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2 *Ecphoric processes in recall and recognition*

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Recall and recognition, like many other concepts in psychology, have a number of different but related meanings. Among other things these two terms refer to (a) experimental tasks given to subjects in a memory experiment, (b) methods of measuring retention, (c) different experiences, or kinds of responses, of a rememberer, and (d) hypothesized processes of utilizing stored information. When we talk about recall and recognition as tasks, methods, experiences or behaviours, they are obviously different in several ways, and the question as to the nature of the relation between them in these respects can be answered relatively simply. When, on the other hand, we wonder about the processes involved in remembering that are not directly observable, the relation between recall and recognition becomes less obvious and a more searching analysis is necessary. The purpose of this chapter is to provide one such analysis of recall and recognition processes.

This analysis will focus on two different theoretical positions that have been advanced to describe the relation between recall and recognition. One, the two-stage theory, assumes that recall and recognition are basically different processes, either because recognition is included as a subprocess in recall, or because recall is assumed to contain certain retrieval processes not present in recognition. The two-stage theory has appeared in several different versions and has recently undergone major revisions.

The second type of theory holds that recall and recognition represent basically similar processes of utilization of stored information and that the differences between them are minor. The basic assumption here is that remembering of an event both in recall and recognition comes about as a consequence of interaction between *trace information*, aftereffects of the initial encoding of the event, and appropriate *retrieval information* from other sources. Recognition and recall differ only with respect to the exact nature of the retrieval information available to the rememberer. In recognition, retrieval information is carried by a literal copy of the event or item to be remembered; in recall, the retrieval information is contained in cues other than copy cues. In other respects the process of utilization of trace information in the act of retrieval is thought to be essentially the same for recall and recognition. This type of theory will be referred to as the episodic ecphory theory, for reasons given later in the chapter.

The question of whether recall and recognition are basically similar or essentially different is not necessarily the most fruitful one to ask about their relation, but since a good deal of theorizing has been focused on this issue, it can serve as a starting point of our discussion. A more appropriate question might be one that initially assumes that the two processes share some commonalities and reveal certain differences, and then asks about the nature of the relation: in what sense are the two different and in what sense are they similar?

The chapter is organized into five main sections. We begin with an overview of the staged nature of the memory process together with a brief discussion of certain terminological problems. The second major section reviews the two-stage theory and experimental evidence on which it has been based. This is followed by a consideration of some difficulties of the two-stage theory. In the fourth section certain additional experimental evidence is described that appears to be relevant to the evaluation of the two-stage theory. In the fifth part of the chapter the episodic ecphory theory is presented as an alternative to the two-stage theory. A final very brief section will present the general conclusions of the analysis of the relation between recall and recognition.

Memory Process and its Description

To place the issue of the relation between recall and recognition into a suitable perspective and to facilitate communication, we begin by presenting a schematic overview of the staged nature of the memory process and by briefly mentioning some terminological problems.

Stages of Memory

The memory process comprises a number of more or less clearly identifiable successive stages. Theorists may disagree on the exact number and nature of these stages, but the general idea of stages is accepted by all. One schematic summary of the staged nature of the memory process is contained in Table 1. The first column of Table 1 lists the three major observables of a complete memory episode: (a) the stimulus event perceived by the rememberer, (b) the instructions and cues given to him for the retrieval of the trace of the event, and (c) the overt response he makes. The second column lists nine directly unobservable process stages, in the order in which they are realized in the system. The stages are numbered in the third column.

The perception of the stimulus event (E_1) is followed by its encoding, translation of the percept into a memory trace (T_E). The trace may undergo changes as a consequence of additional inputs (E_2) into the memory system—we designate these changes as recoding. The recoded trace (T_R) is contacted, activated, matched or complemented by the information provided by the retrieval query, together with one or more specific cues (Q), resulting in the retrieval of stored information (stage 6 in Table 1).

It is at this point that the two-stage theory and the episodic ecphory theory

Table 1. A schema of the stages in the memory process

Observable	Process	Stage
Stimulus event E_1 →	Perception	1
	Encoding	2
	Trace (T_E)	3
(Stimulus event E_2) →	(Recoding)	4
	Trace (T_R)	5
Query and cue (Q) →	Retrieval	6
	(Decision)	7
	Conscious memory	8
Overt response (R) ←	Output decision	9

introduce different assumptions. According to the former, retrieval (the first stage in the theory) consists in the implicit generation of possible response candidates which are then subjected to a recognition decision (second stage). Depending upon the acceptance or rejection of an implicitly retrieved item by the decision mechanism, it is produced or not produced as an overt response. The episodic ecphory theory, on the other hand, postulates no separate decision process following retrieval (stage 6 in Table 1) and prior to the conscious awareness of the remembered event (stage 8). Whenever the trace information is combined with appropriate retrieval information, retrieval is successful and its product is entered into conscious awareness of the rememberer (stage 8). Since the existence, or heuristic usefulness, of the preconscious decision stage (stage 7) is accepted by one theory but not by the other, it is placed in parentheses in Table 1.

Two-stage theories have usually made no reference to the conscious memory stage, and hence its position in the overall sequence in Table 1 may be questioned. It must be shown somewhere in the overall schema, however, because it is at this stage that the memory processes end and other, non-memory processes take over. These other processes, collectively referred to as 'output decision' (stage 9), translate, if conditions warrant it, the conscious contents of memory into an overt response.

Stage 9 in our schema, output decision, serves as a reminder of the fact that not everything the person is consciously aware of and remembers need be reflected in his overt behaviour. In memory experiments, for instance, instructions may be given that the subject recall only the names of the items in the list he studied, although he may know many other things about the retrieved items as well. Similarly, in experimental tasks such as free recall, the person may retrieve and become consciously aware of an item and yet decide not to produce it overtly, because he has already made the same response on the same trial. A third example of the control by the output decision mechanism over overt recall comes from experiments (e.g. Roediger, 1973; Rundus, 1973; Slamecka, 1968) in which the subject is provided with list items as retrieval cues for recall of other items. In these situations, too, the subject may retrieve an item but refrain from overtly producing it, because it is one of the 'cue' items.

As already noted, the exact behaviour of recall or recognition is of little interest in memory experiments. (This is one feature that distinguishes between experiments concerned with memory and those concerned with learning in the sense of modification of behaviour.) The learner can write the recalled word, speak it out aloud, record it in some other language that he knows, and so forth. The experimenter is usually willing to give him equal credit for each of these performances, since they constitute observable manifestations of the same underlying memory state. The same holds for recognition. Again, it does not matter whether the learner checks a test word as 'old', circles its printed form, says 'yes' to an appropriate query, or pushes a button. What does matter is the underlying state in the system, the conscious memory for the event in question. To the extent that the learner's recognition response provides reliable evidence about such a state of the system—and, of course, we know of situations in which it does not—the format of the overt response itself is totally uninteresting to the memory theorist. Theories of memory are concerned with remembering, not with the rememberer's behaviour.

Ecphory and Retrieval

The term 'ecphoric process' is used in this chapter in the sense of 'the process by which information stored in a specific memory trace is utilized by the system to produce conscious memory of certain aspects of the original event'. It comprises stages 5 to 8 in the schema in Table 1. The term 'ecphory' is adopted from Semon (1909), who used it in the sense of 'activation of a latent engram', a sense that is basically the same as the somewhat more elaborate definition given above. Semon also was the first person to use the term 'engram' to designate the aftereffects of stimulation that endured over time, but since there is little danger in confusing 'engram' with its more widely used synonym 'trace', the latter term will be used throughout this chapter.

The adoption of the term 'ecphory', together with its derivatives, was necessary in the present instance because the alternative term 'retrieval' that has usually served to carry the meaning assigned to ecphory (Melton, 1963) had to be reserved for a more specific purpose, namely, to designate the first of the two hypothesized stages in the two-stage theory of recall. The term 'retrieval' in what follows refers to implicit production of response candidates, or covert access to the stored representation of an item in permanent (semantic) memory (Anderson and Bower. 1972; Bahrick, 1970; Kintsch, 1970b).

Like encoding and storage of the trace, ecphory is a process of which the person is not and cannot be consciously aware. Claims of such awareness are more reasonably interpreted to mean that the person is aware of the *product* of ecphory rather than the process. The subjective experience corresponding to the hypothesized stage 8 in our schema is called *remembering*. Thus, remembering refers to the cognitive awareness that results from the successful completion of the ecphoric process. The term 'recollection' is sometimes used as a synonym for remembering.

Recall and Recognition

Our primary interest in recall and recognition in this chapter has to do with them as partly similar and partly different modes of ecphory, that is, as memory processes underlying the conversion of trace information into conscious awareness of certain features of the original stimulus event.

What we have to say about recall and recognition in this chapter is limited to simple episodic memory (Tulving, 1972) experiments in which to-be-remembered materials are familiar words presented for study in unfamiliar collections or lists, and in which the learners' memory for these word events is tested by measuring the relative frequency with which they can reproduce or correctly identify the names of the words. Learners store a good deal more information about the list words than just their names, but tests of these other features are excluded from the present analysis. It is not quite clear what it would mean to say that the subject *recalls* the sensory modality (vision *versus* audition) in which the word occurred, or *recalls* the number of times that one and the same lexical unit appeared in a list, since it seems to be equally meaningful to say that he *recognizes* the presentation modality or occurrence frequency. Hence a contrast between recall and recognition in memory tasks of this sort makes less sense than in the classical situation involving names of word episodes. The issue of the relation between recall and recognition can be raised only if the two processes are at least initially regarded as distinctive.

In this chapter we also ignore experiments in which to-be-remembered units are letters or digits or numbers. Memory processes for these units may not be drastically different from those entailed in remembering word events, but when to-be-remembered items come from such easily numerable sets it again is not clear whether the person recalls or recognizes a learned item when he is tested for it. Murdock, for instance, has suggested that the 'basic difference between recall and recognition is probably whether or not the (subject) can readily generate all possible alternatives. If he can, or if they are physically present, the method would be recognition. If he cannot, and they are not physically present, then the method would be recall' (Murdock, 1970, p. 70). If we accept Murdock's definition of the difference, then, as D'Amato (1973) has pointed out, tasks in which the subject is required to recall digits and letters must be regarded as recognition tasks, and it is not possible for the subject to recall these kinds of materials. If we do not accept Murdock's reasoning, then we may commit the error of confusing subjects' behaviour with underlying processes.

Two-Stage Theory of Recall

The two stages of the initial versions of the two-stage theory applied only to recall. Recognition was assumed to entail only the second stage. More recent versions of the two-stage theory envisage the possibility that at least certain recognition performances are based on both stages, retrieval and decision. In this section we are concerned primarily with the earlier forms of the theory.

