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Encoding Processes in Recognition and Recall

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The present experiments demonstrate that picture–word stimuli are differentially encoded in anticipation of a recognition test than in anticipation of a free-recall test. Subjects perform better on the retention test of which they have been informed, and different information from the stimuli is used to pass each test. These findings cannot be attributed to stimulus selection nor to pure pictorial encoding in anticipation of recognition and pure verbal encoding in anticipation of recall. Recognition is enhanced by encoding which integrates the details within each item while recall is enhanced by encoding which interrelates the items of a list.

The superiority of recognition tests of memory to recall tests has typically been attributed to the fact that less information about an item is needed to pass a recognition test (Postman, 1963). Partial learning may be sufficient to choose the correct alternative or reject an incorrect alternative in a recognition test, but not enough to guarantee correct recall. Recently, several theorists, notably Estes and Da Polito (1967), Kintsch (1970), Bahrick (1970), and Anderson and Bower (1972), have proposed that an important difference between recognition and recall tests of memory is that the former by-pass the retrieval stage of memory necessary in recall. Since the correct alternative is presented in the recognition test, S presumably does not have to search his memory to find it.

To support his contention, Kintsch (1970) reviewed and reported data on variables which have different effects on recognition and recall tests of memory. High frequency words are better recalled, while low fre-

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quency words are better recognized. Intention to learn aids recall, but has little or no effect on recognition. Interlist similarity hinders recall, but not recognition. Finally, certain organizational variables, such as clustering and approximation to English, increase recall, but not recognition. These variables are thought to have their effect by rendering items more or less available at the retrieval or search phase of recall.

Further support for the two-phase theory of recall comes from two programs of experimental work attempting to demonstrate implicit retrieval and recognition of words in a recall task. Bahrick (1970) was able to predict success in prompted recall directly from performance in the two presumably underlying and independent subprocesses, retrieval and recognition. Anderson and Bower (1972) proposed that implicitly underlying free recall is a retrieval process which accesses words, followed by a recognition test of the appropriateness of the list-markers associated to the words at study. While retrievability of words increases as the words appear on more overlapping lists, recognition of the appropriate lists decreases, as predicted by their model.

Implicit or explicit in both these views on recognition and recall, either a strength theory or a two-phase theory, is the notion that the same information is stored by S in both situations. It would seem quite reasonable, however, for S to encode a stimulus differently in anticipation of a recall test than in anticipation of a recognition test, in part, precisely because the correct alternative is presented in a recognition test. When making the acquaintance of a new person, we encode differently in order to recall his name than to recognize his face. Likewise, when learning a new route, say from home to office, we encode the city scene differently to give directions to someone else—recall—from to find the way again the next day—recognize. Learning to speak a foreign language—recalling words—entails different encoding than learning to understand—recognizing words—and understanding spoken language requires different information from the stimuli from recognizing printed words. That is, it is not merely the case that more information is needed to pass a recall test than a recognition test, but rather than a different kind of information, information organized in a different manner, may be more efficacious in one situation than another. The student who asks his teacher whether the final examination will be essay or multiple-choice is in essence asking how to conduct his study.

Several previous attempts to find encoding differences in these two memory tasks have failed (e.g., Freund, Brelsford, & Atkinson, 1969). The experimental task must encourage expression of encoding strategies, as is evident in an experiment conducted by Loftus (1971), who did find better recall performance in pure recall trial blocks than in blocks where recall and recognition trials were randomly mixed, and where the Ss were not forewarned of test type. Demonstration of encoding differences in anticipation of recognition or recall also necessitates stimuli rich enough to be differentially encoded, and memory tests sensitive enough to detect encoding differences. Simple pictures of objects are richer in encoding possibilities than the words typically used in these experiments. It would be to the S's advantage to encode information primarily pictorially from these stimuli if he expected a recognition task entailing discrimination of the correct picture from a similar picture. On the other hand, it would be advantageous to store mainly organized verbal information in anticipation of free recall. Just as object names would not be sufficient to pass a recognition task, unintegrated information about the appearance of objects would not maximize free recall. The present experiments used pictorial stimuli with both recall and recognition tests of retention. Since groups differ only in their instructions, differences in retention can be attributed to differential encoding of the material.

