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Subjective Organization and Effects of Repetition in Multi-Trial Free-Recall Learning*, [1]

ENDEL TULVING

University of Toronto, Toronto, Canada

Some experimental evidence is presented in support of the argument that increasing recall over successive practice trials in free-recall learning (FRL) is a consequence of subjective organization and of the development of higher-order memory units (S units). Two experiments showed that mere repetition of list-items on six continuous "reading" trials has no effect on immediately following learning of these items under the standard FRL procedure. Two other experiments demonstrated that learning half of the items from a list immediately prior to the learning of the whole list under the standard FRL procedure retards the learning of the whole list.

Over the past six or seven years we have conducted a large number of free-recall learning (FRL) experiments at Toronto. One of the major problems in this research has been the elucidation of the processes involved in the learning of a list of items over successive trials. Given the fact that human memory is capable of handling only a limited number of list-items on the first trial, why is rehearsal effective in producing higher recall on subsequent trials?

A concept that has figured prominently in our attempts to answer this question is subjective organization, suggested by Miller's (1956a, 1956b) concepts of recoding and unitization. In FRL it has been commonly observed that *Ss* tend to group certain list-items on successive trials. Such grouping of items in recall can be regarded as suggestive evidence for the development of higher-order memory units, each consisting of two or more related items. Since the instructions given to the *S* in a typical FRL experiment do not prescribe any organization of output, and since it is the *S*'s previous experience with the materials used in the experiment that seems to determine the nature and composition of higher-order memory units, we refer to the organization found in the *S*'s output as subjective organization and to the higher-order units as subjective units (S units).

As a first approximation, we assume that the effect of rehearsal in FRL is a consequence of the development of S units. The *S* may not be capable of retrieving more than a limited number of S units on any given trial, but his total recall score goes up because the size of the S units increases over trials.

Some evidence in agreement with this view has come from observed correlations between subjective organization and number of recalled items, and from the findings that increases in recall over trials are closely paralleled by increases in subjective organization (Tulving, 1962, 1964). This evidence points to the primary role of organization in deter-

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mining trial-by-trial increments in recall, but some critics have quite correctly argued that the evidence is only indirect and that organization need be nothing more than a side-effect of trial-by-trial practice. Carterette and Coleman (1963), for instance, have contended that increases in subjective organization *follow* performance increments and therefore cannot determine these increments. And Asch and Ebenholtz (1962) have claimed that FRL occurs in absence of specific inter-item associations. Since associative mechanisms are probably involved in at least some types of S units, Asch and Ebenholtz's claim constitutes a denial of the primary role of organizational processes in determining trial-by-trial increments in recall.

In the present paper, four experiments will be presented that are relevant to the problem of the nature of the relation between subjective organization and the effects of rehearsal. The first two demonstrate that mere repetition of material has no effect on producing higher recall and that something else is needed. The other two experiments illustrate how the learning of a part of a list prior to learning of the whole list retards the mastery of the whole list, thus suggesting that recall performance is dependent upon the existence and the nature of S units.

Mere Repetition Is Ineffective

The first experiment was designed to assess the effects of repetition under conditions where subjective organization and hence the development of S units was minimized, but where otherwise the conditions of practice were met.

In this experiment, two groups of eight *S*s learned a common list of 22 randomly selected English nouns of Thorndike-Lorge (1944) frequency of more than 100 per million. Typical FRL conditions were used (viz. Tulving, 1962). Words were presented at the rate of 1-sec per word. At the end of each trial *S* had 60 sec for oral recall. Twelve learning trials were given.

The groups differed with respect to the treatment they received immediately prior to the learning of the experimental list. Both groups were given a task of reading 22 pairs of items on six continuous trials, but each group read different kinds of pairs. For the Prior Acquaintance (PA) Group, the pairs consisted of the 22 nouns from the experimental list as left-hand members and single letters, randomly selected without replacement, as right-hand members. For the No Prior Acquaintaince (NPA) Group, the pairs consisted of male names and randomly selected two-digit numbers. The pairs of items were presented by means of a memory drum at the rate of 1 sec per pair. The *S*s in both groups were instructed to simply read and pronounce aloud both members of each pair as they occurred. The order of pairs was systematically changed to maximize inter-pair distances over the six trials.

