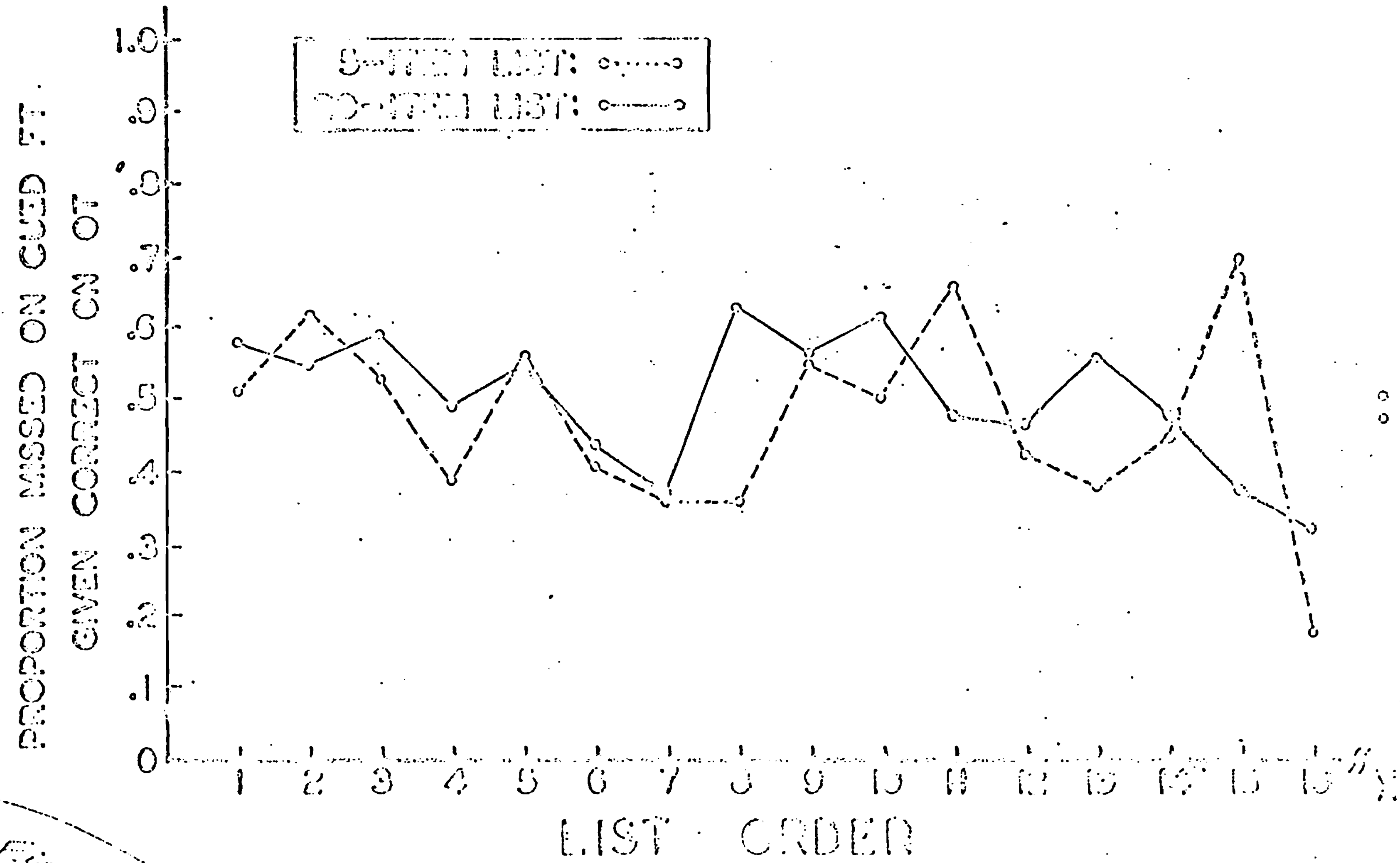

PROPORTION CORRECT ON DT
SIZE OF TEST LIST: 5, 23
PROPORTION CORRECT ON OT
"ORIGINAL STORAGE"
PROPORTION MISSED ON DT
GIVEN CORRECT ON OT
"FORGETTING"
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
5
23
SIZE OF INTERVENING LIST

Fig. 1


PROPORTION MISSED ON CUED FT
GIVEN CORRECT ON OT
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
LIST ORDER