RECALL USING WELL KNOWN AND NEW RELATIONAL INFORMATION

By

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Abstract

The thesis examined the use of two kinds of relational information in the process of recall. Previously, there has been separate study of the recall of items that share well known relations in permanent knowledge, and of items for which relations have been newly learned during study. Two approaches to explaining recall have evolved, each emphasizing the use of a different type of relational information. The thesis attempted to synthesize the two approaches into a single view of the process of recall.

Experiments 1 and 2 established that the two kinds of relations are independent sources of information in memory, and that both are used in recall. Experiment 3 demonstrated that well known and new relations are used differently in recall even when they are processed in the same study episode. Experiment 4 examined how the two sources of information can be used together to maximize recall. Experiment 5 extended the findings to a different way of establishing new relations between previously unrelated items.

The results suggested that the recall process makes use of whatever information is currently available in memory, including what was known previously and what

was added in the course of study. It depends primarily upon any relevant permanent knowledge. If there are no permanently known relations to mediate recall, the process can occur by accessing the record of the new relation as it was formed at study. In addition, the different sorts of relations can combine forces to allow the recall of items that would not otherwise be accessible.

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TABLE OF CONTENTS

LIST OF TABLES

Chapter 1

INTRODUCTION

In order for something to be recalled on the basis of a retrieval cue in the environment, two kinds of information are necessary. There must be information about the target item in memory, which will make it distinct and identifiable as the sought response. In addition, information is needed that relates that item to other words or concepts in memory, so that access to it can be provided by a cue available in the recall task. The distinction between the two types of information, and the importance of both for maximal recall, have been shown in a series of articles by Hunt and Einstein and their colleagues (Einstein & Hunt, 1980; Einstein, McDaniel, Bowers & Stevens, 1984; Hunt, Ausley & Schultz, 1986; Hunt & Einstein, 1981; Hunt & Marschark, 1987; Hunt & Seta, 1984). They refer to the first as item-specific information, and the latter they call relational information.

Consider a case in which a person is asked to recall the word DOG, and CAT has been given as a cue.

Successful performance requires, first, that enough information about each of the items, CAT and DOG, be available in memory for them to be recognizable and useful. The cue, CAT, must be represented in memory, together with the target, in order for it to provide access to the target (Begg, 1982); and DOG must be distinguishable as the particular associate of CAT that occurred in the current task (Einstein & Hunt, 1980; Hunt & Einstein, 1981). Inherent in these needs is the further requirement of a known relation between the two words, CAT and DOG. They must be associated with each other in memory at the time recall is tested, if the cue is to be of any use in providing access to the response.

It is this second type of information, relational information, with which the thesis is concerned. Associations between items have been given an essential role in learning and memory since the study of those processes began. Aristotle said that the sequence of ideas in recall occurred by means of associations between them, as did Locke centuries later (Chaffin & Herrmann, 1987; Mandler & Mandler, 1964). Examination of the memory research of the past two decades reveals a concern with two quite different types of relational information. However, the distinction is rarely drawn; rather, the two have been studied separately for the most part, in two independent lines of research.

Consider again the pair of words, CAT - DOG, and then consider the pair CAT - BOOK. Although there is no obvious difference in the nature of the words themselves, there is a difference in the nature of the two pairs. The words CAT and DOG are related to each other. They share a semantic relation in that they are both members of a common category, ANIMALS. Knowledge of categories and their members, and the relations between them, are part of our linguistic and world knowledge; when a pair like CAT - DOG is encountered, it is recognized as a pair of strongly associated words. Words may be related by virtue of being members of a common taxonomic category, as are CAT and DOG, or they may be related in many other ways. Examples include synonyms and antonyms, words that occur together frequently, and words that are related conceptually, like HAND and GLOVE, or TIGER and STRIPES (Lupker, 1984). In each case, the words share some well known relation in permanent knowledge. At some time, the relation between them obviously had to be learned; but at the point in time at which the knowledge is being tested, it is well known.

In contrast, the members of a pair like CAT - BOOK do not share such a permanently known relation. If they are encountered together, they can become associated by means of any number of kinds of processing. They could, for example, be imagined as interacting with each other in a common image. They could be interpreted in relation to each other by considering the similarities or differences between the two concepts. They could be encoded along with a joining word or concept to link them in a common idea. The point is that they can become related through their joint processing, but they were not associated before the particular occasion of study.