Thus, at the end of this prior practice, *S*s in the PA Group had seen and responded to each of the 22 nouns in the experimental list six times, while the *S*s in the NPA Group had seen and responded to the same number of irrelevant items. If it were just the matter of repeating the list-items in presence of a given set of environmental stimuli and in the context of other items that is responsible for the practice effect, one would expect the PA Group to do considerably better in learning the experimental list than the NPA Group. If, on the other hand, grouping of items in terms of their relatedness is the critical factor, and if, as we assumed to be the case under these conditions, such subjective organization of items by the PA Group were minimal, there would be no reason to expect differences between the groups in memorizing the experimental list.

The learning curves of the two groups for the experimental list are shown in Fig. 1. They are, for all practical purposes, indistinguishable. The mean number of words over all 12 trials was 15.14 for the PA group, and 15.44 for the NPA Group.

It could be argued that *S*s in the PA Group may have incidentally learned associations between nouns and letters in the prior reading task and that these associations may have interfered with the learning of the nouns in the FRL task. To examine this possibility, a second experiment was conducted. All the conditions of this experiment were identical to those of the first one, except that groups of 12 *S*s were used and that the prior reading task involved only single items. For the PA Group, the items were the same as those in the final experimental list, namely 22 high-frequency nouns. For the NPA Group, the items in the reading task were male names. Again, *S*s in both groups were given six continuous trials in the prior task of reading and calling out aloud the items presented by the memory drum.

The two learning curves were again very similar. On the first trial, the PA Group had a nonsignificant

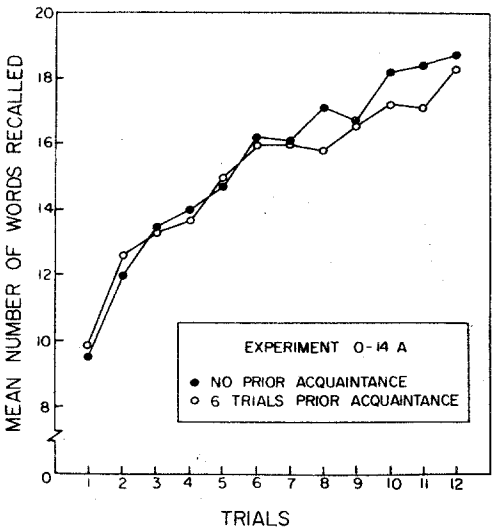

FIG. 1. Learning curves for two groups of *Ss*. One group (open circles) had had prior intra-experimental exposure to list-words, the other group (filled circles) had had no such prior exposure.

advantage over the NPA Group in the mean number of words recalled (10.42 vs. 9.25), but beginning with the second trial there were no consistent or obvious differences. Over all 12 trials, the mean recall for the PA Group was 15.71 and for the NPA Group 15.91.

The findings of these two experiments suggest that mechanical repetition by itself has no effect on recall. If the items are well integrated as independent units prior to the experiment, merely repeating them over and over does not facilitate their memorization. We conclude that only repetition that leads to the formation of higher-order S units, as it occurs under the instructions to memorize the material in a typical FRL task, is effective in permitting the *S* to retrieve more items on later trials than on the first one. It looks as if items in excess of the immediate memory span can be retrieved from the memory storage only through other items as cues for retrieval. However, other items can function as retrieval cues only to the extent to which the material has been organized into higher-order S units.

While alternative interpretations of the findings from the two experiments are undoubtedly possible, it seems that the obtained data cannot be readily accommodated by theories such as the one proposed by Asch and Ebenholtz (1962), according to which free recall depends on "availability" of items, where availability is mainly a function of frequency and recency. The *Ss* in the PA Groups in the two experiments just reported had the benefit of both frequency and recency of repetition of the relevant list items, but this did not apparently help them to recall the items.

