The effect of order of presentation on learning of "unrelated" words[1]

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Abstract

Two input orders of a set of 16 words were constructed on the basis of output orders of the same set of words given by Ss in an earlier free-recall learning experiment. The High Organization (HO) order was highly congruous with the output orders obtained in the earlier experiment, while the Low Organization (LO) order was highly incongruous. One group of Ss learned the word presented in the HO order, the other group in the LO order. In Experiment I, learning took place under conditions of free recall, in Experiment II, under conditions of serial anticipation. In both experiments, HO order was learned considerably faster than the LO order.

Problem

Ss can recall more words from a list representing a small number of conceptual or associative categories than from a comparable list of unrelated words (Dallett, 1964; Jenkins, Mink, & Russell, 1958). Furthermore, recall is better for a categorized list when all words belonging to a given category are presented in immediately adjacent input positions (blocked presentation) rather than in random positions (Cofer, Bruce, & Reicher, 1964; Dallett, 1964).

In order to compare the effects of blocked and random presentation, the E must have some prior information as to the membership of words in various categories. He can rely on his own knowledge of the language to determine category membership, or he can use normative data from groups of Ss tested for free or constrained associations to individual words (Cohen, Bousfield, & Whitmarsh, 1957; Russell & Jenkins, 1954).

Another method of determining interword relations in a set of words is based on subjective organization that Ss impose on words to be memorized in a free-recall learning experiment (Tulving, 1962, 1964). Consistent groupings of words occur in free recall even when the words have been selected for inclusion in the list without regard to their meaning, being in this sense "unrelated." Some of these groupings are idiosyncratic, but there is frequently a good deal of commonality in the way Ss organize their ouput (Tulving, 1962). Such commonality reveals the structure of the set of words constituting the list and provides a basis for ordering "unrelated" words into well and poorly organized sequences which can be used to mimic blocked and random presentation of words in categorized or associatively structured lists.

Two simple experiments are reported in this paper to demonstrate the effect of order of presentation on learning of a set of "unrelated" words. The list of 16 words used in both experiments had been learned on 16 trials by a group of 16 Ss in an earlier experiment (Tulving, 1962). The order of presentation of the list in that experiment was systematically varied from trial to trial, but a certain degree of commonality of output orders among Ss was found in recall. On the basis of the ouput orders of all 16 Ss over the last half of the trials (Trials 9 to 16) two orders of the 16 words were constructed. In the High Organization (HO) order, successive overlapping pairs of words had occurred very frequently in adjacent positions in Ss' recall protocols of the 1962 experiment, whereas in the Low Organization (LO) order adjacent words had seldom been recalled by Ss in adjacent ouput positions. The HO order was as follows: drumlin, pomade, quillet, hoyden, maxim, issue, accent, treason, barrack, office, finding, walker, garden, valley, lagoon, jungle. The LO order was: valley, issue, walker, accent, office, drumlin, jungle, quillet, lagoon, pomade, garden, maxim, treason, hoyden, finding, barrack. The mean proportion of times that the n+1th word in the HO order had followed the nth word in recall in the 1962 experiment was .162. The same measure of sequential dependency for the LO list was .020.

Thus the words in both lists were identical, and only their order varied. The HO list is comparable to the blocked presentation of a categorized list, while the LO list can be thought as mimicking random presentation.

Experiment I. Free Recall

Two groups of Ss, female undergraduates, learned the list under the conditions of free recall. One group (Group HO), consisting of 12 Ss, learned the list presented always in the HO order; the other group (Group LO), consisting of 11 Ss, learned the list presented always in the LO order. Words were exposed by means of a memory drum at the rate of 1.5 sec. per word. On each trial S had 60 sec. to write down all the words she could remember in any order that they occurred to her. Each S continued learning to the criterion of one perfect trial. The number of trials to this criterion constituted the main dependent variable.

The median number of trials to criterion in Group HO was 3.4 with a range of 2 to 8. In Group LO it was 7.0, with a range of 3 to 11. The median test showed this difference to be significant at better than the .01 level. Nine Ss in Group HO were below the common median of 5.0, while nine Ss in Group LO had scores above 5.0. Thus the list was learned more rapidly when the words were presented in the HO than the LO order.

A second analysis of the data compared the order of recall on the criterial trial with the order of input. Since all Ss recalled 16 words on the criterial trial, each S's recall protocol for that trial contained 15 consecutive overlapping pairs. In the HO group, a mean of 6.08 such pairs were composed of words that had occurred in immediately adjacent input positions in the HO list, while in the LO group, a mean of 2.73 pairs corresponded to the sequential pairs in the LO input list. The difference between these two means was highly significant ($t = 3.81$, $df = 1/21$, $p < .01$). Furthermore, there were, on the average, 3.00 pairs in the last recall trial of the LO group that corresponded to the input pairs of the HO list, but only .54 pairs in the recall protocols of the HO group that coincided with the input pairs of the LO list. These data show that Ss learning the HO list followed the input order more faithfully than did the Ss learning the LO list, and that the LO group tended to follow the HO order in recall despite the fact that they had never been exposed to that order.

