Negative Effects of Using List Items as Recall Cues

DEWEY RUNDUS

The Rockefeller University, New York, New York 10021

It is proposed that recall of an item from a free recall list interferes with subsequent retrieval of other list items. Experiments by Slamecka (Journal of Experimental Psychology 1968, 76, 504-513) showing that providing part of a free recall list at the time of test impaired recall of the remaining list items illustrate this effect. Two experiments were performed examining the decrement in recall resulting from providing various numbers of list items to the subject at the time of test. Both studies found a negative relationship between the number of items given and the recall probability of the remaining list items. A model combining a general organizational structure of memory with a retrieval process and a rule for terminating recall is proposed and the way in which this model accounts for the obtained data is described.

There is an almost universal reaction of surprise among subjects when they first attempt to free-recall a list of words. Although a subject may feel he has “memorized” most of the list items during study, he discovers that he can retrieve only a few items during recall. What are the features of the recall process that might account for this apparent failure to fully utilize the information stored in memory?

Most of the attempts to deal quantitatively with questions about the level of performance in free recall have been directed toward storage variables (such as, total-time hypothesis, Murdock, 1962). When search processes have been considered (for example, Shiffrin, 1970) only minimal attention has been given to one of the more obvious features of subjects’ recall protocols—organization. How might the subject-controlled organization of list items during study interact with some subject-controlled search processes and rules for terminating recall?

The experiments to be described deal with the search process during recall and in particular examine the effect of the recall of an item on subsequent recall of other list items. A possible model of the events occurring during recall will first be outlined to provide a framework for interpretation of the obtained results and also to indicate how retrieval may interact with organization to limit utilization of the information stored in memory.

THE MODEL

A description of the model must begin with a consideration of the subject’s activity during study of a list. It will be assumed that while he is studying a list he is attempting to organize the words of the list. This organization may take the form of attempts to form chunks (Miller, 1956; Mandler, 1967), to discover common feature markers (Kintsch, 1970), or to group together subsets of the list items in some unspecified way. The exact organizational methods employed (such as, association, mnemonic strategies, imagery) need not be specified. What will be assumed is that the organization of the list is under the subject’s control and, as a corollary, that some “reasons for groupings” or “organizing ideas” are used as bases for his organization of the list. The particular organizing idea the subject has used to form any given grouping will be assumed
to be a retrieval cue (Tulving, 1966) for that subset of list items. The term “retrieval cue” seems particularly appropriate since the subject is assumed to have formed the item subsets so that the organizing idea behind each grouping will be useful later as a cue to the retrieval of items belonging to that subset (Dong & Kintsch, 1968).

The identification of groups of words and retrieval cues is perhaps most obvious for lists composed of members of several categories. Examination of rehearsal protocols (Rundus, 1971) has shown that subjects tend to group items from the same category during list study. The retrieval cue for the members of each category can then be identified with the subject's name for the category.

Figure 1 provides an illustration of the proposed organizational structure after list study. A hierarchical model of structure was chosen both because of its consonance with several recently proposed descriptions of the organization of memory (for example, Collins & Quillian, 1969; Mandler, 1969; Miller, 1969) and because of recent experimental evidence (Rourke, 1971) showing a hierarchical model to be superior to an associative network model in predicting output order in free recall. The list items (W) are grouped into subsets according to their association with retrieval cues (RQ). The strength of association between members of a group and the RQ for that group will, in general, not be equal due, at least in part, to differential amounts of rehearsal of the items during list study.

The RQs are themselves assumed to be associated with some general “temporal-contextual” cues that serve to specify the list being considered. The strength of association between RQi and the list cues is assumed to be the sum of the strengths of association between RQi and the items associated with it.

Assuming that the list has been studied and organized in the manner just described it is now possible to outline the proposed retrieval process. An experienced subject will usually begin recall by retrieving those items that he had been rehearsing just prior to the recall signal. This is usually interpreted as recall of items from a highly available but temporary short-term storage (Atkinson & Shiffrin, 1968) or as the use by the subject of temporal and acoustic retrieval cues that provide ready access to those items most recently rehearsed (Tulving, 1968). After these initial few retrievals, the subject will begin the following process of retrieval from long-term storage. An RQ will be retrieved; words associated with the RQ will be retrieved; the first RQ will be abandoned and an RQ will again be chosen; words associated with the newly chosen cue will be retrieved; and so on until further effort seems in vain. Recall will then stop.
A block diagram of the proposed model of the subject's activity during retrieval from long-term storage is shown in Figure 2. The following rules are assumed to govern the retrieval of specific items and RQs from long-term storage. The process begins with the

![Flowchart](image)

**Fig. 2.** Routine for retrieval from long-term storage.
retrieval of one of the RQs. The probability of choosing a particular cue is assumed to be the ratio of the strength of association of that cue with the list cue to the sum of the strengths of association of all RQs to the list cue. This is the familiar ratio rule.