Nature of the Theory

Hollingworth, writing more than 60 years ago, summarized the difference between recall and recognition in the following words.

> 'Schematically, at any rate, the difference between recall and recognition seems to be a rather simple matter. Recall is that aspect of memory process in which a *setting*, a background or association-cluster, is present in clear consciousness, but the desired *focal element* is missing. . . Recognition is, schematically, just the reverse of this process. In recognition the focal element is present, in the form of sensation, image, or feeling, and the question is whether or not this element will recall a more or less definite setting or background' (Hollingworth, 1913, pp. 532–3).

In this statement, Hollingworth does not just describe the differences between recall and recognition as methods of measuring retention, but rather points to differences in the underlying processes. Contemporary theorists describe the distinction in rather similar terms. Here, for instance, is what Norman says.

> 'Recall and recognition represent two different forms of queries to the storage system. In a recall task, the initial query consists of the context surrounding the sought for item; the task is to generate the item given its context . . . . In recognition, the required task is just the reverse. Here the item itself is given; the question is whether the context surrounding the item is appropriate . . . . The recognition task does not require the same

type of search used in recall; the recursive query–output–decision–query chain is not needed. All that is required in recognition is an assessment of the appropriateness of the various associations surrounding a stored item to the association demanded by the query' (Norman, 1968, p. 533).

Thus Norman, like Hollingworth, is impressed by the reversal of the process as one goes from recall to recognition. In both cases it is a matter of association between item and context, but while in recognition the task is to proceed from the item to the context, in recall the task is the reverse, to 'generate the item given its context'. Norman, like many other two-stage theorists, also believes that recognition in some sense represents a simpler process than recall '*All* that is required in recognition . . .'.

Kintsch (1970b) has formalized the distinction between a simpler process of recognition and a more complex one of recall by bringing up to date an old theory described, among others, by G.E. Müller (1913). The basic assumption of this two-stage theory is that recall involves two successive ecphoric stages, retrieval and decision, while recognition involves only the last of the two. Since recognition is a subprocess of recall, and recall involves a stage of information processing that is absent in recognition, the two modes of ecphory are regarded as qualitatively different.

Kintsch summarizes the two-stage theory as follows.

'The basic difference between recall and recognition appears to be that recall involves a search process and recognition does not. In recognition, the problem of retrieval is simple: the item is sensorily present and it is a simple matter to retrieve its corresponding representation in memory (although how this is done is by no means obvious); the subject then has some means of judging the newness of the trace (response strength, familiarity); if the newness satisfies some criterion, the subject says he recognizes the item; otherwise he calls it new; irrelevant alternatives are not considered in this judgement . . . . The problem in recall is very different. Items are not sensorily present to be judged for the newness, but they must be retrieved from memory. Retrieval involves getting from one memory trace to the next. What is important therefore are inter-item relationships. An item in a free-recall experiment is not retrieved *in vacuo*, but only as a member of a larger structure' (Kintsch, 1970b, p. 337. Reproduced by permission of Academic Press, Inc.)

Here we have the basic ingredients of the two-stage theory succinctly summarized. (a) Recall entails a process that is absent in recognition, namely, search, or retrieval. (b) Recognition thus represents a simpler process than recall. (c) Retrieval of an item's representation in memory through the copy cue is always guaranteed. (d) Recognition requires only a decision about the 'newness' or familiarity of the trace.

A somewhat different version of the two-stage theory of recall was proposed by Anderson and Bower (1972). These authors conceptualize human memory as a huge network of nodes interconnected by associations. The nodes represent concepts, plus corresponding words, while inter-node associations refer to existing relations between word concepts. Learning a list of words results in (a) a probabilistic marking of pathways in the network between nodes corresponding to list words, and (b) an independent process of associating words to the context in which they are presented, the context being conceptualized as 'list markers'. For the subject to be able to recall a word the pathways between some starting nodes and the target node must have been marked and the list marker must have been associated to the target node. For recognition, the access to the node via marked pathways is unimportant, since the presentation of the copy of the test item automatically provides access to the corresponding node, and the recognition judgment depends on the adequacy of information about the list context, if any, attached to the node.

In a later paper, Anderson and Bower (1974) modified their theory by postulating that a word may be represented by a number of different nodes in memory, corresponding to different semantic senses or 'ideas' of the word. We shall return to this new version of the theory later.

One of the most explicit statements of the two-stage theory, and of the difference between recall and recognition, has been provided by Bahrick (1969; 1970) in an explanation of the effectiveness of extralist retrieval cues. According to Bahrick's formulation, an extralist retrieval cue (such as a word that was not explicitly a part of the presented list) can facilitate recall of a list word, because it elicits, through pre-experimentally established associative connections, the target word as an implicit response (the retrieval stage), which then can be subjected to a recognition check (the decision stage) rather like an explicitly presented 'old' test item in a recognition test. Retrieval cues are effective in facilitating recall, since, on this view, they convert a more difficult recall task into an easier recognition problem.

Several other versions of the two-stage theory have been described at greater or shorter length in the literature. They differ from one another in various details. It would be impossible to treat all of them individually in this chapter. They do, however, share sufficient commonalities to make it possible to discuss them as essentially the same. This is why we shall frequently refer to two-stage theory rather than two-stage theories.

Not all experimental facts are equally important in evaluating the nature of relation between recall and recognition. For instance, the wellknown fact that recognition is usually superior to recall is relatively unimportant inasmuch as almost any theoretical view could accommodate it. Similarly, the fact that the number of alternatives is an important determinant of the extent of the performance difference between recall and recognition is not especially critical, although the existence of the fact has sometimes been used in support of the view that recall and recognition measure essentially the same thing.

Study/Test Interactions

More relevant to the problem of the relation between recall and recognition have been data demonstrating what we shall refer to as study/test interactions. These data come from experiments in which the learning material is presented for study under at least two different input or presentation conditions and tested in at least two different test conditions, typically in free-recall and recognition tests. These data are relevant because they sharply distinguish between two-process and single-process theories. Single-process theories, which are now almost extinct, viewed recall and recognition as differentially sensitive measures of the underlying response strength, and the thrust of the two-stage argument was directed against these strength theories (Anderson and Bower, 1972; Kintsch, 1970b). Other differences between two-process and one-process theories of recall and recognition have recently been thoroughly reviewed by Tiberghien and Lecocq (1973) and Lecocq and Tiberghien (1973).

The study/test interaction of interest—observed in many experiments—is one in which performance on the recall test is different for the two input conditions, whereas performance on the recognition test is the same. A particularly thorough summary of experiments that have yielded these patterns of data has been provided by McCormack (1972), and the interested reader should consult his paper for greater details. Here we shall consider only a few examples. These will suffice to illustrate the reasoning by which the data are related to the two-stage theory of recall.

Four sets of data on study/test interaction are presented in Figure 1. The data in Figure 1A come from an experiment by Bruce and Fagan (1970) which constituted a replication, with certain additional controls, of an earlier experiment by Kintsch (1968). Subjects studied lists of 42 words. The 'related' material consisted of six words in seven conceptual categories, while the 'unrelated' materials were represented by one word from each of 42 different conceptual categories. In free recall, subjects produced as many words as they could, and then added additional words until they had written down a total of 42 words. The number of words corresponding to list words represented the free-recall score. In recognition, the 42 old words were mixed with 42 new words from the same conceptual categories as those in a given input list and the subjects were asked to select 42 words as 'old'. Recognition score was the number of 'hits'. The data depicted in Figure 1A show that the nature of the material had a substantial effect on the free-recall performance, but none whatsoever for the recognition performance.

The data in Figure 1B were reported by Dale (1966). The two study conditions were defined by the presentation of two different types of materials. The 'high-familiarity' items consisted of six names of UK counties that subjects in a previous experiment had been able to generate from memory with ease, while 'low-familiarity' materials were six county names that had been mentioned much less frequently by the subjects in the previous experiment. The critical familiar and unfamiliar county names were mixed with some other buffer items in study lists which were then presented to subjects on a single trial. In the free-recall test, subjects simply wrote down as many list items as they could. As can be seen in Figure 1B, there was a large difference in recall of familiar and unfamiliar items. In the recognition test, the subjects had to select the

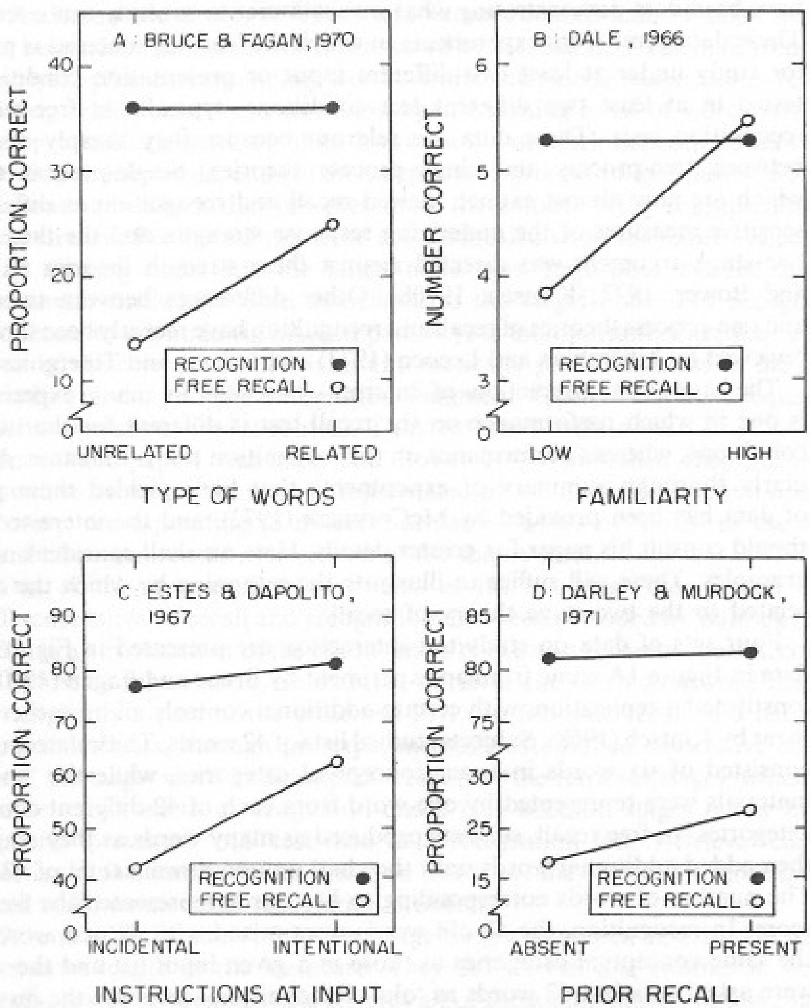

Figure 1. Four sets of data illustrating study/test interactions

list items from a total set of all 40 county names. Figure 1B shows that there was no difference whatever in the recognition of the two types of material.

