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Effectiveness of retrieval cues in memory for words

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Ss had to memorize lists of 24 to-be-remembered (TBR) words. The TBR words were exposed for study on a single input trial, in presence or absence of cue words—weak associates of the TBR words. Recall of TBR words was tested in presence or absence of these cue words. The findings showed that (a) cue words (retrieval cues) facilitated recall of TBR words when they were present both at input and output, (b) retrieval cues did not enhance recall of TBR words when they were present only at output, and (c) 2 retrieval cues presented simultaneously with each TBR word were no more effective in facilitating recall than single cues. The main conclusion was that specific retrieval cues facilitate recall if and only if the information about them and about their relation to the TBR words is stored at the same time as the information about the membership of the TBR words in a given list.

When a person studies a list of to-be-remembered (TBR) words with the intention of recalling them at a later time, appropriate mnemonic information is stored in his memory. This stored information is used at the time of attempted recall to reproduce the original input. The success of recall, broadly speaking, depends on two factors: the amount and organization of the relevant information about the TBR words in the store at the time of attempted recall (availability of information), and the nature and number of retrieval cues which provide access to the stored information (accessibility of information; Mandler, 1967; Tulving & Pearlstone, 1966). The distinction between these two factors can be demonstrated under conditions

where different groups of Ss are treated identically (given identical instructions, presented with identical material, asked to engage in identical activity interpolated between input and output, etc.) up to the beginning of the recall period, and then provided with different kinds of retrieval cues. The availability of relevant information is equal for different groups under these conditions and consequently any variation in recall must be attributed to differences in accessibility of this information.

An earlier experiment in the present series (Tulving & Pearlstone, 1966) provided an experimental demonstration of the distinction between availability and accessibility. The Ss were presented with lists of TBR words

which they had to memorize. At input the TBR words were accompanied by the names of conceptual categories of which the words were members. When these category names were given to *Ss* at output as retrieval cues, *Ss* recalled more words than when no experimentally manipulated retrieval cues were present at output. This finding demonstrates that retrieval depends upon the completeness of reinstatement, at the time of output, of the stimulating conditions present at the time of input (Melton, 1963), but it does not provide much insight into the underlying mechanisms.

The experiment reported in this paper was designed to provide some empirical evidence relevant to speculations about the nature of these mechanisms. This evidence takes the form of answers to four specific questions. First, is it possible for cue words that are only weakly associated with the TBR words to facilitate recall of TBR words? In the Tulving and Pearlstone (1966) experiment, the average frequency of occurrence of TBR words, as responses, to category names as stimuli, according to the Connecticut Restricted Word Association norms (Cohen, Bousfield, & Whitmarsh, 1957) was 6.5%, and in every case the connection between the category name and the TBR word was quite obvious. What would happen if the strength of the associative connection is weaker and less obvious?

Second, given that a retrieval cue is effective if it is present both at input and at output, is it equally effective if it is provided to *S* only at the time of attempted recall of the TBR word? It is conceivable that a preexperimental associative bond between the cue and the TBR word is sufficient to make the retrieval cue effective. On the other

hand, it may be necessary that information about the relation of the retrieval cue to the TBR word be specifically stored at the time of the input of the TBR word.

The third question is related to the second: If a TBR word is paired with a certain cue at input and its recall then tested in presence of a different but preexperimentally equivalent cue, would such a changed cue also be as effective as the original cue? To the extent that the effectiveness of a retrieval cue depends on the existence of a preexperimental associative bond between the cue and the TBR word, the changed cue would still be expected to facilitate recall. If, on the other hand, information about the relation of the cue to the TBR word has to be stored at the same time as information about the TBR word, the changed cue would not be expected to be effective.

The fourth and final question has to do with the effectiveness of double cues. Given *A* and *B* as two different but associatively equivalent cues for a given TBR word, would the presentation of both *A* and *B* at input as well as at output produce greater facilitation of retrieval of the TBR word than each of them separately? Some data from an experiment on tachistoscopic identification of words—selection of words from the long-term store—would lead one to expect that double cues are more effective than single cues (Tulving, Mandler, & Bauml, 1964). It is also conceivable, however, that even though *E* presents two words as both input cues and retrieval cues for a given TBR word, *S* may treat the two words as a single unit, comparable to a single-word cue, and no greater facilitation of recall would occur.