It seems clear that in whatever permanent store of knowledge we possess, some items are associated with each other in well known relations, and some are not. And clearly, new learning can occur by relating previously unassociated concepts to each other.

What is less clear is how these different types of relational information are used in memorial processes. In the process of recall, is all relational information used in the same way? If so, how is it represented in memory, and how is it used in the retrieval of encoded events? Alternatively, there may be differences in the way that well-established relational information in permanent knowledge, and new relational information obtained in the interpretive process, are used. If that is the case, how is each of them represented in memory, and by what processes are each of them used to retrieve items? Further, can they work together or influence each other in any way, or do they have separate influences in recall? It is these questions that will be addressed in the thesis.

Different models of memory have given more or less emphasis to well known relations held in permanent memory and newly encoded relational information. In some models, knowledge is represented in permanent structures arranged according to the relations among concepts, and this permanent relational information is used to retrieve items. Typically, such accounts only briefly describe how new relations might be formed, and give very little emphasis to their encoding and use. At the other extreme, some accounts of memory are based entirely on the formation of new memorial units at the time items are processed, and pay little attention to the role of permanent knowledge in their recall. Although it is assumed that permanent knowledge forms the basis of the system and is used in the interpretation of studied materials, the nature of that knowledge and of its role is typically not examined.

Despite the difference in emphasis, none of the theories suggest that knowledge is exclusively of one kind or the other. Evidence throughout the literature not only attests to the existence of both forms of information, but suggests that they operate differently in memory. For example, the difference can be seen in the effects of using mental imagery to study items. The effects on subsequent cued recall tests of instructions to imagine two items either separately or in interaction with each other depend on the nature of the initial relation between the two words. If the words are not related, as in the pair CAT - BOOK, interactive imagery is followed by much better recall than separate imagery (Begg, 1973; 1978a; 1982; 1983; Bower, 1970). For a pre-experimentally related pair such as CAT - DOG, however, there is usually much less difference between the two types of study (Begg, 1983).

As another example, numerous studies have suggested that well known and newly established relations may be differentially affected in cases of amnesia (Graf, Squire & Mandler, 1984; Kinsbourne & Wood, 1975). In research on estimates of frequency, it has been found that judgments of the frequency of occurrence of particular items in a list are less sensitive for the occurrence of related pairs of words than for unrelated pairs; the difference is attributed to different encoding strategies used for the two types of pairs (Harris, 1981). Studies of the generation effect in recall have shown that subject-generated items are recalled better in a test of cued recall than items that are read by the subjects if the target words are related to the cues (Begg, Snider, Foley & Goddard, submitted); but generation does not improve the recall of pairs of unrelated words (Begg & Snider, 1987). Other studies have shown that related pairs such as CAT - DOG are recalled better if subjects have studied them by considering the differences between the two words than by thinking of similarities. In contrast, subjects recall unrelated pairs such as CAT - BOOK better after thinking of similarities between them (Begg, 1978b; Epstein, Phillips & Johnson, 1975).

It seems that the information encoded at the time of study interacts with the nature of the information held in permanent memory. A particular type of processing at study produces a particular interpretation of the two words in relation to each other; and the effect of the interpretation will differ depending on the way the two words are stored in relation to each other initially.

To reiterate, it is well established that both kinds of relational information exist, but they are given more or less emphasis in different models of memory. The following section presents some of the current approaches to explaining recall, with their differential emphasis on the use of the two kinds of relational information.

The Two Approaches

Historically, the two types of relations between items have most often been studied separately. Early studies of organizational processes in memory compared the recall of lists containing words that were pre-experimentally associated or not. They determined that permanent associations are used to organize items in memory (e.g. Deese, 1959; Postman, 1967; Postman, Fraser & Burns, 1968). However, based on an assumption that items are indeed organized using permanent associations, most experiments used categorically related items in efforts to study the ways in which permanent organization affects recall (e.g., Bousfield, 1953; Bousfield, Cohen & Whitmarsh, 1958). Beginning with the work of Tulving (1962) using a measure of subjective organization, some researchers started to study the episodic organization of unrelated items.