Figure 1C depicts data from an experiment by Estes and DaPolito (1967). Subjects learned lists of eight CVC–digit pairs. They then either recalled response members to stimulus members as cues or attempted to identify the eight old pairs that had been mixed with eight other pairs representing re-paired stimulus and response members. One group of subjects (intentional learners) had been told prior to the presentation of the material that their task was to remember the pairs, while another group (incidental learners) were exposed to the material as part of a problem-solving task. Intentional and incidental learners differed greatly in their ability to recall the material, while differences between the two groups in the recognition task were negligible.

Finally, Darley and Murdock (1971) compared recall and recognition of words from 10 lists. Each list had been presented earlier on a single presentation trial and followed either by an immediate recall test or by a neutral activity filling the interval between the presentation of the list and the next one. The data, depicted in Figure 1D, show the effect of the prior testing of lists on the subsequent recall and recognition. In keeping with the pattern of data in the other panels of Figure 1, here, too, recall was influenced by an experimental variable, the presence or absence of an earlier recall test, while recognition scores for the two types of list were practically identical.

The Logic of Two-Stage Theory

The data appearing in Figure 1 show how four quite different experimental variables—inter-item relations, previous familiarity with items, intentionality of learning and presence or absence of prior tests—have an effect on free recall but not on recognition. While simple one-process theories would have to introduce additional *ad hoc* assumptions to make sense of these findings, the two-stage theory can readily accommodate them. All these patterns of data, according to the two-stage theory, simply illustrate the fact that recall entails two independent ecphoric stages, retrieval and decision, whereas recognition involves only the last of these two.

Probability of correct recall, according to the theory, depends both on the probability of implicit retrieval of the target item and the probability of its acceptance by the decision mechanism. Probability of a recognition 'hit', on the other hand, is determined solely by the probability of the correct acceptance of the 'old' test item by the decision system. Any experimental variable that affects *only* the probability of retrieval, therefore, will produce a difference in recall but leave recognition performance invariant. A variable that exerts an effect only at the second stage will produce a difference in both recall and recognition. The effects of a variable affecting both retrieval and decision cannot be as easily determined, except when the effects of the variable at the two stages are positively correlated, in which case the variable affects both recall and recognition similarly.

According to this logic, all the variables defining study conditions in experiments depicted in Figure 1 affected only retrieval. Consequently, they produced differences in recall but not in recognition performance. For instance, the semantic relations among list words in Bruce and Fagan's (1970) experiment, shown in Figure 1A, facilitated implicit retrieval of one list word by another, but did not affect their recognizability, which depends on the amount of occurrence information associated with each list item.

Two points are worthy of especial attention in evaluating the logic relating the data to theory. First, the argument here appears to be somewhat circular, as long as there exists no independent method of determining whether a variable affects one or the other, or both, stages of processing. If we accept the two-stage theory, then the patterns of data in Figure 1 are explained. But what experimental support is there for the theory? Well, there are the data such as those in Figure 1. And how do we explain these data? Well, we assume that the theory is correct and that the study variable affects only retrieval.

In some cases it may be intuitively obvious that the input variable might have an effect only on retrievability of items and not on their recognizability, in other cases even this kind of feeble independent 'evidence' is lacking. The problem of circularity of reasoning, however, by no means applies only to the two-stage theory, and hence it does not constitute a serious criticism of the theory.

The second point of interest has to do with the assumed independence of the two stages: it must be possible for a variable X to affect one stage without affecting the other. This assumption is critical for the theory. If there were a correlation between retrievability and recognizability of items, across different levels of the variable X, then recall and recognition performances would be necessarily correlated. The data in Figure 1 are consistent with the assumed independence of the two stages, but to add extraneous strength to the assumption, the two stages have sometimes been endowed with different hypothetical properties. For instance, it has been assumed in some versions of the theory (Bahrick, 1970; Kintsch, 1968) that the retrieval process is governed by the associative structure of the memory system as it exists before the experimental presentation of the learning material, while the decision process is based on the consequences of the experimental input. In other versions of the theory, retrieval and recognition decisions are both affected by experimental input, but in different ways. In the Anderson and Bower (1972) model of free recall, for instance, retrieval depends on the associations between list tags and inter-item pathways in the memory network, while recognition decisions are based on associations between list tags and item nodes.

We shall have to keep in mind the assumed independence of the two stages as we move on to consider other sorts of data that have helped to distinguish the two-stage theory from one-process models of ecphory. For instance, one critical finding concerns the correlation between recall and recognition scores among individual subjects. Several experimenters have reported that under conditions where the same subjects are tested for both recall and recognition of different features of the same material (such as recalling *names* of picture stimuli and recognizing the actual pictures) correlations tend to be very low and sometimes not significantly different from zero (e.g. Bahrick and Boucher, 1968; Tversky, 1973; 1974). If both recall and recognition simply index some underlying memory 'strength' of the composite stimuli, then a positive correlation between recall and recognition would be expected: subjects in possession of 'strong' traces ought to get both higher recall and higher recognition scores than subjects who, for whatever reasons, have not learned the material as well.

Yet another example of the situation in which a given experimental treatment seems to produce different outcomes in recall and recognition, contrary to simple one-process theories, concerns the effect of strong associative cues on recall and recognition of target items from a list. The matter has been briefly discussed by Thomson (1972). When a list of target items is presented for study in a to-be-remembered list, with one item presented at a time, then the presence of strong extralist associates of target items as retrieval cues facilitates recall of target items (e.g. Thomson and Tulving, 1970). In contrast, the presence of such extralist cues either has no effect or even interferes with the recognition of the target items. The facts can at least partly be accommodated by the two-stage theory if it is assumed that the strong associate of the target item facilitates the retrieval of the target, whereas the recognition decision is based on the stored information to which access is provided by the 'old' test item.

Criticism of Two-Stage Theory

As we consider some of the weaknesses of the two-stage theory, we must keep in mind that different versions of the theory are not equally subject to all the criticisms that follow. Some versions of the theory can be clearly ruled out by the existence of certain experimental facts, while others suffer only from lack of sufficient detail that makes direct experimental test difficult, and sometimes impossible. The most vulnerable versions of the theory are those that postulate that retrieval processes are determined or governed by the pre-experimental (semantic) structure of memory. Other versions of the theory that assume retrieval processes to be influenced by experimental events, or the 'contents' of episodic memory, cannot be as readily rejected, but they face the problem of justifying the distinction between two separate ecphoric processes, retrieval and decision, *both* of which are guided by episodic information. These points will be elaborated later in the chapter.

Most of the criticisms of the two-stage theory are focused on the hypothesized distinction between the two stages, retrieval and decision, both of which precede the processing stage at which the product of the trace information and ecphoric information is brought into consciousness. The problem of particular interest concerns the need for the postulation of, or evidence for, the preconscious decision stage. Although no extant version of the two-stage theory makes an explicit reference to the subject's conscious awareness of a remembered event in discussing the two stages, it is assumed here that the locus of the decision stage in these theories is prior to conscious awareness. A theory of recall that postulates only a post-ecphoric decision process, designated as stage 9 in Table 1, is not subject to any of the criticisms outlined in this section. Such post-ecphoric decisions, as mentioned earlier, seem to possess an incontrovertible reality that is beyond theoretical dispute.

In this section we shall consider six specific criticisms of the two-stage theory. In the following section of the chapter a seventh difficulty of the theory is examined in the light of experimental data closely related to those providing the critical input/test interactions shown in Figure 1.

Rejection of Correctly Retrieved Items

One of the joint outcomes of the operation of two successive stages in recall is the rejection by the decision mechanism of a response candidate correctly identified by the retrieval system. This hypothesized outcome makes one wonder about the evolutionary utility of the production of wanted information by one cognitive mechanism, retrieval, that is subsequently rejected by another, decision. It also raises doubts about the reality of such a hypothesized state of affairs. Is there any direct evidence that subjects sometimes implicitly retrieve correct list items in a recall task, but fail to recall these items because the decision system does not pass the information through to the conscious stage? At the present time the answer is negative.

The problem is of considerable importance. If everything correctly identified by the retrieval process were always accepted by the decision mechanism, then the necessity for the separation of the two stages would become meaningless: cases where a correctly retrieved item is rejected by the decision mechanism would never occur, and cases where incorrectly retrieved items are rejected would never manifest themselves in the subjects' behaviour. The remaining two possible outcomes, correct recalls (correctly retrieved items accepted by the decision mechanism) and recall instrusions (incorrectly retrieved items accepted by the decision mechanism), can be specified solely in terms of the retrieval process. On the other hand, the postulation of the preconscious decision stage would become almost mandatory if it could be shown that retrievable information about target items can be prevented from reaching the stage of conscious awareness by the preconscious decision filter operating with too stringent an acceptance criterion. If, for instance, the subject in a free-recall experiment were instructed to first recall and then generate items that might have been on the list, as was done by Cofer (1967), would he ever produce any correct items that he fails to recognize as such? Appropriate controls would have to be included in the experiment, of course, but if the demonstration of recognition failure of overtly retrieved correct responses were successful, the two-stage theory would have received important support. Until such time that such evidence becomes available, the postulated preconscious decision stage in recall remains a purely hypothetical and perhaps an unnecessary construct.

'Dissociation' of Retrieval and Decision

So far there has been little direct evidence that recall entails the two hypothesized stages while recognition consists only in one. The study/test interactions and other evidence that were considered earlier are only indirect. The two-stage theory would clearly be stronger if some means existed for separate identification of, and separate measurement of the output from, the two-stages.

An attempt to differentiate the two stages has been reported by Anderson and Bower (1972, experiment III). Subjects were shown, on each of successive trials, a semi-random subset of 16 words selected from a constant total set of 32. The subset shown varied from trial to trial. The subjects had to reproduce on each trial as many words from the *total* set as they could, and for each produced word to indicate their confidence that it had appeared on the *immediately preceding* input trial. Anderson and Bower argued that the number of reproduced members from the total set reflected retrievability of the items, while the confidence with which the subject judged the membership of retrieved words in the set presented on the immediately preceding trial constituted a measure of recognition. Since the number of items produced increased over trials whereas the confidence of trial identification declined, Anderson and Bower claimed that they had 'dissociated' the two postulated components of free recall.

