

CURRENT STATUS OF RESEARCH ON RETRIEVAL PROCESSES IN MEMORY*

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ABSTRACT

A general consideration of the problem of retrieval in human memory is presented. This includes discussion of (a) the nature of experimental operations for studying retrieval separately from learning and storage, (b) the encoding specificity hypothesis as an interpretation of how retrieval cues are effective, and (c) a brief consideration of the phenomenon of state dependent memory. Encoding specificity and state dependent memory phenomena indicate that memory retrieval in humans is, to a certain extent, rigid and inflexible, since it depends critically on reinstatement of the mental operations or mental state surrounding original learning.

For many years psychologists interested in learning and memory ignored the problem of retrieval. This is true of both the animal and human learning tradition with but few exceptions. The emphasis has been on initial acquisition, on "verbal learning" in humans, with the implicit assumption being that recall was an accurate measure of whatever information existed in the memory store. Because of this assumption, differences in recall levels in memory experiments were explained by appeal to differences in amounts of information stored under various experimental conditions. The possibility that the recall differences might be due to factors operating at retrieval rather than storage was overlooked for the very good reason that people typically did not distinguish between the two.

Over the years some psychologists have pointed out that the memory process can be conceptualized as involving several stages: initial acquisition of information, storage of this information, and then eventual retrieval or utilization of the stored information. This formulation has appeared in the writings of such diverse psychologists as Wolfgang Köhler, John McGeoch, Sigmund Freud, and Arthur Melton. Köhler's concise introduction to the chapter on "Recall" in his book Gestalt psychology (p. 279) is especially lucid and bears quoting:

Psychology investigates three main topics in the field of memory: (1) learning and the formation of the traces which later enable us to recall, (2) the fate of these traces in the time between learning and recall, and (3) the process

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of recall itself. To be sure, recall plays a part in the investigation of all these problems, because the study of the laws of learning and of those of retention involves recall just as much as does the study of recall as such. But when interested in problems of learning, we can keep conditions constant with regard to retention and recall, so that only the conditions of learning are varied. If our problem refers to retention, the conditions of learning and those of recall will be kept constant, while those concerning the interval between learning and recall will be varied. In the study of recall there will be variation only of the circumstances which concern this event. Thus the three classes of problems are actually separable.

Since Köhler, among others, made a quite clear verbal distinction among acquisition, storage and retrieval (or recall), why did it take so long for the separation of the memory process into these stages to be reflected in the research and theorizing of most psychologists in the field? The answer, I believe, is that there were no compelling experimental demonstrations to force consideration of these distinctions. In fact, the experimental separation of initial acquisition from storage has eluded us to this day and the two are usually lumped together. The experimental separation between storage and retrieval was accomplished in a compelling experiment reported by Tulving and Pearlstone (1966) but the logic was exactly the same as was spelled out by Köhler 30 years previously: hold the conditions of acquisition and storage constant and vary retrieval conditions at the time of recall. The paradigm Tulving & Pearlstone invented was straightforward and has been used often in memory research, including some of the research we have heard today. Briefly, different groups of people were presented with words from common conceptual categories such as Articles of Furniture, Girl's names, Types of trees, and so on, under identical conditions. Thus we can assume that subjects in the different conditions stored roughly the same amounts and kinds of information about the word lists. There is also much evidence which leads to the conclusion that subjects encode or store these words in terms of "chunks" or higher order units on the basis of their common categorical relationship. At recall some groups of subjects were simply told to recall the list in any order as well as they could without any external cues while other groups of subjects were given the names of the categories at the time of recall to serve as retrieval cues. The results were quite impressive. In almost all cases the presentation of category names as retrieval cues served to increase recall over that of subjects given no external cues and in some cases the increase was dramatic. When subjects were given 48 items in the list each representing a different category, cued recall subjects recalled 225% more items than free recall subjects who were given no external cues (35.35 words recalled vs. 15.57). Let me add, for those who do not know this sort of study, that appropriate controls indicate that this difference cannot be attributed to cued recall subjects "guessing" the words when given the category names.