In the years since the verbal learning studies of organizational processes, research has, in general, followed two separate streams. With few exceptions, there has been little cross talk between the two lines of research. They have comprised two different ways of approaching questions about memory, and in fact have asked different questions. In one area, the interest in organizational processes and their use led to the study of how items are organized at the time of study in the formation of memorial traces, and the retrieval of those traces. The focus has been on relations between items as they are encoded in a particular episode of study. In the other area, the concern has been with the organization of permanent semantic knowledge, and the way information is retrieved from such a system. In this case, the relations of interest are permanently stored ones. In the pursuit of these different questions, different types of materials have been used for study, as well as different study tasks.

The work in this thesis is based on a belief that much can be gained toward an understanding of the workings of memory if we consider both types of recall together. The discussion that follows points out limitations of each approach when they are taken in isolation, and suggests that both are essential for a complete understanding of memory.

A previous effort at rapprochement of the two types of relations in recall can be found in Tulving's conceptualization of memory (Tulving, 1972; 1983). His system includes two different types of memory (or more, in later presentations; cf. Tulving, 1985a; 1985b). What he calls semantic memory corresponds closely to the permanently known relations among concepts discussed here. Semantic memory includes knowledge of the world; of words and ideas, and the relations among them. Tulving's concept of episodic memory contains information that is encoded with respect to particular episodes of learning, including the time and place of the study event. This would include the newly acquired relations discussed here, between items that are related only because of the way they were studied together in particular study episodes.

Although Tulving's system provided a way of bringing the two areas of concern into the same discussion, his distinction is not entirely congruent with the one being made in this thesis. His concepts of semantic and episodic memory are contained in the two types of memory considered here, but do not define them completely. The present distinction is not in the nature of the knowledge itself, but rather in the state of knowledge at the time of the experiment. Before the two approaches to understanding recall can be put together, a description is needed of what each entails.

Several current theories of memory emphasize almost exclusively the semantic relations among concepts in permanent knowledge. The study of the permanent structure of semantic knowledge has its modern roots in the work of such people as Anderson and Bower (1973), Collins and Quillian (1969), and Meyer and Schvaneveldt (1971; 1976), although similar ideas can be traced back to James (1890).

The common characteristic of this group of theories is their assertion that words or concepts have permanent representations in long term memory, and that the knowledge system is structured in such a way that associated concepts are connected with each other. Among the best known examples of this type of approach are the semantic network models (e.g., Anderson, 1983; Anderson &

Bower, 1972; Bahrick, 1969; 1970; Collins & Loftus, 1975; Collins & Quillian, 1969; Mandler, 1968). These theories describe the memorial system as a network of words or concepts that are represented permanently in memory, with links between related concepts. The associative links might be between the items directly, or they might join each of the items to a higher order concept. It is also possible, of course, that both types of association exist. These possibilities will be examined later in the thesis.

The network models hold that upon study of an item, its representation in memory is tagged to allow later recognition. In this way the network, containing the tags or "occurrence markers", serves as the memorial record of what has been processed. In general, such theories account for the encoding of unrelated pairs by saying that if items that are not linked in the permanent knowledge structure are studied together, new associations can be created between them temporarily at the time of study (e.g., Anderson, 1983; Anderson & Bower, 1972; 1974; Kintsch, 1970; Mandler, 1968). Typically, however, little attention is paid to newly formed associations by these models.

In contrast, trace theories hold that the contents of each episode of study are encoded in a memorial record of that episode. Permanent knowledge is used in the interpretation of the items at study, but the product of that interpretation then exists independently as a record of the particular interpretive event. By this type of account (e.g., Begg, 1982; Watkins & Tulving, 1975), when a pair of items is studied, they are interpreted in relation to each other, in accordance with the demands of the particular study task. The resulting interpretation of the two items forms a unit in memory. Thus any stored relation is a newly encoded one, specific to the circumstances of the particular episode of study.

Several accounts of the memorial system hold that recall of a set of items depends on the way in which it was encoded, placing their emphasis on the importance of newly encoded information and relations. A prominent example of this type of approach is the levels of processing framework (Craik & Lockhart, 1972). By this account, the ability to retrieve an item depends on the quality of its encoding at the time of study. Another example is the encoding specificity principle (Thomson & Tulving, 1970; Tulving & Thomson, 1973), by which recall is successful only if the cue provides information that was encoded in the particular episode of study. Similarly, the account that emphasizes the importance of transfer appropriate processing (Morris, Bransford & Franks, 1977) is an account based on the use of newly encoded information. Performance on a test of recall is said to depend on the type of processing required to perform the task and its similarity to the way the items were processed at the time of study. In all these accounts, a record of the initial processing of the items exists in the form of an episodic trace, which must contain information that is appropriate for the requirements of the test in order for recall to be successful.