METHOD

Design.—Lists of 24 TBR words were presented to Ss for study and subsequent recall on a single trial. Four input conditions were combined factorially with five output conditions, except that one input condition was associated with only four output conditions. The input conditions were: (a) the TBR words were presented alone (Input Cond. 0), (b) each TBR word was accompanied by Cue A (Input Cond. A), (c) each TBR word was accompanied by Cue B (Input Cond. B), and (d) each TBR word was accompanied by both Cues A and B (Input Cond. AB). The output conditions were: (a) noncued recall of TBR words (Output Cond. 0), (b) recall of TBR words in presence of Cues A (Output Cond. A), (c) recall of TBR words in presence of Cues B (Output Cond. B), (d) recall of TBR words in presence of both Cues A and B (Output Cond. AB), and (e) free recall of TBR words and of all cues shown at the time of input (Output Cond. WC). The Output Cond. WC was not used in conjunction with Input Cond. 0, since in the latter condition no cues had been presented. Thus there was a total of 19 experimental treatment combinations. Each combination can be designated in terms of its input and output conditions. Thus, for instance, Cond. 0-0 was a standard free recall condition—TBR words shown alone and tested in absence of any cues; in Cond. B-AB each TBR word was presented in presence of Cue B and tested for recall in presence of both Cues A and B; in Cond. AB-WC each TBR word was presented in presence of both Cues A and B and Ss had to recall TBR words and both Cues A and B in absence of any experimentally provided aids to retrieval, etc.

Independent groups of Ss were used in each of the 19 treatment combinations. The design is reflected in the organization of the data in Table 1.

Materials.—Two equivalent lists of TBR words (I and II) were used to provide for sampling of materials. Each list consisted of 24 words selected from among the stimulus words in the Minnesota Free Association Norms (Russell & Jenkins, 1954). For each TBR word two other words were selected to serve as cues. These were low-frequency responses from the associative hierarchy of each TBR word. Each cue

had been given as a response to the stimulus words in the Minnesota norms by fewer than 1% of Ss. Of the two cues thus selected for each TBR word, one was arbitrarily labelled as Cue A and the other as Cue B. The two sets of cues, A and B, for each list were thus approximately equally related to the TBR words. Some examples of A and B cues and TBR words are: fat, LEG—MUTTON; village, DIRTY—CITY; dark, GIRL—SHORT; body, VIGOR—HEALTH; empty, HURT—STOMACH; emblem, SOAR—EAGLE.

Independently of the present experiment, free association data were collected for cue words of this experiment as stimuli. The Ss were 278 high school students in the same school system in Metropolitan Toronto where the present experiment was carried out. One-third of these Ss were presented with 48 A cues, another third with 48 B cues, and the remaining one-third with each pair of corresponding A and B cues presented simultaneously (double cues). The Ss were instructed to write down for each single or double stimulus word some other word that the stimulus word or words made them think of. The observed proportions of responses corresponding to the TBR words used in this experiment (the total number of TBR words given to their respective cues, divided by the product of number of words and number of Ss) were as follows: A cues—.011, B cues—.015, and double cues—.025.

The Ss' assignment to experimental conditions.—The Ss were 674 boys and girls from 23 eighth grade classes in 10 different elementary schools in the Metropolitan Toronto area. (Original design called for testing of Ss in 24 classes, but Ss were lost in 1 class because of apparatus failure) They were tested in intact groups in their own classrooms, classes varying in size from 22 to 36. Each of the four input conditions was administered to 6 classes, each in a different school. Three classes in each input condition were tested with List I, and 3 with List II. (Because of the apparatus failure, Input Cond. 0 was given to only 2 classes with List I). In each class, Ss were assigned to the five output conditions (four in the case of Input Cond. 0) on the basis of a random distribution of five (four) kinds of recall booklets to the seats in the classroom. Thus, each of the 19 experimental groups, corresponding to

the 19 treatment combinations, consisted of Ss from 6 different classes, each in a different school. The sizes of the 19 experimental groups varied 32-39, with a median size of 36.