Prior Part-List Learning Retards Subsequent Whole-List Learning

If subjective organization and formation of higher-order S units is necessary for the *S* to be able to recall more items in an FRL task than can be handled by immediate memory, and if the number of S units that can be retrieved on any given trial is limited, then it follows that the existence of inappropriate S units may hinder rather than facilitate memorization of a set of items. It is difficult to have *Ss* form completely inappropriate S units under the conditions of a typical FRL task, but it is possible to induce them to form S units that are only partly appropriate for a particular task. For instance, if *Ss* learn only a part of a list first and then attempt to learn the complete list, the S units that have been formed during part-learning need not be most appropriate for handling the material in the whole-learning. If the number of S units that can be retrieved on any given trial is limited, formation of new S units in addition to those developed during part-learning would be ineffective for increasing recall. The *S* could memorize the whole list either by adding "new" words, those that did not occur in the part-list, to the existing S units, or by reorganizing and modifying the existing S units. The first expedient, adding new words, may be applicable only on a limited scale if the items in the list have been selected randomly. The second alternative, reorganizing and

modifying, would probably require extra effort and time, offsetting any potential advantage of prior learning. Therefore, under the conditions of FRL, prior learning of a part of the list may have very little facilitating effect on the learning of the whole list or perhaps even an inhibiting effect.

The third experiment was designed to examine the effect of part-learning on the whole-learning. Two groups of 24 *Ss* learned identical final lists (whole lists) of 36 familiar words on eight trials under the standard FRL procedure. Words were presented at the rate of 1 sec per word on a memory drum. After each trial *Ss* had 72 sec to recall the words orally.

Prior to the learning of the whole list, the Part Learning (PL) Group was given eight trials of standard FRL practice with an 18-word list. All the words in this list were taken from the whole list which the *Ss* were to learn later, although they were not told about this fact. Words were presented at the rate of 1 sec per word and 36 sec was given for oral recall at the end of each trial. The No Learning (NL) Group was given an irrelevant list of 18 words under the same conditions. Thus, at the end of the learning of the first, 18-word list, the *Ss* in Group PL had had eight trials of FRL practice with one-half of the words from the final whole list, while *Ss* in Group NL had had no exposure to the words in the final whole list.

The two learning curves on the whole list of 36 words are shown in Fig. 2. The point on the far left in Fig. 2 shows the mean number of words recalled from the 18-word prior list on the eighth trial. It happened to be identical for both groups. On the whole list of 36 words Group PL had a higher recall score on the early trials than Group NL, but as Fig. 2 shows the curves cross after the fourth trial, with recall scores for the NL being higher than those of the PL Group over the last four trials. The difference in the slopes of the two curves is highly significant statictically, $F(1, 46) = 22.50$, $p < .01$. Prior part-learning aids the recall of items from the whole list on early trials only, while on later trials part-learning seems to retard memorization of the whole list.

It can be argued that the finding of the experiment just described is true only under limited conditions, such as relatively long lists and relatively small amounts of prior learning. Another experiment was therefore designed as a replication of the experiment just reported. In this experiment shorter lists were used and greater amounts of prior part-list practice given to *Ss*. The common final lists consisted of 18 words and prior lists of 9 words. Twelve trials were