The two approaches, therefore, differ in the nature of the memorial record. In one approach, the permanent network stands as the representation of the current state of knowledge, and particular portions of that network are tagged to record the fact of their recent occurrence. In the other approach, a trace of the studied items functions as an independent record of the particular study event.

It can thus be seen that more emphasis on one or the other type of relational information leads to different notions of the structure of the memorial system. It is furthermore the case that the different models of the structure of the system lead to different accounts of the way the system functions in the retrieval of items from memory. There are thus two general approaches to explaining the process of retrieval, deriving on one hand from theories that emphasize permanent relations, and on the other hand from those emphasizing episodically formed relations.

Theories that emphasize permanent relations lead to accounts of retrieval that come under the general heading of generation-recognition theories. In a system composed of a network of permanently represented concepts, retrieval depends on the identification of the specific items that were studied from among the others in the network. Marking or tagging an item's representation at study records the fact of its occurrence, and allows its subsequent identification. The organization of the network according to semantic associations is thought to enable entry into the memory store at the appropriate semantic category. That is, the focus of search can be narrowed to a subset of knowledge related to the item in question, on the basis of the cues provided by the recall task. The marked item can then be identified from among the items in that particular subset.

In an early precursor to the generation-recognition theories, James (1890) suggested that recall begins with a search among a hierarchy of associations; a response is retrieved and then recognized as the item that occurred at study. More recently, many authors have described retrieval similarly (e.g., Anderson & Bower, 1972; Bahrick, 1969; 1970; Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & Seta, 1984; Kintsch, 1970; Martin, 1975). By this view, there are two stages in recall. First, permanent knowledge is searched, and a subset of items is selected that is relevant to the retrieval cue. This is done on the basis of the semantic associations in the network, which enable selection of a subset of items that belong to the conceptual category of which the target item is a member. Then from the selected set of knowledge, the target item is recognized as having occurred, by means of the tag it was given at study, and can then be produced as the response. Thus the process of recall is mediated by higher order categorical knowledge, rather than a direct association between the cue word and its studied partner. The model is clearly meant to explain recall of permanently related sets of words, and gives little consideration to episodic associations between unrelated items, and whether they might be used differently.

The process of associative recall is explained quite differently by episodic trace theories. By this view, words that were studied together are stored together as a unit in memory. Recall depends upon retrieval of that memorial unit. Representative of this type of account is the organization-redintegration hypothesis (Begg, 1982). In this account of cued recall, the cue provides access with the trace of its occurrence at the time of study. When the appropriate memorial unit has been accessed, everything stored in that unit becomes available. Therefore a word that was studied in relation to the cue will be retrieved upon access to the record of the cue. By this approach, then, associations are formed directly between the items in question. There is nothing in these theories to suggest that associations between studied partners would ever be indirect through the mediation of higher order concepts in permanent knowledge.

The two general approaches are not restricted to the types of questions addressed here. The distinction between permanently stored knowledge and episodically constructed information can be seen with respect to many other problems in cognitive psychology as well. An example is the area of reading comprehension. Theories explaining reading comprehension fall into two broad categories. Some hold that each word or phrase has a prestored meaning in memory which is accessed when it is read (e.g., Collins & Loftus, 1975; Kleiman, 1980; Reder, 1983; Seidenberg, Tanenhaus, Leiman & Beinkowski, 1982). Other theories suggest a more episodic type of account, in which a meaning appropriate to the current context is constructed or computed each time the word is encountered (e.g., Anderson & Ortony, 1975; Anderson, Reynolds, Schallert & Goetz, 1977; Anderson & Shifrin, 1980; Barclay, Bransford, Franks, McCarrell & Nitsch, 1974; Bransford & Johnson, 1972; 1973; Halff, Ortony & Anderson, 1976; Spiro, 1980).

As Whittlesea (1987) has pointed out, the issue is also a central one in the question of concept formation. Concept formation has been explained by prototype theories (e.g., Rosch, 1977), according to which general information about categories is held permanently in knowledge and accessed when needed. In contrast, episodic or instance theories (e.g., Brooks, 1978; Medin & Schaffer, 1978) hold that categorical information is derived with respect to particular episodes of study.