Procedure.—Upon entering each classroom recall booklets were first distributed. These booklets contained pages for Ss' recording of their recall, different sections of booklets being of different colors and separated by blank pages. The E then gave some general information to Ss about the study of memory conducted by the psychology department of the University of Toronto and about the nature of the task, explaining how the material to be "learned" was to be presented, how Ss were to write their recall at the proper time in their recall booklets, and how they were to work independently. A practice list, consisting of 24 adjectives as used by Tulving and Pearlstone (1966) was then administered. Words were projected on the screen by means of a film-strip projector, at the rate of 2 sec/word, and Ss were allowed 3 min. to record their recall in the booklets. The Ss were then asked to turn to the next (blank) page in the recall booklet and were given *study instructions* with respect to the "second part of the experiment," memorization of the experimental list proper.

Study instructions varied according to input conditions. The Ss were told that they had to study and try to remember words projected in capital letters on the screen. In Input Cond. A, B, and AB, they were told that each of the capitalized words was to be accompanied by another word which was "somehow related to the capitalized word. . . ." (two other words in Cond. AB) typed in smaller case letters above the capitalized word. They were told that although their memory was going to be tested only for words typed in capital letters (TBR words) they should also pay attention to the words typed in lower case letters (cue words), because these "may help you to remember the capitalized words later on." They were also told to try "to see how each word and its accompanying cue (cues) are related."

The list was projected on the screen in front of the classroom, at the rate of 5 sec/frame in all input conditions. Each frame contained one TBR word in capital letters, and, in Input Cond. A, B, and AB, one or two cue words in lower case letters above the TBR word. After all 24 frames had been shown, Ss were asked to turn to the next page in their recall booklet, read the

recall instructions on the top of the page, and then to record their recall. Recall instructions in the booklets varied according to the output condition to which S had been assigned. The first sentence in all instructions was, "Now write down all the capitalized WORDS you remember," and the final sentence was, "The important thing is to get as many WORDS correct as possible." Some examples of the rest of the instructions follow:

Condition 0-0: "write them down in any order you like. . . ."

Conditions 0-A and 0-B: "the words you see written on this and on the following sheet may help you to remember the WORDS since each of them is related to one of the capitalized WORDS. If you can, put each of the WORDS you remember opposite the word to which it is related. If you find this too difficult, however, put down the WORDS you remember anyhow, anywhere on this sheet or on the following sheet. . . ."

Conditions A-A and B-B: "the cue words you saw are given on this sheet and on the following sheet. If you can, write down each WORD on the line opposite the cue word. If you remember a WORD but you do not remember which cue word it went with, put it down anyhow, anywhere on this sheet or the following sheet. . . ."

Conditions A-B and B-A: "each of the words you see on this sheet and on the following sheet is related to one of the capitalized WORDS in more or less the same way as the cue words which appeared on the slides together with the WORDS you had to remember. If you can, put each of the WORDS you remember opposite the word to which it is related. If you find this too difficult, however, put down the WORDS you remember anyhow, anywhere on this sheet or the following sheet. . . ."

Conditions A-WC and B-WC: "write them down in any order you like in the blank spaces on the right hand side of this sheet and the following sheet. If you can, you should also write down as many of the cue words as you remember. Write the cue words in the blank spaces on the left side of this sheet and the following sheet. If you can, write each capitalized WORD on the line op-

posite the cue word that went with it. But if you do not remember the connection between a WORD and its cue word, write both of them anyhow, anywhere on this sheet or on the following sheet. . . ."

The 24 words in each of two lists were shown in the same constant order to all Ss. In Output Cond. 0, the recall sheets in the booklet consisted of 24 consecutively numbered lines on two successive pages. In Output Cond. WC, there were two columns of 24 numbered lines, the left one for cue (cues) and the right one for TBR words. In Output Cond. A, B, and AB, the cues were shown in the same order in which their corresponding words had appeared in the input list.

In each group, 6 min. were allowed for recall. Recall booklets were then collected and Ss permitted to ask questions they had about the experiment, problems of memory, or psychology. Finally, Ss were asked not to discuss the experiment with other students at the school until the next day and reasons for this request were given.