Experiment II. Serial Anticipation

The second experiment was identical with the first one in design, except that the Ss' task was to learn the list under the conditions of serial anticipation rather than free recall. Two groups of 14 female undergraduate students served as Ss. None had participated in Experiment I. One group learned the HO list, the other the LO list. Words were presented by means of a memory drum, at the rate of 3 sec. per word. Typical serial anticipation procedure was followed. On each trial the list started with three asterisks as a cue for responding with the first word. Intertrial interval was 9 sec. Each S learned the list to the criterion of one perfect recall.

The median number of trials to criterion in Group HO was 8.2, with a range of 5 to 13. In Group LO it was 13.2, with a range of 7 to 32+ (one S did not reach criterion in 32 trials). The mean number of words correctly anticipated on Trials 1 to 4, on which no S had yet reached perfect recall, was 5.1, 6.9, 8.4, and 10.3, respectively, in the HO group, and 3.2, 4.4, 6.0, and 6.9, respectively, in the LO group. These data are in full agreement with the data from Experiment I, with the exception of overall slower learning under the conditions of serial anticipation. The list was learned considerably more rapidly in the HO than in the LO order.

Discussion

The results of both experiments suggest that the order of presentation is an important determinant of learning of "unrelated" words. When the material is presented in an order that keeps subjectively related subsets of words intact, it can be learned more readily than when the order is antagonistic to the inherent structure of the total set. Thus the present findings are in good agreement with the findings of other experiments demonstrating the effectiveness of blocked presentation of categorized lists (Cofer, Bruce, & Reicher, 1964; Dallett, 1964).

Waugh (1961) has shown that free-recall learning is as effective when the input order is scrambled on successive trials as it is when the order is constant. Waugh's data were averaged over many different constant orders. Since different constant orders have different effects on the ease of learning, Waugh's finding does not necessarily mean that the order of words is irrelevant.

The present investigation shows that it is quite possible for E to organize a set of randomly selected words into "easy" and "difficult" sequential patterns. Any set of words is sufficiently structured for an articulate S to enable him to discover meaningful relations among the words in the set and to utilize these relations in memorization. The way Ss organize a set of words in free recall thus provides a normative base that E can use to manipulate interword relations. Norms obtained for a set of items in this fashion constitute a useful supplement to norms derived from free and constrained associations. They not only reveal relations among words that probably would never become manifest in typical free or constrained association tests, but also illustrate the large variety of kinds of interword relations that define higher-order memory units formed in the course of memorization of experimenter-defined units of verbal material. It is very unlikely, for instance, that any S in an association test would ever respond to "pomade" with "quillet," or to "finding" with "walker." Yet these and other rather esoteric groupings emerged strongly in Ss' recall in the earlier experiment (Tulving, 1962) and their presence as intact groupings in the HO order produced considerable facilitation of recall.

As has been mentioned elsewhere (Tulving, 1962, 1964), subjective organization is based on many different kinds of interword relations. Classification of these relations into associative and categorical relations (Cofer, 1965) may constitute a useful beginning of the analysis of the laws of verbal association and their role in memory, but such classification does not seem to exhaust the great variety of bases of organization that Ss use and Es can manipulate in various memory tasks.

References

Cofer, C. N. On some factors in the organizational characteristics of free recall. *Amer. Psychologist*, 1965, 20, 261-272.

Cofer, C. N., Bruce, D. R., & Reicher, G. M. Clustering in free recall as a function of certain methodological variations. *Tech. Rep. No. 3*, 1964, Contract Nonr 656 (30), The Pennsylvania State University.

Cohen, B. H., Bousfield, W. A., & Whitmarsh, G. A. Cultural norms for verbal items in 43 categories. *Tech. Rep. No. 22*, 1957, Contract Nonr 631 (00), Office of Naval Research, University of Connecticut.

Dallett, K. M. Number of categories and category information in free recall. *J. exp. Psychol.*, 1964, 66, 1-12.

Jenkins, J. J., Mink, W. D., & Russell, W. A. Associative clustering as a function of verbal association strength. *Psychol. Rep.*, 1958, 4, 127-136.

Russell, W. A., & Jenkins, J. J. The complete Minnesota norms for responses to 100 words from the Kent-Rosanoff Word Association Test. *Tech. Rep. No. 11* 1954, Contract N8-onr-66216, University of Minnesota.

Tulving, E. Subjective organization in free recall of "unrelated" words. *Psychol. Rev.*, 1962, 69, 344-354.

Tulving, E. Intratrial and intertrial retention: Notes towards a theory of free recall verbal learning. *Psychol. Rev.*, 1964, 71, 219-237.

Waugh, Nancy C. Free versus serial recall. *J. exp. Psychol.*, 1961, 62, 496-502.

Note

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