With regard to the questions of concern in this thesis, there are strengths and weaknesses evident in each of the approaches. A clear advantage of the permanent structure view is that it accounts for the advantages often found in the recall of semantically related items as compared to unrelated items. Trace accounts do not provide a clear reason why a pair of items sharing a well known relation like CAT - DOG would be recalled differently than unrelated pairs such as CAT - BOOK. According to trace theories the primary factor influencing associative recall is whether the cue and target items had been processed and encoded together as a unit. It is not immediately apparent why having shared a previous association should have the effect that it does. Traces containing previously related items could be hypothesized to be stronger, by virtue of those pairs having been encountered many times before. Each encounter with a set of items could strengthen the association between them, and perhaps eliminate competing associations. But the dissociations previously noted in the effects of study variables on the recall of pre-experimentally related and unrelated pairs of words suggest that there are differences between the two types of relations other than differences in strength. Double dissociations like that seen in the effects of similarity and contrastive processing, for example, suggest a qualitative difference in the nature of the two types of relational information. Double dissociations have been commonly interpreted in memory research as indicative of basic distinctions between processes (e.g., Shoben, Westcourt & Smith, 1975; Tulving, 1983).

To repeat, then, the semantic network theories account for the good associative recall of pairs of items that are related in permanent memory. Episodic trace accounts are less clear in doing so. But there are also difficulties with an extreme semantic view. A permanently structured memorial system containing permanent associations among its components would be a relatively static system. There is evidence throughout the literature suggesting that the interpretation of studied items must be a flexible process. Numerous findings indicate that the interpretation of a word derived at study, and thus what is encoded and remembered, varies as a function of such factors as the context in which the item was encountered (e.g., Anderson & Ortony, 1975; Shoben, 1980), the purpose for which it was studied (e.g., Morris et al., 1977), and the other items in relation to which it was interpreted (e.g., Begg & White, 1985; Harris, Begg & Upfold, 1980). It is difficult to reconcile such ideas with that of an item being represented by a permanent "node" which is simply "tagged" if the word is encountered. It has been suggested that each different sense of a word could have its own representation (Reder, Anderson & Bjork, 1974), but a virtually infinite number of nodes would be required. Consider, for example, the experiment by Halff et al. (1976) in which they suggested nineteen different senses of the single word "red". Also, if an encoding does depend on the context in which the word was studied, there would have to be nodes for all possible contexts. In a functional sense, such a system with infinite capacity would be little different from one with no permanent structure.

Related to this is the more basic question mentioned earlier, of how new associations between initially unrelated items are recorded and recalled. It could be suggested that all the items in the network are interconnected; but a model with every item connected with every other item eliminates the value of proposing such a structure at all. The only way to account for the recall of an unrelated pair of items such as CAT - BOOK, then, is to suggest that a new, episodic representation is formed at the time of study in which the two items are linked. Concepts can thus be linked in different ways depending on the circumstances (Foss & Harwood, 1975). In fact this is, as mentioned earlier, how many of the theorists explain memory for unrelated pairs. In their propositional account, for example, Anderson and Bower (1972; 1974) suggest that new propositions are created to link the two concepts that were encountered together at study. But it is once again difficult to see how this could capture the virtually infinite variety of ways that items and combinations of items can be interpreted, and still be functionally distinct from an episodic system.

Thus neither of the approaches in their extreme forms account easily for all the phenomena of recall. This is what could be expected on the basis of the evidence mentioned earlier, regarding the differences in the nature of recall of the different types of relations. It seems that each must be true to some extent: both types of information and process are needed to completely account for the process of recall.

The following experiments therefore look for evidence of both types of recall. They then attempt to determine how the two might work together in a complete memorial system. The goal of the thesis is to attain some kind of synthesis of the two approaches to recall.