The argument for dissociation of retrieval and recognition in this instance is not entirely convincing. Retrievability in the experiment referred to subjects' knowledge of the membership of the total set, whereas recognition referred to the subjects' knowledge of a particular subset, the words appearing on a particular trial. On any given trial after the first, subjects had had two or more trials of practice during which they could accumulate knowledge about the membership of the items in the total set, whereas recognition decisions had to be based on the appearance of items on a single trial only. Thus, while the effects of practice could be transferred from trial to trial with respect to 'retrievability' of the items, an item's appearance on trial t could not and did not provide any useable information to the subject about its appearance on trial $t+1$.

Anderson and Bower's reasoning underlying 'dissociation' can be extended to any situation in which a smaller subset of items (such as the words appearing in a list) is selected from a larger total set (such as all words in the language) and the subject has to decide, in a recognition test, whether or not a given item appeared in the subset. Since it is well known that under these conditions probability of recognition of an item as a member of the fixed subset increases over trials, while the subject's lexical knowledge of the words in the language (retrievability) does not, the dissociation argument could also be made on the basis of these familiar facts. Yet these facts do not appear to be highly critical for distinguishing the two-stage theory from other theories.

Sources of Recognition Failure

According to the standard two-stage theory, recognition failure is a consequence of the decision mechanism rejecting the information retrieved by the 'old' test item (e.g. Anderson and Bower, 1972; Kintsch, 1970b). The negative decision is made by the system if the representation of the test item in memory is not marked with appropriate occurrence information or list tag. This account of recognition failure follows from two assumptions: (a) test items are represented in (semantic) memory, before they have occurred as a part of a unique episode (e.g. first time in a list), and (b) a test item invariably provides access to its representation. Since there is no problem of retrieval in recognition, recognition failure can only mean that the list marker, or occurrence information, was absent or inadequate.

Such a conceptualization overlooks the possibility that negative recognition decisions can also result from the failure of access to the test item's representation, that is, using the terminology of the two-stage theory, from the failure of the retrieval process. It is easy to imagine that retrieval failure is responsible for the judgment that a test item is 'new' in a recognition situation in which the test item can have no prior representation in the memory structure and hence access to it is precluded on logical grounds. If, for instance, the test stimulus is a melody that the subject has never heard before, or perhaps an unknown olfactory stimulus (cf. Engen and Ross, 1973), the new test items must be identified by the subjects as 'new' because no representations of such stimuli exist in memory, and not because there is no occurrence information attached to the representation. Under these conditions it is also possible to conceive of similar reasons for negative recognition decisions for 'old' test items.

Theories that assume a content-addressable storage system (e.g. Shiffrin and Atkinson, 1969) could explain recognition failures in terms of the absence of appropriate occurrence information in the ('empty') location where the information about a particular stimulus would be stored had such a stimulus ever occurred. But the idea that episodic information is stored in content-addressable locations in memory is contraindicated by certain other data (e.g. Herrmann and McLaughlin, 1973; Murdock and Anderson, 1975).

Higher Recall than Retrieval

A basic and very firm prediction of the two-stage theory is that only that can be recalled that first passes the retrieval stage. Hence recall cannot be higher than retrieval.

This prediction was put to a test in an experiment conducted by Olga C. Watkins at Yale. Subjects were tested in two separate situations: (a) a semantic memory search task, in which the subject had to use certain cues to locate familiar words in memory, and (b) a simple episodic memory task, in which the subject was given similar cues as aids for recall of studied list words. The cues used were word fragments such as (a) A——AS——N, (b) A—P—N—I— and (c) HO———ON, where dashes represent missing letters. Each of these word fragments permitted only one meaningful completion, that is, each was selected to provide access to only one familiar word in semantic memory. In the semantic search task, subjects were presented with one word fragment at a time, for 15 seconds, and asked to use the fragment for the production of a meaningful word. The proportion of target words that subjects were able to generate under these conditions (the correct answers for the above fragments are ASSASSIN, APPENDIX and HORIZON) was 14 per cent. In the episodic memory task, subjects saw first a list of 17 words, with each word presented once for 1.5 seconds. The first word and the last four words in the list served as buffer items whose recall was ignored in the analysis of the data. After the presentation of the list subjects were asked to recall as many words as they could under free-recall instructions. The mean number of words recalled was 7.9, consisting of 3.5 buffer items and 4.4 words (37 per cent) from the critical, middle part of the list. Following the free-recall test, the subjects were provided with the word-fragment cues, with each cue shown for 5 seconds, and asked to recall any additional list words. In this cued recall task subjects recalled 77 per cent of the 63 per cent of the words they had failed to recall in free recall, a figure considerably higher than the 14 per cent retrieval rate in the semantic task.

Why did these word-fragment cues greatly facilitate recall of words from the studied list, in comparison with free recall? (It is reasonable to assume here that subjects could have recalled most or all of the words recalled in free recall also in response to the cues.) One might want to argue, in keeping with the two-stage theory, that the subject used the word fragment to implicitly retrieve the corresponding word from semantic memory, and then performed a recognition decision on the basis of the list tag attached to the word's representation. But this argument is ruled out by the extremely low probability of identifying the target words in the semantic retrieval task.

The results of this simple experiment require that implicit retrieval, if it is postulated as a separate stage, be either determined by the consequences of the episode of the word's appearance in the list, or thought of as constituting access to information stored in the episodic memory system (Tulving, 1972). Be it as it may, the independence of the retrieval stage from the decision stage, at least in this kind of situation, cannot be accounted for in terms of the structure of memory existing prior to the episode in question.

Context Effects in Recognition

One criticism of the two-stage theory derives from the known facts about context effects in recognition memory. A fair number of experiments have been reported showing that recognition of the study list item depends on the relation between its context at the time of the study and at the time of its test (e.g. Light and Carter-Sobell, 1970; Marcel and Steel, 1973; Thomson, 1972). Context is usually defined in terms of the presence of other items to which the subject attends. The typical findings are that the changes in the context between study and test produce an impairment in recognition performance.

Why should the context of a to-be-remembered item and its literal copy at test matter, if recognition results from a simple decision about the occurrence information attached to the item's representation in permanent memory? The two-stage theory does not have an answer to this question.

A possible revision of the two-stage theory that could handle context effects would incorporate assumptions (a) that most words have several different semantic meanings or senses, each one being represented by a separate entry in memory, and (b) that the word's context determines the sense of the word to which the list marker or occurrence information is associated at input and to which access is provided by the test word at recognition (and by the implicitly retrieved word at recall). On this view, the test word appearing in a particular context may provide access to a sense of the word different from the one that was marked at input, with the result that the recognition decision is negative. Thus, the 'old' test item in a 'new' context is judged to be 'new' for the same reason that a 'new' test item is correctly identified as such in the recognition test: lack of occurrence information in the memory location that is examined.

This kind of modification of the two-stage theory (Anderson and Bower, 1974; Martin, in press; Reder, Anderson and Bjork, 1974) assumes that recognition sometimes fails because the information available in the store cannot be found, that is, because of the failure of retrieval. Thus, the modified theory implies that recognition, too, may require both retrieval and decision. We shall return to the modified theory and some of its other implications later in the chapter.

Higher Recall than Recognition

The next criticism of the two-stage theory concerns the assertion implicit in the theory that it is impossible for a person to be able to recall an item that he cannot recognize. According to the theory, there are two potential sources of *loss* of information in recall, the retrieval stage and the decision stage, while there is only one such source, the decision stage, in recognition. Whenever an item is correctly recalled, it means that the stored information successfully passed both of these two potential bottlenecks. The logic of the theory therefore demands that recallable items must always be recognized. Experimental data showing recognition failure of recallable words, however, do exist, in direct contradiction to the theory.

Evaluation of the experimental data demonstrating superiority of recall over recognition requires that we be quite clear about the problems of measurement that the comparison entails. When, for instance, are recall and recognition performances equal? Determination of equality is a prerequisite for the determination of inequality of the two performances. Since subjects in both recall and recognition tests, and particularly in the latter, can make correct responses by 'guessing' alone, their performance has to be corrected for guessing. Statements about equality and inequality of recall and recognition, therefore, presume the adoption of some set of rules for such correction. Since agreement is as yet lacking as to what methods of correction are appropriate under what conditions, it looks as if there could be no generally acceptable solution for the problem of determining equality of recall and recognition performances.

Fortunately, it is possible to demonstrate superiority of recall over recognition in a manner that (a) leaves relatively little room for dispute on the grounds of disagreement about methods of correcting for guessing and other scaling problems, and (b) obviates the necessity to accept any particular theory of recognition memory. All that is needed is the testing of one and the same subject twice for the same set of target items, once under conditions of recall, and once in a recognition test. Each target item then can be classified for each subject into one of four mutually exclusive subsets: items both recalled and recognized (Rc, Rn), items recognized but not recalled ($\overline{\text{Rc}}$, Rn), items recalled but not recognized (Rc, $\overline{\text{Rn}}$) and items neither recognized nor recalled ($\overline{\text{Rc}}$, $\overline{\text{Rn}}$). If the frequency of items in the Rc, $\overline{\text{Rn}}$ category is reliably higher than that in the $\overline{\text{Rc}}$, Rn category, it can be concluded that recall is higher than recognition. A possible objection that the frequency of correct responses attributable to guessing might be higher in recognition than in recall would not apply here, since such a state of affairs could only inflate the $\overline{\text{Rc}}$, Rn score and hence only attenuate the difference on which the statement of superiority of recall over recognition is based. The argument that the higher frequency of Rc, $\overline{\text{Rn}}$ may simply reflect a higher criterion used by subjects in the recognition than in the recall test would not change the experimental fact; it only suggests one of many possible explanations of it. References in the rest of this chapter to superiority of recall over recognition are to data of this sort, higher frequency of items in the Rc, $\overline{\text{Rn}}$ category than in the $\overline{\text{Rc}}$, Rn category.

Superiority of recall over recognition has been observed in a number of experiments (e.g. Tulving, 1968b; 1974; Tulving and Thomson, 1973; Watkins, 1974; Watkins and Tulving, 1975). One of the clearest sets of data was obtained in experiments 1 and 2 described by Tulving and Thomson (1973). Subjects were shown to-be-remembered words (e.g. BABY) in an input list, accompanied by weak semantic associates of these words (e.g. *grasp*) serving as input context, or as list cues. Following the presentation of the list, subjects were given strong pre-experimental associates of target words (e.g. *infant*) as stimulus words in a free-association task, and asked to generate a number of related words to these stimuli. The generated associates included many copies of target items from the input list. The subjects were then asked to examine all words that they had generated, and to circle those words they recognized as having occurred in the previously seen input list. Finally, in an immediately following cued recall test, subjects were given the list cues and asked to recall the corresponding target items from the list. In the two experiments, the number of Rc, $\overline{\text{Rn}}$ items exceeded the number of $\overline{\text{Rc}}$,Rn items by a ratio greater than 15:1. In other words, in many cases the subjects did not recognize BABY as a list word when it had been generated in response to the extralist cue *infant*, although they could produce BABY in response to the list cue *grasp*. This superiority of recall over recognition was sufficiently large to render unreasonable any argument about chance fluctuation in the accessibility of stored information or about scaling problems. Since the recall test followed the recognition test, any forgetting that may have taken place between the two tests could have served only to attenuate the difference, thus producing an underestimation of superiority of recall over recognition.