RESULTS

The mean number of words correctly recalled from the practice list of 24 adjectives was 6.19 for all 674 Ss. The same list administered under comparable conditions to 948 high school Ss in the Tulving and Pearlstone (1966) study had yielded a mean recall score of 9.48. This difference indicates that the authors are here dealing with a different population of Ss and that therefore no direct comparisons of the main data between the two experiments would be very useful. The mean scores on the practice list for different experimental groups varied from 5.74 to 6.69.

The primary data are provided by the mean number of TBR words correctly recalled. "Lenient" scoring was used throughout. The S was given credit for recall of a TBR word regardless of whether or not the word was paired with its appropriate cue.

The data on correct recall of TBR words were pooled over Lists I and II and are summarized in Table 1. Table 1 shows the number of Ss in each experimental group (n), the mean number of TBR words recalled (M), and the standard deviation of the distribution of the correct recall scores (SD). The last column in Table 1, Output Cond. WC, also shows the mean number of cue words correctly recalled. Thus, for instance, the entry $8.45 + 5.88$ in the cell corresponding to Cond. A-WC means that the mean number of TBR words recalled was 8.45 and the mean number of cues recalled was 5.88. The figure for the standard deviation, however, applies only to the distribution of TBR word scores.

Table 1 contains all the data needed to answer the four questions posed in the introduction. First, is it possible for cue words that are only weakly associated with the TBR words to facilitate recall of TBR words? The answer to the question is affirmative. When single cues were present at

TABLE 1
NUMBER OF Ss- (n) , MEAN NUMBER OF WORDS RECALLED- (M) , AND STANDARD DEVIATION- (SD) FOR EACH EXPERIMENTAL CONDITION

Input Condition	Output Condition				
	0	A	B	AB	WC
0					
n	37	38	39	37	
M	10.62	8.39	8.64	8.43	
SD	(2.79)	(2.97)	(2.43)	(2.68)	
A					
n	37	36	36	36	33
M	9.00	14.94	6.94	14.81	8.45+5.88
SD	(2.96)	(3.50)	(2.68)	(3.72)	(2.87)
B					
n	36	37	35	37	35
M	8.44	7.95	14.91	14.84	8.86+6.63
SD	(2.94)	(3.23)	(4.14)	(4.76)	(2.72)
AB					
n	32	34	34	33	32
M	9.06	11.24	11.79	14.33	8.31+5.91
SD	(4.08)	(3.69)	(3.86)	(4.05)	(3.15)

Note.—For explanation of entries in column WC, see the text.

input, cued recall (Cond. A-A and B-B) was approximately 70% higher than noncued recall (Cond. A-0 and B-0). With the data pooled over Input Cond. A and B, the two means are 14.93 and 8.73, respectively.

Second, does an otherwise effective retrieval cue still facilitate recall if it is provided to *S* only at the time of output? This question receives a negative answer. When single or double cues were present at output, but not at input (Cond. 0-A, 0-B, and 0-AB), recall was lower than in the absence of cues at both input and output (Cond. 0-0). With the data pooled over relevant conditions, the two means are 8.49 and 10.62, respectively.

Third, would a changed cue, pre-experimentally equivalent to the cue paired with the TBR word at input, be as effective as the original cue? This question is also answered negatively. Recall of TBR words in Cond. A-B and B-A was not only considerably lower than in Cond. A-A and B-B (means of 7.45 and 14.93, respectively), but also lower than in Cond. A-0, A-WC, B-0, and B-WC (pooled mean of 8.70) in which the cue present at input was simply omitted at output.

Fourth, does the presentation of two cues at input as well as at output facilitate recall of TBR words to a greater extent than do the single cues? Again the answer is negative. The mean number of TBR words recalled in Cond. AB-AB was 14.33, while in Cond. AB-0 and AB-WC it was 8.68. Thus, with input conditions held constant, recall in presence of two retrieval cues per TBR word was approximately 65% higher than in absence of these cues. The facilitation of recall by double cues thus is of the same order

of magnitude as that observed in the case of single-cue input conditions (70%).