Overview of the Research

The experiments to be presented in the thesis examine the use of the two kinds of information in the process of associative recall. The first two experiments establish that the two types of relation are in fact different sources of information, and that they operate separately in recall. To this end, the experiments required subjects to study and recall lists of pairs of unrelated words, while varying the nature of the relational information available to the subjects. The first experiments manipulated the permanently held information that was available for the subjects' use at the time of study. This was done by presenting categorical sets that included some of the items in the study list, before the study list was presented; other exemplars in the list were not categorically primed in this way. In addition, the tests in these experiments assessed recall for items sharing different kinds of relations with the cues, by asking for either studied categorical exemplars that were related to the cues, or the unrelated items with which they were studied. In this way we can measure the effects of prior categorical knowledge on the recall of category exemplars, and whether such permanent knowledge has any effect on new items with which they were studied. Finally, the types of cues given for recall were varied, to provide different sorts of relational information for use in the retrieval process. Some of the cues were categorical labels, which had not been seen in the study list and which therefore required the use of permanently known categorical information. Other cues were items from the list, so that recall could occur on the basis of direct relations between the items learned in the course of study. Thus by varying the use of permanent knowledge, the information provided for use in retrieval, and the relations among the tested words, we can observe the use of the two kinds of information in various aspects of the process of associative recall.

Thus Experiments 1 and 2 establish that the two types of relational information are in fact both used in recall, and are used independently of one another. Experiments 3, 4 and 5 examine how the different processes can be used together. The last three experiments vary the presence or absence both of permanent relations, and of episodic relational information, within sets of studied items, in order to observe the way the two can be used together to maximize recall. Their combined use is further studied by examining mediated recall, in which the joint recall of items that are unrelated to each other in any way can make use of separate relationships between each of the words and a common contextual item.

Chapter 2

EXPERIMENT 1

The purpose of Experiment 1 was to establish whether or not a distinction can be made between permanently known and newly learned relational information, and whether they operate separately in recall. To this end, subjects were asked to study a list of words that contained both kinds of relations. It contained unrelated items for which new relations had to be established; but there were also permanent, categorical relations present in the list. The list consisted of pairs of words, the members of which were unrelated (e.g., CAT - BOOK). However, one member of each pair had a categorically related word elsewhere in the list. Each pair contained one word that belonged to a common taxonomic category (in the above example that word is CAT, which belongs to the category ANIMAL), and each category was represented twice in the list (e.g., another pair would be DOG - BICYCLE).

Thus recall could be tested for newly acquired relations, by asking subjects for the list partners of given items. In addition, recall of permanently known relational information could be tested, by asking for a word's categorical relative from elsewhere in the list (for example, asking for DOG as the categorical relative of CAT). This effectively separates the two kinds of relation: the words that are related by virtue of having occurred together in the list share no permanent categorical relation; and the words that are permanently related have not been studied together in the list.

With the two types of relation thus separated, we can examine the effects a particular condition of study has on each of them; different patterns of recall would suggest that they are indeed different. Nicholson (1987) showed that instructions for the way items were to be studied affected the recall of newly related pairs, but not the recall of permanently known relations. The present experiment examined the effect of having permanent knowledge available for use at the time of study. Permanently known relational information about some of the words in the list was made available to subjects before they actually saw the list. The subsequent tests of recall should then show whether the availability of permanent information affected the recall of the permanent relations in the list; and whether it affected the recall of items that were newly associated with those words.

Thus the experiment required subjects to study and subsequently recall the pairs of unrelated words, and varied the nature of the permanently held information that was available for use at the time of study. Although the subjects' permanent store of knowledge obviously cannot be manipulated, their use of such knowledge can be influenced by drawing attention to particular sets of information. Before the list of pairs was presented for study, permanent relational information about some of the categorical exemplars in that list was made available to the subjects, but not about others. The information was provided in a separate list of words, shown to the subjects before they saw the pairs they would have to study. That list contained the names of all the categories that were represented in the pairs. Some of those category names were accompanied by the exemplars that would appear later in the studied pairs; for example, one set might be ANIMAL - CAT, DOG. Others appeared with two random words (e.g., ANIMAL - PEARL, PEN). Still others were accompanied by one exemplar and one unrelated word (e.g., ANIMAL - CAT, PEARL). Thus when the list of pairs was studied, subjects had just seen some of the words together with their categorical labels and, in some cases, another categorical relative; others they were seeing for the first time in the experiment. This allowed a comparison of the recall of newly related pairs when only the new episodic relation existed as a basis for recall, and when there was also relevant permanent information about the items.

As a way of obtaining items that share permanent relations in knowledge (and, by exclusion, items that do not), categorical norms were used (Battig & Montague, 1969). The words in this set of norms are people's responses when asked for words that were related to categorical names; they therefore represent the permanently known categorical relations of a large norming sample. Thus they provide a set of materials found statistically to be related in people's permanent knowledge.