These data, demonstrating recognition failure of recallable words, were obtained under conditions where the context of the word at the time of the test was nominally identical in recall but quite different in recognition. They can therefore be regarded as representing an extension of the earlier data demonstrating context effects in recognition memory. Regardless of theoretical interpretations of the data, the fact that a reversal of the usual superiority of recognition over recall can occur under any circumstances constitutes a weakness of the standard versions of the two-stage theory that do not permit such a relation between recall and recognition performance. The modified two-stage theory, however, that postulates many semantic senses of words determined by the context, handles the recognition failure of recallable words as adequately as it handles other context effects in recognition memory.

Further Facts about Study/Test Relations

The final criticism of the two-stage theory concerns data from experiments that have demonstrated various study/test interactions. We have already seen how the main experimental support for the standard two-stage theory is derived from these data (e.g. Anderson and Bower, 1972; Kintsch, 1970b; McCormack, 1972; Underwood, 1972). But now the criticism is offered here that the patterns of data depicted in Figure 1 represent only arbitrarily selected instances of study/test relations, and that other patterns of study/test relations must be included in the evaluation of the two-stage theory. These data are described and their compatibility with the theory discussed in this section of the chapter.

Figures 2 and 3 contain some other illustrative findings from experiments of the same general type that produced the results depicted in Figure 1. Two types of material, or one and the same type of material presented under two different input conditions, are tested in two different retrieval situations. The data shown in Figure 1 came from experiments in which one test was free recall and the other recognition, and some of the experiments represented in Figures 2 and 3 entailed the same two tests. In others, cued recall tests were used.

In the Lachman and Tuttle (1965) experiment, subjects were presented with 100 words whose order in the list constituted either a high degree of approximation to English (meaningful prose) or a low degree (random order). Retention was tested by free recall and recognition. As the data in panel A of Figure 2 show, both recall and recognition were higher for the prose than for the randomly ordered words. The two-stage theory would have to explain these data by assuming that in this particular case organization of words affected the recognizability but not necessarily the retrievability of the words. Storage of information about word-episodes, or development of list markers, may in this case have been more efficient for high than low approximation to English. It may be worth noting in passing that the problem of circularity of reasoning is relevant here, too. *If* we get an input/test interaction, retrieval processes, and hence the recall scores, are said to be affected by input conditions, while the decision processes are not; *if* we observe parallel effects in recall and recognition, the conclusion is that both processes may be affected, or perhaps only the decision process is. In either case, the data can be explained by the theory, and the theory is supported by the data.

In the Murdock (1968) experiment, subjects were presented with lists of 10 words on a single trial. The presentation was either visual or auditory. In the probe-recall test, one of the list words was presented as the probe and the subject's task was to recall the word that had followed the probe in the list. In the recognition test, a pair of words was presented. It consisted either of two words that had followed one another in the list, in the same order ('old' pair), or of two list words that had not appeared in adjacent positions ('new' pair). In panel B of Figure 2 proportions of correct responses for the words from the last two serial positions (probe positions 8 and 9) are graphed. Both probe-recall and recognition scores were higher for auditory than visual input. The two-stage theory could account for the data by assuming that the presentation modality affected only the second of the two ecphoric stages, and that the superiority of recall over recognition in this experiment is a scaling 'artefact' of some sort or another.

The next two experiments manipulated instructions to subjects at the time of input. Winograd, Karchmer and Russell (1971, experiment II) presented their subjects with 50 pairs of words on a single trial, telling them that their task was to remember the target word (right-hand member of the pair) and instructing them either to form associations between the target word and its accompanying cue word or to form a bizarre mental image combining the two words. Subjects' memory for the target words was tested in a recognition test with or without the cue words that had accompanied target words at input. The data from the experiment are depicted in panel C of Figure 2. The two kinds of instructions, associative *versus* imagery, had no effect on recognition of target words presented in the absence of the original context words, but imagery instructions did yield a considerably higher score for recognition in a test situation in which the original context words were presented alongside the target words. It is not immediately obvious how the two-stage theory would explain this sort of study/test interaction. Since the retention test entailed recognition only, differences in retrieval mechanism cannot be invoked.

The second experiment in which input instructions were manipulated is Tversky's (1974). The study materials consisted of line-drawings of objects accompanied by words labelling the objects. These object-word items were presented to the subjects on a single trial under instructions to expect either a recognition test or a free-recall test. Subjects in both instructional groups were in fact tested for both free recall and recognition. The data, shown in panel D of Figure 2, show a strong interaction between input instructions and the test mode: subjects who expected the recognition test did considerably better on the recognition test and considerably worse on the recall test than subjects who had been given the recall instructions. This type of study/test interaction cannot be readily handled by the two-stage theory without additional assumptions, since the correlation between recall and recognition

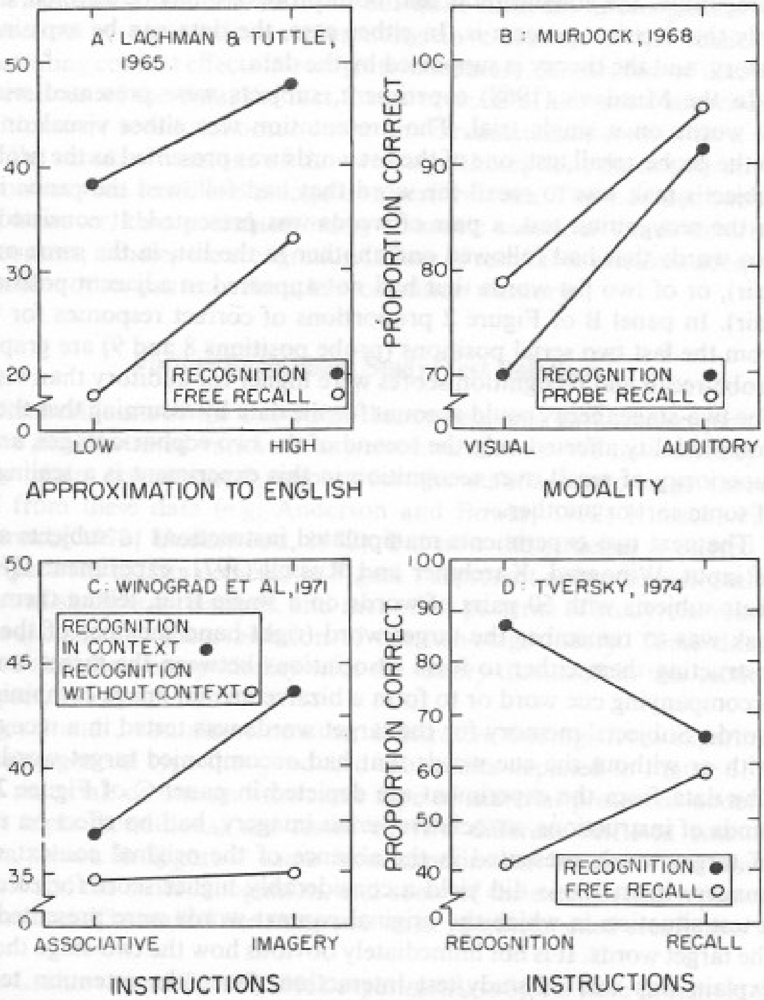

Figure 2. Four sets of data illustrating various study/test interactions

performances is negative, rather than zero, as in the data depicted in Figure 1.

The next two illustrations come from experiments that we have already mentioned earlier in connection with context effects in recognition memory. In the Tulving and Thomson (1971) experiment (only part of the data is shown here) subjects saw a long list consisting of single words or pairs of words. The pairs consisted of normatively strongly associated words. Subjects were instructed to study each presented word carefully and to expect a recognition test. In the test that followed the presentation of the list, old words were presented either alone (no context) or paired with a normatively strongly associated word (context). For the target words that had been presented as single items in the input list (input context absent) the test context was new, while for target words presented in the company of the strongly associated word (input context present) the context word at test was old. Panel A in Figure 3 shows corrected recognition scores (hits minus false positives) from the four experimental conditions. The pattern of data shows a strong interaction between input and test conditions, with the two curves, representing cue conditions at test, being crossed. The difficulties for two-stage theories in accounting for these data have already been mentioned, and need no repetition here.

Similar data from a further experiment (Thomson, 1972, experiment 4),

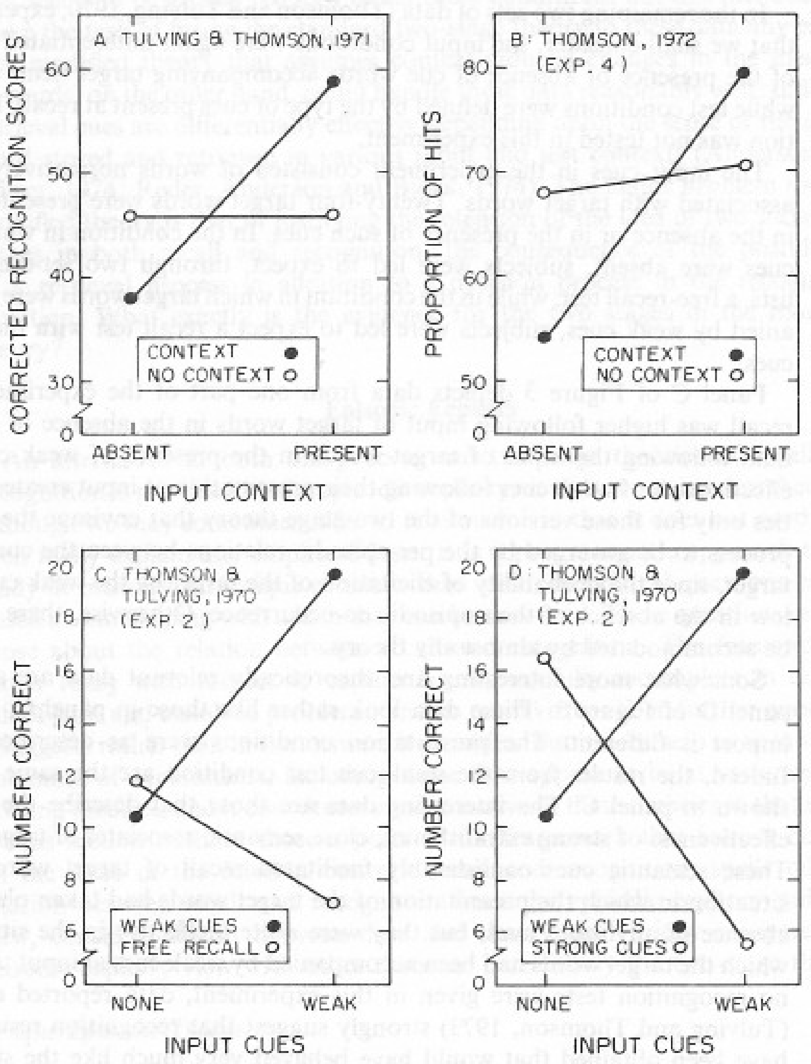

Figure 3. Four sets of data illustrating various study/test interactions

with proportion of hits as the response measure, are shown in panel B of Figure 3. The major difference between Thomson's experiment and that summarized in panel A of Figure 3 lay in the nature of the relation between words presented as pairs both at input and at test. In Thomson's experiment the words in pairs were associatively unrelated. These data thus extend the generality of the context effects in recognition memory and compound the difficulties for the two-stage theory. Even the 'homograph' theory (Anderson and Bower, 1974; Reder, Anderson and Bjork, 1974) might have to be stretched unreasonably far to handle the exceedingly large number of meanings and senses of words appearing in the context of other randomly selected words.