Since such drastically different levels of recall could be obtained with acquisition and storage held constant, the Tulving & Pearlstone study emphasizes that the retrieval phase is of great importance. The presence or absence of appropriate retrieval cues is one of the most potent experimental factors yet discovered to control memory performance. The term "retrieval cue" has become so popular that it is commonly used now without reference to Tulving & Pearlstone's study, though as far as I can tell they introduced it to the psychologist's technical vocabulary.

So experimental psychologists have known for at least ten years now that retrieval cues can be extremely important factors in determining recall. What more do we know about retrieval? Do we have an adequate theory as to why retrieval cues are effective? Do we have any idea as to why cues are sometimes so dramatically effective, while at other times cueing procedures which also seem to have face validity have no effect in increasing recall performance over the level of noncued control subjects? I am afraid that the answer to these last questions is "no" or at least "not yet," but what I want to do now is to consider briefly some recent ideas and problems in the study of retrieval processes and relate these as much as possible to the phenomenon of state dependent memory.

The predominant idea today in experimental psychology as to the reason retrieval cues are effective is the encoding specificity hypothesis. The essence of this idea is the same as that of state dependent memory: reinstatement of a mental state or cognitive environment which was present at the time of original learning greatly aids later recall. More specifically, the encoding specificity hypothesis states that retrieval cues facilitate recall of to-be-remembered experiences if and only if the information about the relationship between the cues and the to-be-remembered experiences is stored at the time of acquisition (Tulving & Osler, 1968; Tulving & Thomson, 1973). The idea that performance at a given task improves as the similarity between stimulus and test conditions increases, which is common to both the encoding specificity hypothesis and the concept of state dependent memory, is not particularly new. It seems quite similar to the venerable principle of stimulus generalization, except the stimulus is now internalized so that it is the cognitive environment or mental state of the organism and not some external cue. Thus there may be some merit in considering the concepts of stimulus generalization, encoding specificity, and state dependent memory as having several features in common.

The hypothesis of encoding specificity, however, allows counterintuitive predictions which the older notion of stimulus generalization never did. This is because the encoding specificity hypothesis maintains that a strong preexperimental semantic relationship between two experiences (such as the words table and chair occurring in a list) will allow one word to serve as an effective cue for the other only if the relationship is noticed at the time of input or learning. So if subjects are led to think of chair in some way relatively unrelated to its use as an article of furniture (such as electric chair) then even a strong associate like table is unlikely to serve as an effective cue. Several experiments have shown

that strong associates are very poor cues when subjects were led to encode the target words in some other way at input (Thomson & Tulving, 1971; Barclay, Bransford, Franks, McCarrell, & Nitsch, 1974). This is one of the main sorts of evidence for the encoding specificity hypothesis.

One objection which has been leveled at the encoding specificity idea is that it is a tautology: If a given cue is effective in aiding recall then it must overlap with information encoded at storage or the original cognitive state, but if it is not effective then there is no overlap between the information in the cue and that which was originally encoded. If this logic is assumed a priori, then the hypothesis is untestable. But this is a misuse of the idea (in my opinion) and it is subject to experimental test. If we have independent evidence that people in a particular situation encode information along a certain dimension and then we find that cues which tap this dimension are ineffective in aiding recall relative to the noncued situation, this constitutes evidence contrary to the encoding specificity hypothesis. For example, we have independent evidence that subjects encode categorized lists along categorical dimensions since even when the items are presented in random order they tend to cluster together in categories during recall. Thus it would be quite embarrassing to the encoding specificity notion if presentation of category names did not facilitate recall, but of course they do.