EXPERIMENT I

Method

Stimuli. The stimuli were 30 slides of line drawings of familiar objects, with their names. The pictures were comparable in style and quality to dictionary drawings. The objects, in order of presentation as well as test, were: camera, umbrella, barrel, teapot, butterfly, television, windmill, barn, refrigerator, typewriter, submarine, binoculars, iron sailboat, cake, tricycle, tent, tree, lawnmower, kangaroo, fireplace, books, baggage, skyscraper, desk, tractor, streetcar, pipe, fish, purse. For each stimulus, there was another picture with the same name, used as the foil in the recognition test, which differed from the original in one of three ways: by orientation (O), preserving detail; by exemplar (E), altering both outline and internal detail; or by internal detail (D), preserving outline. There were 10 stimulus pairs of each type; one of each pair was randomly chosen to be the originally presented stimulus, and the other, to be the foil. The first stimulus presented was of pair-type O; the second, pair-type E; the third, pair-type D; the fourth, pair-type O, and so on.

Subjects. Subjects were 76 Stanford students paid for their participation. They were divided into four groups by factorially combining memory instructions for recognition or for recall with memory test order, recognition first or recall first. Subjects were run in groups of four to ten.

Procedure. Subjects expecting recall were told:

> This is an experiment in memory for pictures. I will project on the screen a series of 30 pictures of familiar objects with their names, one after the

> other, for about 2 sec apiece. Afterward, your task will be to write down the names of as many of the objects as you can remember, in any order. Any questions?

The pictures were presented for 2 sec each by a Carousel projector operated by Hunter timer. Afterward, paper was distributed for the recall or recognition tasks as the appropriate instructions were read. Subjects receiving the recall test first ($n = 18$), were told: "Please write down the names of as many of the objects in the pictures as you can remember in any order they come to mind." Subjects given the recognition test first ($n = 23$) were told:

> Before we proceed to the test of recall, I want to test your recognition of the pictures you saw. I will project the pictures you saw, one by one, alongside another similar, but new, picture. Your task is to decide which of the two pictures you saw previously. It you think it was the picture on the left, put an "X" in the left column. If you think it was the picture on the right, put an "X" in the right column. Then fill in the rating column. Put a "1" if you feel very confident of your judgment, a "2" if you feel confident, or a "3" if you feel unsure of your pair of pictures as they appear, and you will have 6 sec in which to examine the pictures, make your judgment and ratings, and mark them on the paper. Is that clear?

Subjects were then given the other retention test with essentially the same instructions. Three minutes were allowed for recall.

Recognition instructions were as follows:

> This is an experiment in memory for pictures. I will project on the screen a series of 30 pictures of familiar objects, one after another, for about 2 sec apiece. Afterward, your task will be to recognize the pictures you are about to see and to discriminate each from another, very similar picture of the same object. Any questions?

Subjects were then given the two retention tests with essentially the same instructions as the recall-instructed groups, except "Before we proceed to the recognition test" preceded the recall instructions of the group receiving the recall test prior to the recognition test ($n = 17$; $n = 18$ for the group receiving recognition test first).

Results

Median percentage correct recognition and recall for each instructions by first test group is reported in Table 1.

On the recognition test, there was a highly significant effect of instructions ($p < .001$, median test). Median correct recognition for the groups informed of the recognition test was 26.5 (88%) for the group tested on recognition first, and 27 (90%) for the group tested on recall first. Median correct recognition for the recall-instructed groups, however, was 22 (73%) for the group tested first on recognition, and 21.5

TABLE 1
Median Percentage Correct Recall and Recognition (Chance = 50%) for Each Instruction by First Test Group

First test	Instructions: Recall	Instructions: Recognition
	Recall scores	
Recall	47 (n = 18)	50 (n = 17)
Recognition	60 (n = 23)	60 (n = 18)
	Recognition scores	
Recall	72	90
Recognition	73	88

(72%) for the group tested first on recall. Change performance would have yielded 15 correct (50%). Subjects expressed more confidence when their responses were correct.

On the recall test, there was a highly significant effect of test order ($p < .001$ by a median test) but no apparent effect of instructions. When recall was tested first, recall-instructed Ss remembered a median of 14 items (47%) while recognition-instructed Ss remembered a median of 15 items (50%). When recognition was tested first, recall scores increased to a median of 18 items (60%) for both instructional groups. Close synonyms (e.g., "luggage" for "baggage") were scored as correct for all groups in all experiments. These constituted 2.2% of the correct response for recall-instructed groups and 3.7% of the correct responses of recognition-instructed groups.