In the remaining two sets of data (Thomson and Tulving, 1970, experiment 2) that we shall consider, the input conditions were again differentiated in terms of the presence or absence of cue words accompanying target items at input, while test conditions were defined by the type of cues present at recall. Recognition was not tested in this experiment.

The input cues in the experiment consisted of words normatively weakly associated with target words. Twenty-four target words were presented either in the absence or in the presence of such cues. In the condition in which input cues were absent, subjects were led to expect, through two set-establishing lists, a free-recall test, while in the condition in which target words were accompanied by weak cues, subjects were led to expect a recall test with these weak cues.

Panel C of Figure 3 depicts data from one part of the experiment. Free recall was higher following input of target words in the absence of any cues than following the input of target words in the presence of weak cues. The effectiveness of weak cues following their presentation at input creates difficulties only for those versions of the two-stage theory that envisage the retrieval process to be governed by the pre-episodic relations between the cue and the target, since the probability of elicitation of the target by the weak cue is very low in the absence of their episodic co-occurrence. Otherwise, these data can be accommodated by almost any theory.

Somewhat more interesting and theoretically relevant data are shown in panel D of Figure 3. These data look rather like those in panel C, but their import is different. The presentation conditions were as described above. Indeed, the results from the weak-cue test condition are the same as those shown in panel C. The interesting data are those that describe the retrieval effectiveness of strong extralist cues, close semantic associates of target words. These semantic cues considerably facilitated recall of target words in the situation in which the presentation of the target words had taken place in the absence of any input cues, but they were quite ineffective in the situation in which the target words had been accompanied by weak cues at input. Although no recognition tests were given in this experiment, data reported elsewhere (Tulving and Thomson, 1973) strongly suggest that recognition results could have been obtained that would have behaved very much like the strong-cue recall scores.

The problem for theory here is to explain the striking crossover of the two curves. A simple two-stage theory must necessarily founder on these data. It might explain the superiority of recall in the presence of strong cues as compared with weak cues, under input conditions where no cues were presented alongside the targets, in terms of superior retrieval, more efficient recognition decisions, or both. But such assertions would be very difficult to reconcile with the weak-cue input conditions where the data show that such retrievability, recognizability, or both, of target words in the presence of strong cues was drastically diminished. We know now, on the basis of subsequent experiments (Tulving and Thomson, 1973), that it is the recognizability of target words that seems to be greatly reduced under these conditions, but this fact does not make the task of fitting the standard two-stage theory to these data any easier. The modified theory that assumes context-induced changes in the meaning of words, on the other hand, could handle these data reasonably well: different retrieval cues are differentially effective depending upon the sense of the target word stored and retrieved in various input and test contexts (Anderson and Bower, 1974; Reder, Anderson and Bjork, 1974). The major problem for this modified theory is that of justifying the retention of the idea of two successive stages in both recall and recognition, the consequence of the postulation of a retrieval process in addition to a decision process in the recognition situation. What exactly is the evidence for the two stages in the modified theory?

Episodic Ecphory

An alternative to both one-process and two-stage theories of recall and recognition is provided by the episodic ecphory view. It is not another theory—although we may sometimes refer to it as such—in that it does not predict or even really explain any empirical facts. It is a programmatic approach to the study of memory for unique events within which theoretical questions can be posed and in keeping with which they can be answered. These questions include those about the relation between recall and recognition. The framework is rather fuzzy with respect to certain issues, woefully incomplete in details, full of gaps and unsolved problems, and its main virtues lie in further questions it suggests rather than in the answers it provides. But it does help us to interpret outcomes of experiments, including those that appear to be at variance with existing theories, and it constitutes an alternative to these theories in that sense.

This section outlines those aspects of the framework that have a bearing on the issue of the relation between recall and recognition, spells out the relation between recall and recognition from the episodic ecphory point of view, considers the fit between data and theory, and briefly compares the episodic ecphory view with other theories, particularly the two-stage theory.

Unique Episodic Traces

Perception and encoding of a unique event, such as the occurrence of a word in a list, result in the creation of a unique trace in the episodic memory system (Tulving, 1972) without necessarily affecting the nature of the pre-episodic representations of the components of the event. Information in the semantic memory system is frequently used in the encoding of the event—as is information derived from other cognitive systems, including episodic memory. As a consequence, the trace of a word event may share certain features with the concepts, ideas, meanings and word senses, but it also has features not represented in the semantic system.

The role of semantic memory in the construction of an episodic trace of a word is not unlike that of, say, a person in the act of the production of a photograph of himself: the person is a necessary condition of his photograph, but not a sufficient one, and he himself is not changed as a result of being photographed. The person and his photograph obviously have certain features in common. They are in some sense very similar, and yet in other ways are also quite different. Among other things, many properties of the photograph that may be critical for its identification, or for the purpose of locating it, cannot be determined on the basis of the inspection or even questioning of the person.

The properties of the episodic trace of a word are determined not only by the perceptible properties of the word and its semantic meaning, but also by the context in which it occurs and by the specific encoding operations performed on the input into the system. Numerous experimental demonstrations exist to show that the ecphory of a target word, in nominally identical test situations, may be greatly determined by the conditions under which the word event was stored in memory. Some of this evidence has been summarized by Craik and Lockhart (1972), Tulving and Bower (1974) and Tulving and Thomson (1973). Among other things, encoding operations and the resulting traces of word events are affected by the subject's knowledge as to the method by which his memory is going to be tested. Memory performance in a recall test may be different when the subject studies a word in the expectation of a recall test than when he expects a recognition test, and the same holds for recognition (Tversky, 1973; 1974; Carey and Lockhart, 1973).

An important part of the information stored in the trace of an event has to do with the temporal date of its occurrence. In episodic memory experiments, whether they involve recall or recognition tests, the experimenter must always specify the temporal date of the event the subject is to recollect. In a situation in which a person is reminded of a past experience by some other stimulus, he also typically remembers something about the temporal coordinates of the original event. It is also possible that the contents of both episodic and semantic systems are routinely and continuously scanned as long as the organism is engaged in any perceptual or other cognitive activity. Such scanning would explain why certain inputs lead to the ecphory of previous experiences in the absence of any explicit instructions for recall or recognition.

We have no idea about the nature of the temporal code of episodic traces, although it is generally agreed that it makes more sense to talk about it in terms of temporal relations among events (e.g. event_1 occurred simultaneously with, or preceded or followed event$_2$ by a certain amount of time) rather than in terms of the readings of absolute values of an internal clock. The units of time in episodic memory are probably determined by experienced events and need not correspond to units of the clock and the calendar in a one-to-one relation.

Two Sources of Information

The search or scanning for information in episodic memory is guided by the subject's knowledge of the temporal date of the original events, specified in the recall or recognition instructions. The success of the search depends not only on the properties of the trace but also on the amount and relevance of ecphoric information available to the system at the beginning and in the course of ecphory. Ecphoric information is manipulated in experiments in the form of specific cues, but the assumption is that even when no such cues are explicitly provided by the experimenter, some ecphoric information that is initially separate from the trace information must be brought to bear on the trace system.

Ecphory is thus conceptualized as a joint product of information from two sources, the memory trace and the ecphoric cue. The problems of fact and theory in the study of memory consist largely in the specification of the nature of the two kinds of information and the elucidation of the laws according to which they are combined to produce conscious awareness of certain aspects of the original event.

The statement that ecphory is a joint *product* of information from two sources, the trace and the ecphoric environment, implies at least three things about the relation between the two sources of information. First, the absence of either kind of relevant information will produce a null ecphoric effect—the person cannot remember the event if either the trace information *or* ecphoric information is lacking. Second, with the amount of trace information held constant, the level of ecphoric performance is a monotonically increasing function of the amount of relevant ecphoric information. Third, with the amount of ecphoric information held constant, the level of ecphoric performance is a monotonically increasing function of the amount of trace information. It also follows that small amounts of one kind of information can be compensated for by larger amounts of the other kind to yield a constant memory performance.

Information from both sources must be compatible. A certain trace of a certain event may contain a great deal of information, but it may be unrelated to, and not compatible with, a given pattern of ecphoric information. Similarly, a given ecphoric environment can contain a great deal of information, but it may be completely unrelated to a particular trace. The probability of recollection depends on the amount of *overlapping* information between the trace and the ecphoric cues.

The presence of a specific cue has little effect on the course of memory for an event, unless appropriate information can be and is extracted from it.

The information extracted from the cue, like the information stored about an event, depends on perceptible properties of the cue, on information stored about it in memory, on the cognitive environment of the rememberer in which the cue is presented, and on encoding operations performed on it. It is possible for a cue to be lexically identical with the target word and yet fail to effect the recall of the target word, because relevant information is not extracted from the cue.