Recent research and theorizing concerning the encoding specificity hypothesis has led to the interpretation that encoding in these experiments, usually involving the presentation of words, is semantically specific (Reder, Anderson, & Bjork, 1974; Martin, 1975). So, following our previous example, the reason that a subject does not recall chair to the cue table when the subject originally saw electric chair in the list is that two different meanings of the word chair are tapped at study and test. When subjects study chair when it is paired with electric at input they may think of a device for executing people, but when presented with table at the time of recall if subjects are led to think of chair at all, it is quite likely to be as an ordinary piece of furniture and not a device for executing people. This seems a quite reasonable interpretation to me and, apparently, to many other people. However, Tulving (1974) has rejected this interpretation of encoding specificity on the basis of two experiments where he attempted to manipulate the congruity of cues at test with encoding of to-be-remembered words at input, and found very little or no effect of congruity. That is, cues which he judged to be more congruous with the original encoding of to-be-remembered words did not aid recognition more than cues he judged to be relatively incongruous with the originally encoded interpretation. He concluded that "the specificity of encoding of word events in episodic memory transcends the semantic meaning of words" (1974, p. 778). The important question then remains that if encoding is not specific with regard to the meaning of words, what factor is responsible for the specificity? One possibility is that encoding is temporally specific, but to my knowledge neither Tulving nor anyone else has speculated much on this issue. Until some alternative

is rather carefully spelled out, I think we should not yet discard the idea that encoding in these experiments is semantically specific, especially since there is other evidence which is in agreement with this idea (Reder, Anderson, & Bjork, 1974).

Let me turn now to a brief consideration of the issue of state dependent memory. This is a phenomenon that has been rather extensively researched with infrahuman subjects (see Overton, 1974, for a recent critical review), but experimental work with humans is just beginning (e.g., Eich, Weingartner, Stillman, Hillman, & Gillin, 1975). The evidence for state dependency almost always comes from experiments employing a 2 X 2 design where two different states at the time of presentation (say hypnotized and normal or drugged and normal or manic and depressed) are crossed with these same two states at recall. The general finding is that testing under the same state as at input facilitates recall relative to testing under a different state. An ancillary finding is that powerful retrieval cues (such as category names in the case of categorized list recall or recognition tests in other situations) either greatly attenuates or eliminates altogether the state dependency effect. So when subjects are given some sort of powerful retrieval cue they perform no better when tested under the same state as at input than when tested under a different state. This finding puzzles me quite a bit, though others seem to take it for granted. Why should it be that state dependency affects recall of only higher order units or categories and not items within categories in the categorized list situation? How can this finding be interpreted in the framework of the state dependent memory notion? Does presentation of the category names reinstate the mental context present at input? It seems unlikely that the category names induce drunkenness or sobriety, for example, so we must be quite careful in defining the nature of the "mental state" in state dependent memory phenomena. I frankly do not understand this effect at all, although it agrees with other research with categorized lists in that most independent variables affect recall of categories and not items within categories.

Since this finding (that state dependency effects are eliminated with powerful cues) leads one to the conclusion that state dependent memory is cue dependent or due to retrieval failures in some way, let me mention two relatively new techniques that should aid in evaluation of this hypothesis. One, which is too complicated to explain briefly, is Buschke's (1973) technique called selective reminding which allows demonstration of recoveries of "forgotten" information in much the same way as does the retrieval cueing technique. A second technique which I have been using is simply to allow subjects very long recall periods and to measure recall cumulatively. When this is done even without external retrieval cues, one typically finds that with well motivated subjects cumulative recall of categorized lists increases for quite a long time, much longer than the two or three minute recall period typically allowed. In one experiment I have found recall to be still increasing, albeit slowly, even after fifteen minutes. Since the shape of the cumulative recall curve approximates an exponential, one can derive two measures of recall rather than simply reporting the number of words recalled. One of these measures is the asymptotic level of recall and the other is the rate of approaching this asymptote. It would be interesting to know whether

state dependency affects only one or both of these parameters. Time does not permit me, fortunately, to speculate on how these techniques will aid in our understanding of state dependent memory, but since these techniques both reveal recoveries of supposedly forgotten information, they should allow further evaluation of the idea that state dependency is a phenomenon due to retrieval failures.