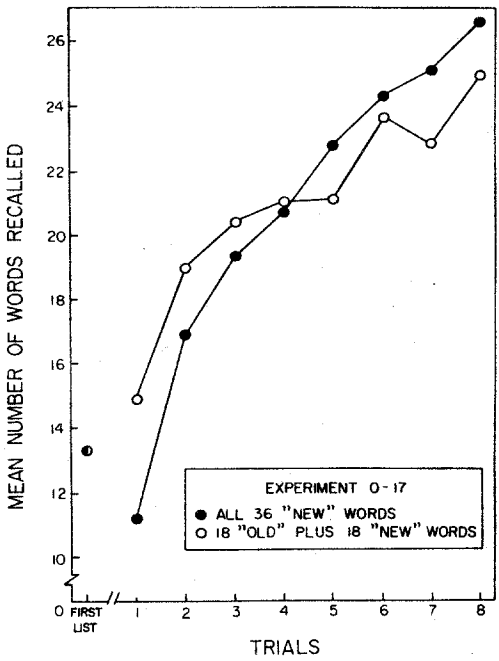

FIG. 2. Learning curves for two groups of *Ss* on a whole list of 36 words. One group (open circles) had learned half of the whole list before learning the whole list, the other group (filled circles) had learned an irrelevant list.

given on both the prior and final lists. Two new groups of 24 *Ss* were used. Words were presented at the rate of 1 sec per word. The amount of time given for recall after each trial was 18 sec for the prior list and 36 sec for the final list.

The two learning curves, shown in Fig. 3, bear a marked similarity to those from the previous experiment. The groups reached approximately the same level of performance on the 12th trial of the prior list. On the final list the PL Group started higher, but the NL Group surpassed it after the seventh trial. Judging by the slopes of the two curves it also looks as if the *Ss* in the PL Group might have had some real trouble ever reaching perfect performance, since they made little progress from Trial 7 to Trial 12.

The finding that learning a part of the list prior to the learning of the whole list retards the acquisition of the whole list may sound paradoxical in the light of what is commonly known and assumed about the effects of practice. But it does make sense if we assume the primary role of subjective organization and of

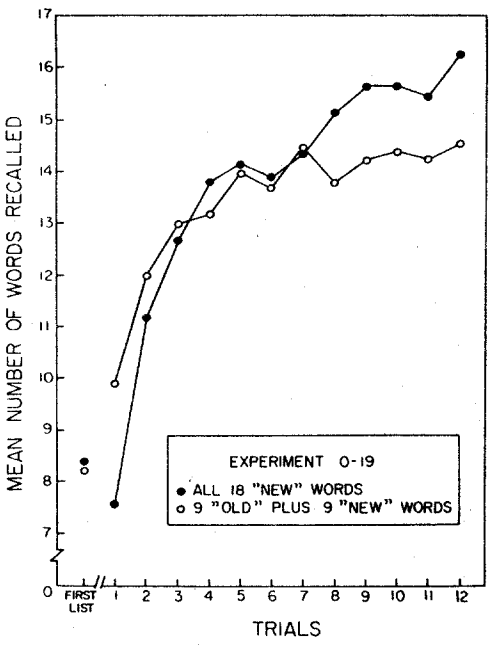

FIG. 3. Learning curves for two groups of *Ss* on a whole list of 18 words. One group (open circles) had learned half of the whole list before learning the whole list, the other group (filled circles) had learned an irrelevant list.

S units in determining the amount of material that can be retrieved. The organization that develops in the course of part-learning is not always appropriate for handling the whole list. To learn the whole list, the *S* must reorganize some of the existing units to accommodate the new material or integrate at least some of the existing S units into larger units. To the extent that *Ss* are incapable or unwilling to abandon or modify the S units formed during part-learning, and to the extent to which retrieval of material on any given trial is limited to a fixed number of S units, the existence of inappropriate S units precludes the successful accomplishment of the task.

CONCLUSION

We believe that the evidence presented here is consistent with the hypothesis that rehearsal is effective in producing increments in recall only if it permits the *S* to organize the material into appropriate S units. Under conditions where repetition of the material does not result in the development of higher-order S units, or where it results in the development of inappropriate S units, it fails to facilitate or may even retard the mastery of the material. At the very least it seems that the findings from these experiments are difficult to reconcile with theories that ascribe the effects of rehearsal in FRL to frequency and recency of responses corresponding to individual items, or theories that regard organizational processes in FRL as by-products of more basic phenomena. The key to the understanding of the effects of rehearsal in FRL lies in the understanding of the subjective organization and of the nature and development of S units.

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