After retrieval of one of the RQs, the subject will then attempt to retrieve the items associated with that cue. Here again the probability of retrieving a particular word on a given retrieval attempt is governed by the ratio rule (that is, the probability of choosing the item is equal to the strength of association of that item to the cue, divided by the sum of strengths of association of all items to that cue).

If the retrieved item has not already been recalled, the subject will respond with that item and will then return to the RQ to continue recall. If the retrieved word has already been recalled, he will note that fact and return to the RQ. Sampling is always assumed to be with replacement so that previously retrieved items may be re-retrieved. Retrieval of an item is assumed to increase the strength of association between that item and its RQ. This assumption seems quite compatible with the results of studies which have shown (a) that a test trial is roughly comparable to a study trial in increasing the probability of subsequent recall of items in a free recall list (Tulving, 1967; Lachman & Laughery, 1968), and (b) that the locus of the facilitory effects of a test trial is in the consolidation of higher-order memory units (Rosner, 1970; Donaldson, 1971). The assumptions of sampling with replacement and the competition in retrieval between items strengthened by prior recall and items remaining to be retrieved have also been posited as reasons for the negative transfer observed in part–whole free recall studies (Brown, 1968).

Attempts to retrieve items using the chosen RQ will continue until a series of $k$ consecutive retrievals of already recalled items suggests to the subject that continued use of that cue will be of little value. At this point he returns to the list cues, again retrieves an RQ, and begins retrieving items in the manner just described. Sampling among RQs is also assumed to be with replacement. Recall is assumed to stop when a series of $m$ consecutively retrieved RQs have each yielded no new items for recall. The parameters $k$ and $m$ are assumed to be under the subject's control within limits imposed by the length of time allotted to him for recall. The parameter $k$ represents the criterion the subject uses to decide that search for another RQ may be more productive than continued retrievals using the current RQ. The parameter $m$ represents the number of consecutively sampled unproductive RQs the subject will tolerate before deciding that further attempts to recall new list items will be of little or no use.

One implication of the retrieval process just described is that recall of one of the items associated with an RQ will lower the probability of recall for other items associated with that cue. Two factors contribute to this effect. First, retrieval of an item is assumed to strengthen the association between that item and the RQ. Since the probability of retrieving an item on any given retrieval attempt is governed by the ratio rule, strengthening the association between a retrieved item and its RQ will cause the probability of re-retrieving the recalled item to increase with a concomitant decrease in the probability of retrieving some other item associated with the RQ. The second way in which recall of an item lowers the probability of recalling other items associated with the same RQ is by increasing the probability of ceasing to sample using that RQ. This occurs because as more items associated with a particular cue are recalled, the probability of retrieving a series of already recalled items, and consequently abandoning the RQ, increases.

If, following the study of a list of words, the subject is given a subset of the list just studied (that is, if some of the items are printed on the recall sheet) and then asked to free-recall the remaining list items, what might be the expected effect? One possibility is that recall of the
nongiven items should be improved since the given items might be expected to provide access to the RQs the subject has established. Alternatively, by the argument just outlined, it might be expected that recall of the nongiven items would be impaired since the given items should have a tendency to be re-retrieved, thus blocking access to other words from the list.

Experiments like the one described were first reported by Slamecka (1968, 1969) and further examined by others (see, Allen, 1969; Hudson & Austin, 1970; Luek, McLaughlin, & Cicala, 1971). Contrary to what might be expected from an association theory interpretation, the given items did not facilitate recall of the remainder of the list. In fact recall of the nongiven list items was impaired when some of the words from the list were provided on the subject’s recall sheet. Unfortunately, characteristics of the design of the Slamecka studies made it difficult to quantitatively examine the negative effects of the given items. In particular, for those studies in which the number of given items was varied, there was a possible confounding of recall from short-term storage with the presence or absence of given items to be examined and possible effects of the time required to read varying numbers of given words.

EXPERIMENT I

Experiment I was designed to provide a set of data free of some of the interpretational difficulties just mentioned: (a) The effects of recall from short-term storage were minimized by interpolating a counting task between study and recall, and (b) the number of words in the set given to the subject at the time of recall was held constant. The manipulated variable in this study was the number of words in the given set that were associated with each of the assumed RQs for a list.

Procedure

Eleven college age subjects were paid for their participation in individual 50-minute experimental sessions. A within-subject design was used with each subject receiving a single study-test trial on each of eight 40-item lists of nouns. Each list was composed of four 10-item categories with different categories used for each list. The category members were chosen from the norms of Battig and Montague (1969) with the restriction that none of the six most frequently given members of a category were included in the lists. The lists were presented auditorily at a rate of 3 seconds per item. The order of presentation of items in a list was randomized for each subject. Immediately following study of a list, a three-digit number was read to the subject and he was required to begin with that number and count forward aloud rapidly by threes for 30 seconds. Following the interpolated counting task, he was given a recall sheet upon which were printed a random ordering of eight of the items from the list just studied. These items were read aloud by the subject and then he was given 2 minutes for written free recall of the remaining 32 list items.