One final issue I would like to consider briefly is the utility of a memory system in which retrieval is so heavily dependent on the resurrection of the original cognitive state existing at acquisition. This principle of the memory system serves the admirable function of ensuring that its owner remembers the right thing at the right time, since the state of the organism at the time of recall determines to a large extent what will be recalled. This helps make the memory system adaptively selective in what is retrieved; the system only retrieves information relevant to a given context so that, when faced with the requirement to pull out relevant facts to solve some problem or other, it does not retrieve all sorts of irrelevant information. However, this property of the system is a double edged sword, because when an old fact stored in one way is needed in a new context it is quite unlikely that this fact will be retrieved. This is similar to the phenomenon of functional fixity in problem solving where discovery of a novel use for an object is often retarded when the object has already been used in a different manner (e.g., Duncker, 1945). Thus there are situations in which the operation of encoding specificity or state dependency can be quite maladaptive since a memory system built along these lines is relatively incapable of retrieving old facts when they are needed in new situations. (Other aspects of the retrieval process also seem partially maladaptive; see Roediger, 1974). This fact of encoding specificity, if it can be regarded as such, seems an important exception to recent research in cognitive psychology where the emphasis has been on the flexibility and optional use of control processes in numerous cognitive operations. Apparently there is a severe limit to the strategies that can be employed in the successful retrieval of information from memory, viz., information can only be retrieved if the mental state or cognitive operations surrounding original learning are reinstated.

Consideration of the problem of retrieval in human memory is a relatively new enterprise and, I think, quite exciting. As we come to better understand the mechanisms of memory retrieval there is every reason to expect practical gains in applying this knowledge. If we have good theories of memory retrieval, we should be able to apply them in education, in psychotherapy, in law enforcement settings (e.g., aiding recall of witnesses), and in other areas as well. Of course these potential applications remain, for the moment, just hopes and promises. But I see no reason in principle that they cannot be accomplished facts in the not too distant future.

References

- Barclay, J. R., Bransford, J. D., Franks, J. S., McCarrell, N. S., & Nitsch, K. Comprehension and semantic flexibility. Journal of Verbal Learning and Verbal Behavior, 1974, 13, 471-482.

- Buschke, H. Selective reminding in the analysis of learning and memory. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 543-550.
- Duncker, K. On problem solving. Psychological Monographs, 1945, 58 (5, whole No. 270).
- Eich, J. E., Weingartner, H., Stillman, R. C., & Gillin, J. C. State dependent accessibility of retrieval cues in the retention of a categorized list. Journal of Verbal Learning and Verbal Behavior, 1975, 14, 408-417.
- Köhler, W. Gestalt Psychology. New York: Liveright, 1947.
- Martin, E. Generation-recognition theory and the encoding specificity principle. Psychological Review, 1975, 82, 150-153.
- Overton, D. A. Experimental methods for the study of state dependent learning. Federation Proceedings, 1974, 33, 1800-1813.
- Reder, L. M., Anderson, J. R., & Bjork, R. A. A semantic interpretation of encoding specificity. Journal of Experimental Psychology, 1974, 102, 648-656.
- Roediger, H. L. Inhibiting effects of recall. Memory & Cognition, 1974, 2, 261-269.
- Thomson, D. M. & Tulving, E. Associative encoding and retrieval: Weak and strong cues. Journal of Experimental Psychology. 1970, 86, 255-262.
- Tulving, E. & Osler, S. Effectiveness of retrieval cues in memory for words. Journal of Verbal Learning and Verbal Behavior, 1968, 77, 593-601.
- Tulving, E. & Pearlstone, Z. Availability versus accessibility of information in memory for words. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 381-391.
- Tulving, E. & Thomson, E. Encoding specificity and retrieval processes in episodic memory. Psychological Review, 1973, 80, 352-373.
- Tulving, E. Recall and recognition of semantically encoded words. Journal of Experimental Psychology, 1974, 102, 778-787.