As is evident from Table 2, correct responses were distributed more or less evenly over the three types of stimulus-foil pairs, those differing in

TABLE 2
Percentage of Correct Responses for Stimulus-Foil Pairs Differing by Orientation, Exemplar, or Detail for Each Instructional Set and Each Retention Test

Instructional set	Stimulus-foil difference: Orientation	Exemplar	Detail
		Recognition test	
Recall	31.2	29.2	39.7
Recognition	33.9	31.2	34.9
		Recall test	
Recall	33.5	32.4	34.1
Recognition	31.8	30.7	37.6

orientation, exemplar, or detail, for both instructional groups and both retention tests. It appears that these manipulations yielded sets of picture pairs of comparable difficulty.

EXPERIMENT II

While an encoding effect was clearly demonstrated for the recognition test, no such effect was obtained for the recall test. This in itself is noteworthy, as the present experimental paradigm may be regarded as a double intentional-incidental learning paradigm. The "intentional" task is the retention test Ss were informed of, and the "incidental" task is not strictly so, but rather the retention test Ss were not informed of. In this light, the results indicate a strong positive effect of intention to learn on recognition memory, an effect typically demonstrated only on recall tasks.

The recognition instructions, however, in contrast to the recall instructions, were suggestive of an effective encoding strategy, that is, encoding sufficient visual information to make a difficult discrimination. In the second experiment, recall-instructed Ss were also provided with an effective encoding strategy. They were told that attempting to find relationships among the words and to group and remember related words together was very likely to increase their recall (Anderson, 1972). To further promote organization of items, the pictures were ordered in natural groups or clusters as much as possible in presentation.

Method

Stimuli. The previous stimuli were used in the following order: books, typewriter, desk, camera, binoculars, pipe, fireplace, television, refrigerator, cake, teapot, iron, umbrella, purse, baggage, barrel, submarine, sailboat, tent, butterfly, fish, kangaroo, tree, skyscraper, windmill, barn, tractor, lawnmower, tricycle, streetcar.

Subjects. Forty-five Ss were recruited from an ad in the local newspaper and paid for their participation. All were 16 or older and most were students from Stanford University summer school or Palo Alto High school. Subject were run in groups of four to ten.

Procedure. The procedure varied from that of the previous study in several ways. Twenty-six received the recall instructions of the previous experiment with the following addition: "Many experiments in free recall have shown that a very effective way to increase recall is to attempt to find relationships among the words and to group and remember related or associated words together." Nineteen Ss received the same recognition instructions as in the previous experiment. All Ss were tested first on recall and then on recognition, since test order was shown to have an effect on recall, but not on recognition.

Results

Appropriate instructions significantly increased retention scores for both recall and recognition tests ($p < .05$, median test). Recall instructions increased recall scores from a median of 12 (40%) under recognition instructions to a median of 18.5 (62%) under appropriate instructions. Recognition instructions increased recognition scores from a median of 20 (67%) under recall instructions to a median of 26 (87%).

To help assess the extent to which recognition and recall tests utilized the same stored information, a phi correlation coefficient was computed between recognition and recall scores of each S. For convenience, these data from both experiments are reported together. The average correlation over both experiments was .061; this is significantly greater than zero by a t test ($p < .001$) on the correlations transformed by Fisher r to z transformation. Overall, 70 Ss showed positive correlations, 41 Ss showed negative correlations, two Ss showed zero correlation, and for the remaining eight Ss the correlation was undefined, due to perfect recognition; significantly more Ss had positive than negative correlations by a sign test ($p < .01$). The average phi correlations, as well as the number of Ss with positive and negative correlations for each instruction by test group, is shown in Table 3. From there, it seems evident that while there is a small positive correlation between recognition and recall scores for the groups receiving the recall test first (average phi correlation is .086), this relation seems to vanish in the group receiving the recognition test first (average phi correlation is .008).