The experimental manipulation involved the choice of the eight list items that appeared on each recall sheet. The items were chosen such that each of the categories of a list contributed either 0, 1, 2, 3, or 4 items to the set of eight given items. There are eight possible combinations of 0, 1, 2, 3, and 4 that yield a total of eight items (e.g., 4, 3, 1, 0; 3, 2, 2, 1). For each subject, seven of these combinations were randomly assigned to Lists 2-8. The combination 2, 2, 2, 2 was always assigned to List 1, which was used as a practice list and not included in the data analysis.

Results and Discussion

The data of primary concern are those relating recall of the nongiven items of a category to the number of given items chosen from that category. The mean numbers of nongiven items recalled from categories that contributed 0, 1, 2, 3, or 4 items to the given set were 3.82, 3.85, 3.36, 2.51, and 2.27, respectively. Since the number of potential candidates for recall decreases as the number given from a category increases, the data are more easily interpreted when they are converted to probabilities of recalling a nongiven item. These probabilities were .38, .43, .42, .36, and .38 for categories contributing 0, 1, 2, 3, and 4 items, respectively, to the given set. A test of these data indicated that the effect of number of given items on recall was only marginally significant \( F(4, 40) = 2.12, .05 < p < .10 \).
It had been expected that the number of items given from a category would be negatively correlated with the probability of recall for the nongiven members of the category. This appears to be the case for 1–4 given items while recall in the 0 condition is much lower than would be expected. This pattern of results can be interpreted as illustrating a combination of both the positive and the negative effects of the given items. A further analysis of the data showed that the probability of recalling at least one nongiven item from a category was lower for the 0 condition than for condition 1–4 (.87 and .96, respectively). Thus, it appears that providing the subject with at least one member of a category at recall increased the likelihood that he would access that category. This result is in agreement with other cueing studies (see Tulving & Pearlstone, 1966; Hudson & Austin, 1970; Tulving & Psotka, 1971).

It is possible to provide a post hoc control for the access problem by including in analysis only those instances when the subject recalled at least one nongiven item from a category. The probability of recall for the nongiven members of a category, conditional upon recall of at least one nongiven member from the category, is shown in Figure 3 as a function of the number of members of that category in the given set. The negative effect of the given items now becomes apparent. The effect of the number of given items on recall for this conditionalized set of data is significant \(F(4, 40) = 2.70, p < .05\). Thus, the given items appear to produce two effects: A given item increases the probability of accessing the RQ to which it is associated, and decreases the recall probability of other items associated with that RQ.

In addition to correct recalls of study words, the subjects also produced a small number of intrusion errors (a mean of .69 extra-list items per subject list), all of which were members of one of the categories appropriate for the list being tested. Occasionally subjects would write one or more of the given items in his recall, but this occurred with a probability of only .03. Both of these types of errors bore no systematic relationship to the number of items given from a category.

**EXPERIMENT II**

Due to the marginal significance of the unconditionalized results of Experiment I, a partial replication of that study was performed. In Experiment II only two conditions were employed—either 1 or 4 given items per category—and an attempt was made to minimize the access problem by always providing at least one instance of each category among the set of given items.

**Procedure**

Thirteen paid subjects of college age each participated in single 1-hour sessions. The details of procedure were the same as in Experiment I with the following two exceptions. First, only seven lists were used with the first list treated as a practice list and not included in analysis, and second, there were 10 items given on the subject's recall sheet, four items from each of two of the list categories and one item from each of the two remaining two categories.

**Results**

As in Experiment I, the probability of recalling a nongiven member of a category was
reduced as the number of items given from that category increased. The observed recall probabilities were .350 and .305 for nongiven items from categories which contributed 1 and 4 items, respectively, to the given set. The effect of number of given items on recall was significant, \( p < .05 \).

**Discussion**

The question posed at the beginning of this paper was “Why does recall stop?”. The results of Experiments I and II provide at least a partial answer to this question: Recall of some of the items of a list reduces the probability of recall for the remaining list items. The model outlined in the introduction illustrates one way of incorporating this partial answer into a more general framework describing the retrieval process and in particular pointing out why recall may stop prior to exhausting all of the information stored in memory.

A computer simulation of this model was written and tested. No systematic attempt was made to fit the data from Experiments I and II; instead, a variety of parameter combinations were examined. Details of the various simulations will not be described, but the following general results of the model simulations should be noted. First, the model does predict that recall will stop with the resulting levels of recall in the range to be expected. The model predicts both the direction and the magnitude of the effects observed in Experiments I and II. The simulation also produces actual output protocols, which include commonly observed features such as a high degree of clustering of items during the initial part of the recall period with the appearance of isolated single members of already recalled categories appearing at the end of recall. The model that has been outlined has been limited in scope so as to provide a minimally complicated framework in which the results of Experiments I and II might be interpreted. More general versions of the model are currently under study.

**References**


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