Statistical analyses, in the form of one-way analyses of variance within each input condition and subsequent contrasts of individual means using Scheffé's method, were found to support all of the above statements at least at the .05 level of significance and will not be reported in detail. Some additional observations, however, may be of interest and will be mentioned briefly.

In Cond. A-A and B-B, e.g., over 96% of all TBR words correctly recalled were paired with their cues on recall sheets, while in Cond. 0-A and 0-B only 39% of recalled words, and in Cond. A-B and B-A 34% were so paired. The two latter figures are probably inflated because of the correspondence between input positions of words and the ordering of cues on the recall sheets. These data again demonstrate that otherwise potent retrieval cues are quite ineffective in facilitating recall if they are not presented together with the TBR words at input.

When two cues were presented with each TBR word at input, but recall was tested in presence of only one of those cues (Cond. AB-A and AB-B), recall was lower than in presence of both cues (Cond. AB-AB). This finding is reminiscent of stimulus selection in paired associate learning (Underwood, 1963), although alternative interpretations are possible.

When TBR words were accompanied by cues at input but had to be recalled in absence of any cues, recall was approximately equal in Output Cond. 0 and WC. The mean recall of TBR words in Cond. A-0, B-0, and AB-0 was 8.83, and in Cond. A-WC, B-WC, and AB-WC it was 8.55.

panied by single cues. The same phenomenon may well hold for cued recall as well.

REFERENCES

- BEVAN, W., DUKES, W. F., & AVANT, L. L. The effect of variation in specific stimuli on memory for their superordinates. *American Journal of Psychology*, 1966, 79, 250-257.
- BILODEAU, E. A., & BLICK, K. A. Courses of misrecall over long-term retention intervals as related to strength of preexperimental habits of word association. *Psychological Reports*, 1965, 16 (Monogr. Suppl. 6).
- COHEN, B. H., BOUSFIELD, W. A., & WHITMARSH, G. A. Cultural norms for verbal items in 43 categories. Technical Report No. 22, 1957, University of Connecticut, Contract Nonr-631 (00), Office of Naval Research.
- EARHARD, M. Cued recall and free recall as a function of the number of items per cue. *Journal of Verbal Learning and Verbal Behavior*, 1967, 6, 257-263. (a)
- EARHARD, M. The facilitation of memorization by alphabetic instructions. *Canadian Journal of Psychology*, 1967, 21, 15-24. (b)
- FOX, P. W., BLICK, K. A., & BILODEAU, E. A. Stimulation and prediction of verbal recall and misrecall. *Journal of Experimental Psychology*, 1964, 68, 321-322.
- LLOYD, K. E. Short term retention as a function of recall point coding. *Psychological Reports*, 1964, 14, 752-754.
- MANDLER, G. Organization and memory. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation*. New York: Academic Press, 1967.
- MELTON, A. W. Implications of short-term memory for a general theory of memory. *Journal of Verbal Learning and Verbal Behavior*, 1963, 2, 1-21.
- POSTMAN, L., ADAMS, P. A., & PHILLIPS, W. Studies in incidental learning: II. The effects of association value and of the method of testing. *Journal of Experimental Psychology*, 1955, 49, 1-10.
- RUSSELL, W. A., & JENKINS, J. J. The complete Minnesota norms for responses to 100 words from the Kent-Rosanoff Word Association Test. Technical Report No. 11, 1954, University of Minnesota, Contract No. Nonr-66216, Office of Naval Research.
- TULVING, E. The effect of alphabetical subjective organization on memorizing unrelated words. *Canadian Journal of Psychology*, 1962, 16, 185-191.
- TULVING, E., MANDLER, G., & BAUMAL, R. Interaction of two sources of information in tachistoscopic word recognition. *Canadian Journal of Psychology*, 1964, 18, 62-71.
- TULVING, E., & PEARLSTONE, Z. Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior*, 1966, 5, 381-391.
- UNDERWOOD, B. J. Stimulus selection in verbal learning. In C. N. Cofer & B. S. Musgrave (Eds.), *Verbal behavior and learning: Problems and processes*. New York: McGraw-Hill, 1963.

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