The nature of ecphoric process by which information from two sources is combined is unknown. A simple analogy, however, may help to convey the general idea of it. In Figure 4 are shown six word fragments. Each makes a complete eight-letter English word when an appropriate letter is inserted into each of the unfilled spaces. Let each word fragment represent a bundle of informational features either in a memory trace (source X, i.e. PO————IT, etc.) or in a retrieval cue (source Y, i.e. CH——CH——, etc.), and let the general retrieval instructions specify that what is being sought are 'English words'. Neither the information in the memory trace nor that in the cue alone is very likely to be sufficient for the construction of a product that matches the information given and satisfies the general criterion of 'wordness'. When information in the cue is matched to an appropriate trace, however, the resulting pattern (analogous to the remembered event) may be sufficient for the construction or selection of a response (analogous to the recalled name of the word). Thus, when we combine CH——CH——with ——IT——AT, we get CHITCHAT, when we combine PO————IT with —OR——AI—, we get POR——AIT, which readily suggests PORTRAIT. Thus, the analogy shows that something meaningful, or something that has certain general characteristics, can be created by combining components that are not meaningful in the same sense, or which in themselves do not possess the same characteristics.

TWO SOURCES OF INFORMATION

SOURCE X	SOURCE Y
1a: PO _ _ _ _ IT	1b: CH _ _ CH _ _
2a: _ _ IT _ _ AT	2b: CH _ _ _ _ NK
3a: _ HI _ UN _	3b: _ OR _ _ AI _

Figure 4. Word fragments illustrating information from two sources that can be combined to create meaningful products

The episodic ecphory view has many obvious shortcomings, and the absence of any specified mechanism of ecphory or retrieval is one of the more conspicuous ones. It is simply assumed that ecphory consists in somehow combining the information from two sources, and the exact mode of this combination is left open as a problem for future research. Whether such an admission of ignorance is more or less desirable than the adoption of a hypothesized mechanism consisting of implicit generation of response candidates and implicit recognition checks seems to be more a matter of one's scientific style and philosophical convictions than something that can be legislated by means of experimental facts and logical arguments.

An important consequence of the conceptualization of ecphory as a joint product of information from two sources is that the system never retrieves anything 'incorrectly'. Whatever is retrieved by the episodic system is determined by the information available in the store, by the specified temporal date of the original event, and by any additional ecphoric information that is provided. Search in the episodic memory, or some temporally defined region in it, takes place with a view to matching the ecphoric information to the trace information. The product of every successful match is entered into consciousness as a remembered event or some part of it. Recognition of certain properties of the product of ecphory is a precondition for a successful match between the trace information and ecphoric information, but there is no monitoring of the product before it is remembered. (The forced-choice recognition situation, in which the subject is always required to identify one and only one of a set of *k* alternatives as an 'old' item, is a more complex one, combining ecphoric processes with other task requirements, and its analysis would take us too far afield.) The system may retrieve information that does not meet certain criteria set by the experimenter, or that in fact does not correspond to a given earlier event, and the subject may decide, *after* he becomes consciously aware of the product of retrieval, that what he remembers does not fit what he wants. Such discrepancies between what is retrieved and what is accepted by a post-ecphoric decision, however, only mean that the initial ecphoric information was in some sense inappropriate or inadequate. The output from the ecphoric system is never 'wrong', only the input into the system may be.

Continuity Between Recall and Recognition

The presence of appropriate ecphoric information is as important for free recall as it is for cued recall and for recognition. When recall is compared between two situations, one entailing specific experimenter-manipulated cues and the other one containing no such cues, the contrast is not between some ecphoric information and none, but rather between some information and more information. As an illustration, consider the results of an experiment by Tulving and Watkins (1973). Subjects were shown lists of 28 five-letter words, and their retention for the list words was tested immediately after the presentation, either under conditions of free recall or with two, three, four or five initial letters of words serving as specific cues. The amount of trace information was held constant by experimental design. The results are graphed in Figure 5. Probability of recall—written production of target words—is plotted against the number of letters as cues. There is a reasonably smooth monotonically increasing function between the amount of ecphoric informa-

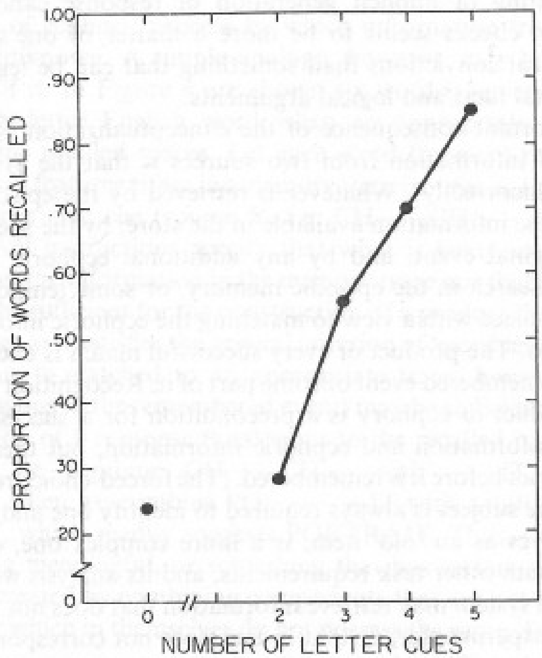

Figure 5. Proportion of five-letter words recalled as a function of number of initial letter cues. (From an experiment by Tulving and Watkins, 1973. Reproduced by permission of The Board of Trustees of the University of Illinois)

tion—corresponding to the size of the word fragment presented as a cue—and the probability of recall.

It is assumed that in all five experimental conditions recall was a product of trace information and ecphoric information. In the free-recall test only *general* ecphoric information was given, while in the conditions involving the presentation of word-fragment cues both general and *specific* ecphoric information were combined with the trace information. The situation is schematically depicted in Figure 6. The amount of general ecphoric information is assumed to have been constant in all experimental conditions, while the amount of specific additional information increased with the size of the word fragment given as a cue.

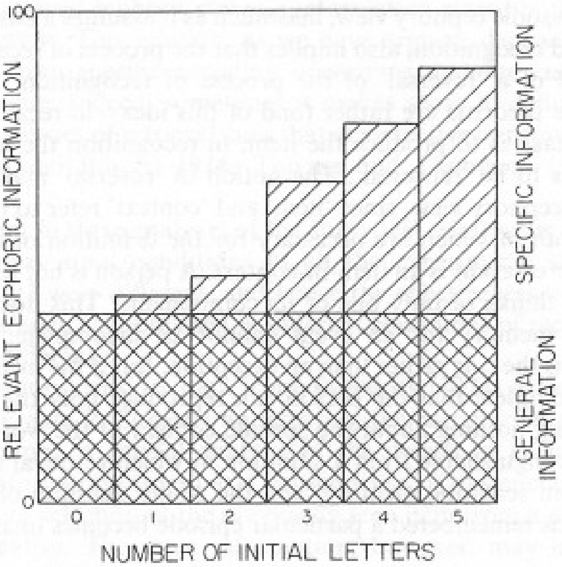

Figure 6. An illustration of the amount of general and specific ecphoric information present at recall as a function of number of initial letter cues in the experiment by Tulving and Watkins (1973)

Recall and recognition are different inasmuch as the retrieval information that is present at the time of recall is different from that at the time of recognition. They are the same inasmuch as in both cases ecphory is a consequence of appropriate combining of trace information with retrieval information. The question to the rememberer is always one and the same, 'What event or events took place at time *t*?', although the question can be expressed in different forms. For instance, one can ask whether or not a given event *E* did take place at time *t*, but this question only changes the ecphoric information that the subject can use in solving the problem. The 'old' test item in a formal recognition memory experiment, too, is simply another source of ecphoric information that may facilitate the utilization of the information stored in the memory trace.

If one wants to insist that free recall and recognition are different, one should, for the sake of logical and theoretical consistency, also hold that each form of cued recall is different from each other form, and that there are, therefore, as many qualitatively different ecphoric processes as there are different kinds of retrieval cues. But the postulation of such 'qualitative' differences does not help much in the ordering and summarizing of facts and hypotheses. Moreover, if one insists on a 'qualitative difference' between recall and recognition, one should know what kinds of test situations are to be classified as recall and what are to be thought of as recognition. For instance, given the data in Figure 5, where does recognition begin and recall end?

The episodic ecphory view, inasmuch as it assumes a basic similarity between recall and recognition, also implies that the process of recall does not represent any kind of a 'reversal' of the process of recognition. We saw earlier that two-stage theorists are rather fond of this idea—in recall the context is given and the task is to produce the item, in recognition the item is given and the context is to be 'retrieved'. The notion of 'reversal' makes little sense in the episodic ecphory view, since 'item' and 'context' refer to two different components, both of which are necessary for the definition of an event. The to-be-remembered event is an item-in-context. A person is not remembering an event when he thinks of only one of its components. This does not mean that the person's memory for an event cannot be incomplete. Indeed, incomplete memory is the rule rather than an exception. But if the memory of a word event is so incomplete that the person can reproduce only the word part of it, remembering nothing about the specific context of the word, then the outcome is not distinguishable from a situation in which retrieval of information takes place from semantic memory, and the whole question of whether or not the person has remembered a particular episode becomes unanswerable.

Episodic Ecphory and Experimental Data

The data we considered earlier in relation to the two-stage theory of recall can now be viewed in the light of the episodic ecphory framework. As we said earlier, the episodic ecphory view does not provide an explanation of these data, but the data can be interpreted within the general framework without any additional assumptions.

Consider the typical finding that recognition is higher than free recall. When trace information is held constant, the finding means that there was more ecphoric information present in the recognition test than in the free-recall test. Specifically, the difference lies in the information contained in the 'old' test items as specific cues, in the manner of the picture presented in Figure 6.

The data shown in Figure 1 demonstrate that the effectiveness of retrieval cues depends on specific encoding conditions under which to-be-remembered events were stored in memory. Depending upon input conditions, the informational content of the ecphoric environment in the free-recall situation was more appropriate for traces of related words than unrelated words, for high-familiarity items than the low-familiarity items, for traces resulting from intentions to learn than those produced under non-intentional conditions, following prior recall tests than following no such tests, and so on. The informational content extracted from the old test items, however, was not only greater than the informational content of the 'invisible' retrieval cues in free recall, but it was equally appropriate and overlapped the trace information equally well under both input conditions in each of the experiments considered.

The same general interpretation holds for the data summarized in Figures 2 and 3. In each case the data tell us what the relation was between information extracted from a given ecphoric cue and information stored in the trace of the original word event. This relation, as we have argued, depends on both the trace resulting from specific encoding operations and the encoded version of the retrieval cue. Indeed, sometimes it makes sense to define the trace in terms of the properties of retrieval cues that are effective in providing access to it (e.g. Tulving and Bower, 1974; Tulving and Thomson, 1973; Tversky, 1973).

The main point in these analyses of the study/test relations is that the traces created in various input conditions in all the experiments summarized in Figures 1, 2 and 3 were different, and hence the effectiveness of any two sets of retrieval cues, such as those used in different conditions of recall or recognition, were also different.