EXPERIMENT III

There remains a possibility that, although the organization recall instructions were given before presentation of the stimuli, their effect

TABLE 3
Mean Phi Correlation Between Recognition and Recall Scores and Number of *S*s Showing Positive and Negative Correlations For Instruction and First Test Groups of Experiments I and II

	Instruction	
First test	Recall	Recognition
	Experiment I	
Recall	.068 (12+, 6−)	.049 (7+, 6−)
Recognition	−.006 (11+, 12−)	.030 (7+, 7−)
	Experiment II	
Recall	.071 (18+, 7−)	.157 (15+, 3−)

was only to organize at retrieval, and not to encode differently at input. To eliminate this possibility, two more groups of Ss were run. One group received the organization instructions before and after viewing the stimuli, while the other group was instructed to organize only after stimulus presentation.

Method

Stimuli. The stimuli, order, and time of presentation were the same as in Experiment II.

Subjects. Fifty-seven Ss, native English-speaking students at the College for Overseas Students, Hebrew University, Jerusalem, Israel volunteered to participate in this experiment.

Procedure. A group of 32 Ss received the organization recall instructions of Experiment II and a group of 25 Ss received the simple recall instructions of Experiment I. Before handing out response sheets to both groups, the experimenter repeated the organization recall instructions to both groups. No test of recognition was given. In other respects, the procedure was identical to that of Experiment II.

Results

Organization instructions before presentation of stimuli yielded significantly ($p < .05$, median test) higher recall than organization instructions only before recall. Median correct for the group receiving organization instructions prior to the stimuli was 14.5 (48%) while median recall for the group receiving organization instructions after the stimuli was 12 (40%). It can be concluded that the present organization instructions served to alter storage of these items rather than alter the manner in which they were retrieved.

DISCUSSION

Stimulus selection vs encoding strategies. Subjects, viewing the same picture-name stimuli, perform substantially better on the memory test, either free or picture recognition, for which they had been prepared. This finding cannot be attributed to stimulus selection, that is to attending selectively to some aspects of the stimulus, say the name for recall instructions and the picture for recognition instructions.

In stimulus selection (Underwood, 1963; Shepard, 1963), the S chooses some aspects of the whole or nominal stimulus to enter into memory, called the functional stimulus, and fails to input to memory other aspects of the stimulus. In encoding, the S performs some operation on the functional stimulus; he may group several functional stimuli together, by association, category, function, sound; he may form a pictorial image of a word or an acoustic image of a picture. For the recall task, simple recall instructions which, according to the selection hypothesis, would have encouraged selecting the name for memory produced no better recall performance than recognition instructions, which would have encouraged selecting the picture. Recall improved, in Experiments II and III, only under instructions to integrate and organize the various stimuli, processes which entail differential encoding of the stimuli over and above stimulus selection. For the recognition task, ignoring the pictures and simply selecting the name, as the recall Ss would have done under the selection hypothesis, would not have allowed above chance performance on the recognition test, in which the foils were similar-appearing pictures with the same names. Out of 67 Ss receiving recall instructions, only one S performed at chance level on the recognition test, and this S also had a very low recall score (30%). In a task designed to elicit stimulus selection, Loftus (1972; Experiment II) monitored eye fixations while presenting pairs of pictures, one of which was chosen at random at the start of each trial to be ignored. Subjects successfully selected the appropriate stimulus for viewing on 98% of the trials. For those pictures not fixated, recognition memory remained at chance level. In contrast, the author (1973) monitored eye fixations in a replication of the present Experiment II. Instructions to recall or recognize had the expected effect on memory tasks; that is, recognition-instructed Ss performed significantly better on the recognition task than recall-instructed Ss, while recall-instructed Ss performed significantly better on the recall test than recognition-instructed Ss. Fixation patterns, however, were identical under both sets of instructions. Under recall instructions, there were, on the average, 1.9 word and 3.8 picture fixations, and under recognition instructions, there were, on the average, 1.8 word and 3.9 picture fixations ($t(13) = 0.92$ for word fixations; $t(13) = 0.97$ for picture fixations). Thus, Ss selected the picture and name aspects of the stimuli for viewing with the same frequency under both recognition and recall instructions. Finally, the failure to find even a moderate correlation between recognition and recall of items indicated that Ss could not have been using information selected for recall to pass the recognition test or vice versa. Information appropriate for performing both tests must have been selected and encoded during stimulus presentation by both instructional groups, yet information accessed for recall had been more effectively encoded under recall instructions, and information accessed for recognition had been more effectively encoded under recognition instructions.