As an illustration, consider data from Tversky's (1974) experiment shown in panel D of Figure 2. Subjects anticipating the recognition test may have performed, at input, a careful analysis of the details of each picture-word item, and the information stored as a consequence of this encoding operation permitted efficient selection of the previously seen item from a pair containing a similar alternative. The same information, however, may have been less compatible with the ecphoric information in the free-recall task. Subjects anticipating the recall test, on the other hand, were encouraged to encode list items in relation to each other. Such an encoding activity is likely to result in the storage of a good deal of semantic information, and to the extent that such semantic information matched that available in the free-recall situation, recall was facilitated.

As another illustration, let us examine the data from the Thomson and Tulving (1970) experiment shown in panel D of Figure 3. The curve showing the effect of weak cues is expected by any theory, since the subject learned the associations between weak cues and target words at input in the weak-cue input condition but not in the no-cue input condition. The striking opposite effect of strong cues which were seen by subjects under neither input condition is more interesting. The interpretation offered (Thomson and Tulving, 1970) was that the subjects under the no-cue input conditions did encode to-be-remembered items in a fashion whereby associated cues became a 'part' of the encoded trace (we should now say, the informational content of the strong cues overlapped considerably with the trace information). The specific encoding of to-be-remembered words under the weak-cue input conditions, however, created traces of target words very low on the same kind of semantic information that characterized the strong cues, with the resultant low level of recall.

Similar arguments can be advanced in the interpretation of the data showing subjects' inability to recognize words that they could recall in the presence of list cues (Tulving, 1974; Tulving and Thomson, 1973; Watkins and Tulving, 1975). These data suggest that the list cue contained more relevant information for the purpose of providing access to the stored cue-target trace than did the literal copy of the target item, either because the cue-target compounds stored in memory contained little information that matched the information in 'copy' cues or because the subjects did not know what was the appropriate information to be extracted from the copy cues in the recognition test.

The interpretation of the experimental data of this sort within the episodic ecphory paradigm essentially restates the findings, but in different terms. The restatement has the value of suggesting specific questions that can be asked and experimentally investigated. Whatever the effectiveness of a cue in a given situation—whether high or low, whether surprising by whatever other standards or not—the theory points to further specific questions. Why is a given cue at recall more effective following input condition A than input condition B, given that the nominal target item is the same? Why is retrieval cue X more effective than retrieval cue Y, given that the stored information is identical? Why does a given interaction between input and test conditions come about? What is the nature of the information contained in traces of events in input conditions A and B, and what information is extracted from retrieval cues X and Y when they are presented following these conditions? These questions about the effectiveness of cues are as appropriate with respect to copy cues used in recognition tests as any other kind of cue.

Another advantage of the episodic ecphory point of view lies in its open-endedness: it can make sense, at an initial level of understanding at least, of all the data that can be produced in recall and recognition experiments. It is not at a loss when recognition performance depends on context changes, or when recall is higher than recognition. It simply converts these findings into further experimental and theoretical questions.

Comparison with Other Theories

Like all other contemporary attempts to draft the broad outlines of a general framework in which problems and phenomena of memory can be meaningfully handled, the episodic ecphory view consists of a large number of assumptions and hypotheses, each one of which can be found in some other theory, but the totality of which does not quite correspond to any other system. It would be impossible here to even mention, let alone discuss, all the points of agreement with other theories, although a small list of similarities can be given as an illustration of the relations between episodic ecphory view and other theoretical notions about episodic memory.

The idea that the memory trace of an episode is unique or is laid down in a cognitive system that is in some sense different from the semantic memory system has been mentioned or advocated by a number of writers. For instance, Hintzman and Block (1970) have pointed out the usefulness of Koffka's idea of a 'trace column', a more or less precise record of the temporal order of experienced events. Herrmann and McLaughlin (1973) have described data they interpreted as contrary to models of memory that assume episodic tagging of semantic representations of words. Atkinson, Herrmann and Wescourt (1974) have postulated an event-knowledge store (EKS) as a necessary component of the memory system and distinguished it from what they call the conceptual store. Finally, Murdock (1974) has used the metaphor of a 'conveyor belt' to describe the temporally ordered record of events that is assumed to exist in some sense separately from other memory structures.

The problem of the relation between episodic and semantic memory seems to be shaping up as an important focus of experimental and theoretical activity and perhaps controversy. Indeed, one of the major differences between the episodic ecphory point of view and most versions of the two-stage theory—Kintsch's (1974) new theory is an exception—has to do with the question of whether the trace of a word event becomes a part of the preepisodic representation of the word in semantic memory, or whether it is in some sense separate from that representation.

Rather strong evidence for the idea that the storage of episodic information is better conceptualized in a form other than tagging of existing structures has recently been found by Murdock (1974, p. 272; also Murdock and Anderson, 1975). The amount of time a person requires for a 'hit' in a recognition test is a linearly increasing function of the number of interpolated study and test items, and the amount of time needed to correctly reject a distractor item is a linear function of the position of the test item in the test sequence. These findings strongly imply a search along something corresponding to the temporal dimension in a system different from semantic memory. Since the scanning speed in episodic memory may be very high—Murdock has obtained rates close to 1 msec/item, and higher rates cannot be ruled out—the data also make more reasonable the proposition that semantic and other kinds of specific cues can be effectively and quickly used to locate information stored in episodic memory.

Correspondences between the episodic ecphory view and other theories also exist with respect to other assumptions. Thus, for instance, the proposition that recall and recognition processes are essentially identical in nature has been advanced by Shiffrin and Atkinson (1969) and by Lockhart, Craik and Jacoby elsewhere in this volume. The notion that recognition entails an access problem to the stored information, as does recall, has been accepted by many writers (e.g. Anderson and Bower, 1974; Kintsch, 1974; Light and Carter-Sobell, 1970; Mandler, 1972; Thomson, 1972; Winograd and Raines, 1972; Tversky, 1974). Retrieval process as some sort of a matching operation, or at least involving a matching process, is an old idea accepted by most theorists, and Kintsch (1972; 1974) has reminded contemporary readers of Otto Selz's idea of pattern completion as a useful metaphor to describe the retrieval process.

The episodic ecphory view incorporates the encoding specificity principle (Tulving and Thomson, 1973), which is a scheme for interpreting the relations between encoded traces and retrieval cues. The episodic ecphory view, however, attempts to encompass more than just the problem of why some and not other stimulus events serve to facilitate access to the stored information. It is concerned with the process of trace formation and the nature of representation of episodic information, with the relation between episodic and semantic memories, the relation between recall and recognition, as well as with the general problem of ecphory.

Among other theories the most similar to the episodic ecphory point of view is the new theory of Kintsch (1974). It shares with the episodic ecphory view a number of basic propositions: the distinction between episodic and semantic memory; the relevance of the encoding specificity principle; the importance of the context in the encoding of the perceived events at input and of the cues at output; the requirement that theories of memory be applicable to, and reflect the fact that memory systems can handle retention of, verbal materials as well as all other sorts of information; and the potential usefulness of the concept of pattern completion. Despite these important agreements, and perhaps paradoxically, Kintsch (1974) still maintains that it is useful to think of recall and recognition as 'essentially different' processes, and feels that the two-stage theory is a useful device for capturing the differences.

The new version of the two-stage theory proposed by Anderson and Bower (1974) is in several ways quite similar to Kintsch's. An important exception concerns the nature of stored information. In the Anderson and Bower theory, episodic information is recorded in the form of tagging of preepisodic structures, while in Kintsch's the episodic system is 'operationally distinct' from the semantic system. But like Kintsch, Anderson and Bower agree that at least in some recognition situations the access to the location in memory where the relevant episodic information is stored is not automatically guaranteed by the 'old' test word, and that there is, therefore, a significant access problem in recognition memory, as there is in recall. Thus, it looks as if the number of theorists is rapidly diminishing who believe that recall and recognition can be distinguished in terms of the presence or absence of a fallible retrieval process.

Conclusions

Whether recall and recognition are basically similar or different depends on what one means by 'basically' and by 'different'. In the early versions of the two-stage theory the meaning of both of these terms was unambiguous: since recall consisted of two stages, and recognition of only one of the two, the two processes were different and the difference was basic.

Although the distinction between recall and recognition is still made in the two-stage theory, it has become more blurred and less 'basic'. The objectives of the theory have shifted with various sorts of new experimental evidence that have been seen as presenting a challenge to the theory. The problems for the theory have also changed.

The two-stage theory originally came into existence at a time when data-based comparisons between recall and recognition involved only free-recall and standard recognition tests. Under those conditions the distinction between the two appeared sharp and the data clear. Recognition was usually superior to recall performance, and even the exceptional cases could be handled either as experimental artefacts or as otherwise theoretically uninteresting special cases. The study/test interactions constituted the most complex phenomena that were deemed to be within reach of theory, and the two-stage theory handled them admirably. The data from a large variety of cued recall experiments, the discovery (or rediscovery) of context effects in recall and recognition, and the findings that sometimes subjects can recall items they cannot recognize have now created a somewhat different world of experimental facts with which theories of retrieval have to contend.

The problems for the two-stage theory concern (a) the involvement of retrieval processes in recognition, and (b) the influence of episodic inputs on the retrieval stage. In the original versions of the the theory (e.g. Bahrick, 1970), recognition did not include the retrieval stage, and the retrieval stage in recall was independent of episodic inputs. In both Anderson and Bower's (1974) and Kintsch's (1974) new two-stage theories, retrieval is involved in recognition, and episodic inputs do determine the retrievability of the desired information. These relaxations of the initial restrictions have enabled the two-stage theory to accommodate data it could not have handled otherwise, but they have also raised the question of the necessity or usefulness of the distinction between the two stages. The problem concerns the relation between data and theory. What aspects of observable output from the memory system can be identified with each of the two stages, and how? Are there any facts left, now that the theory is changed, that still require the postulation of two successive processing stages for their explanation? The new versions of the theory are not entirely clear on these issues.

It is partly because of these difficulties with the two-stage theory that the episodic ecphory view deserves attention as an alternative way of making sense out of the phenomena of recall and recognition. This view holds that the distinction between recall and recognition, which at one time may have been indispensable, has outlived its usefulness. Successful ecphory of any kind and in whatever form depends on a large number of factors having to do with (a) the properties of information stored in traces of events, (b) the ecphoric information available in the system at any given time, and (c) the interaction of the information available in these sources. The understanding of these factors undoubtedly will require further analysis and finer distinctions with respect to the process of ecphory (Anderson and Bower, 1974), but the idea that recall and recognition represent basically different forms of recovery of stored information does not appear to be a promising vantage point in the pursuit of this understanding.

Notes

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