Just as Ss did not select the word part or the picture part of the stimuli in anticipation of recall or recognition, similarly, it is evident that Ss in general do not encode pictures only verbally for recall nor do they encode only pictorially for recognition. In an experiment with pictorial stimuli, Bahrick and Boucher (1968) found no correlation between visual recognition and verbal recall of their items. They argue, however, that their recall task was performed from pictorially encoded information, albeit different pictorial information from that used in the recognition task. Further support for pictorial encoding in free verbal recall comes from the results of Frost (1971), who found a high degree of clustering by the arbitrary visual shapes of her pictures in verbal recall. On the other hand, although information about the appearances of the stimuli was necessary for above-chance recognition performance in the present experiments, that information conceivably could have been encoded verbally (e.g., "front-top view of camera with black bands top and bottom, small button left of lens, two large and one small button top left, and small rectangular device with four circles top right"). This does seem unlikely, given the visual complexity of the stimuli and the difficulty of the recognition task, but Freund (1971) and Wyant, Banks, Berger, and Wright (1972) have presented evidence for a strong verbal component in picture recognition. Freund (1971) found that recognition could be enhanced by enforced verbal encoding or reduced by an interpolated task (counting backward) known to reduce verbal memory. Wyant *et al.* (1972) found picture recognition accuracy to be strongly related to rated verbal describability at 3- and 10-sec presentation rate, and only weakly related to rated visual similarity only at the 3-sec rate. Rather, it seems that the modality of encoding—pictorial, verbal, or some combination thereof—depends to a large extent on the exact nature of the expected retention test. In a same–different memory task, Tversky (1969) showed that Ss could pictorially encode both pictures and names in anticipation of picture recognition, yet verbally encode the same stimuli in anticipation of word recognition. Finally, Frost (1972) found that Ss encoded pictures both pictorially and verbally, though the particular aspects of the stimuli accessed depended on which memory task Ss had been set for as well as which memory task was given. Free recall protocols of recognition-set Ss revealed clustering by visual orientation as well as by semantic categories, whereas recall protocols of recall-set Ss revealed only semantic clustering. Reaction times in recognition tasks showed that both groups of Ss had stored information pictorially, though this information enjoyed faster access for the recognition-set Ss. Thus, although different information about the stimuli is drawn upon for recognition than for recall, it cannot be asserted that the former information is purely pictorially encoded and the latter verbally encoded.

If modality does not necessarily characterize the difference between recognition encoding and recall encoding, what, then, does? The marked improvement in recall scores between Experiment I and Experiment II indicates that the active formation of associations and interrelations among the items is, as the instructions said, an effective way to increase recall (Anderson, 1972). The problem in recall is retrieving more items than are readily accessible from the memory span; no more need be retrieved than the name of the items. To the extent that retrieving one item renders others accessible via associations or subjective organization (Tulving, 1961), recall is enhanced. Anderson (1972) has successfully simulated a wide variety of free recall situations using a model based on these notions. In contrast, successful recognition depends on encoding enough detail about the appearances of the stimuli to discriminate them from similarly appearing stimuli. Given each item name or some visual details at test, sufficient remaining details must have been encoded to correctly discriminate, although information about other items need not be stored with the encoding for a particular item. Thus, recognition is enhanced by integration of the details of each item while recall is enhanced by interrelating the items within a list. This analysis offers an explanation of the seemingly paradoxical finding that recognition memory is better or no worse under incidental than intentional instructions (Eagle & Leiter, 1964; Dornbush & Winnick, 1967; Postman, Adams & Phillips, 1955). The incidental task, typically a rating performed on each item, often requires detailed attention to each item, a condition favorable to recognition performance.

Relation to retrieval. This analysis also suggests a way to reduce recognition performance, even below recall performance, as Tulving and Thomson (1971), Tulving (1968), and Light and Carter-Sobell (1970) have demonstrated. Tulving and Thomson (1971) reasoned that if the context or "cognitive environment" of a stimulus at recognition test is sufficiently different from the context at presentation, the stimulus will be differently encoded at test, and thereby fail to match or retrieve the original stimulus. These results, the authors claim, argue against the notion that recognition memory by-passes the retrieval stage of memory. Thus, both recognition and recall tasks entail encoding and retrieval stages, although the processes occurring at those stages differ in the two tasks. Taken together with the present experiments, these studies point to the intimate relationship between encoding and retrieval. Efficacious encoding anticipates retrieval in order to insure that the particular retrieval cue accesses the appropriate encoded stimulus.

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