Recall was measured for items sharing different kinds of relations. That is, the test asked for words that shared permanent categorical relations with the provided cues, and words that were semantically unrelated to the cues but had been studied with them. For example, consider the case in which the word CAT was given as a cue. The subjects were required to recall the word DOG, a word that is categorically related to the cue and which appeared in the list, although not with the cue. Success depends upon the use of permanently known relational information. Subjects were also asked to recall the list partner of the cue, in this case BOOK, which was studied with the word CAT. Successful recall depends in this case on the use of newly acquired relational information. Thus recall of each of the two kinds of relations was measured, with or without the availability of well known relational information at the time of study.

Finally, different types of cues were given, which provided different types of information for use in the retrieval process. For some subjects, words from the studied list were given as cues for their list partners, so that recall must depend on the two items having been stored together; for example, the word BOOK would have been tested with its list partner, CAT, as the cue. For other subjects, extralist cues in the form of categorical labels were given, requiring retrieval to be done on the basis of permanently stored categorical information; for example, for the recall of CAT, these subjects would have been given the category name ANIMAL as a cue. The purpose of this factor was to establish the distinction in the functioning of the retrieval process. Presenting the two different types of retrieval cues provides an opportunity to observe whether the process of recall can operate in both of the ways discussed in the previous chapter, using the two different types of relational information.

Method

Subjects

Eighty introductory psychology students participated in the experiment for course credit, with ten students in each of eight conditions. Subjects were tested in small groups, in sessions lasting approximately forty minutes. The groups were randomly assigned to conditions.

Materials and Procedure

Thirty-six category labels were selected from the Battig and Montague (1969) category norms, such as ANIMAL, CLOTHING, and FRUIT. For each of the 36 categories, two exemplars were also selected from Battig and Montague. For example, the words COW and PIG were selected as exemplars of the category ANIMAL; for the category FRUIT, the words ORANGE and LEMON were selected as exemplars. The exemplars were all of medium frequency as responses to the category names; they were all single words, and did not include any proper nouns, as will be the case in all of the experiments.

A set of 108 unrelated nouns was selected from Paivio, Yuille and Madigan (1968) and were randomly assigned to the two lists. None of the words was an exemplar of any of the selected categories. The nouns all had frequency values of 10 or greater, and imagery values between 5.0 and 6.5.

From the selected words, the priming list and the study list were constructed. The priming list consisted of 36 sets of words, each set containing a categorical label and two nouns. For an example of what the priming list looked like, refer to Table 1. Twelve of the labels were accompanied by the two exemplars chosen for those categories. For example, the label INSECT was presented with the words BEE and HORNET, as shown in the first column of Table 1. Twelve of the categorical labels were accompanied by one category exemplar and one unrelated word. This condition is illustrated in the next two columns of the table. For example, one such set could have the label INSECT and the word HORNET; the other space was occupied by an unrelated noun such as VILLAGE. The remaining twelve labels were presented with two unrelated nouns. For example, the label INSECT in such a case would not be accompanied by either of its exemplars, but instead might have been presented with the words JURY and PARTY. The 36 sets of words were videotaped, and presented one at a time on a television monitor at the rate of five seconds from onset to onset. The words were arranged on the screen with the label centred at the top, and the two other items below it on either side of the screen. The subjects were instructed to choose the more typical of the two items as a member of the accompanying category. They were given a response sheet on which to indicate their choices, by circling either an "L" for the word on the left of the screen or an "R" for the word on the right.

Following the presentation of the first list, the subjects studied the second list, which contained 72 pairs of nouns. Each pair consisted of a categorical exemplar and an unrelated word. For an illustration, see the example of study list items in Table 1. The categorical exemplars were the two words selected for each of the 36 categories presented in the initial list. Thus for twelve of the categories, both exemplars had occurred previously, as in the first column of the table. For another twelve, only one had been seen previously (in the second column of Table 1 HORNET had been seen in the first list but BEE had not; in the third column, BEE had been seen previously, but not HORNET). For the remaining twelve, neither exemplar had been presented previously, as shown in the fourth column of the table. These pairs of words were also videotaped at the rate of five seconds a pair. They were arranged side by side in the centre of the screen.

Recall of the pairs in the second list was tested immediately following study by means of two types of test. Half the subjects were given an exemplar cue test, in which one of the exemplars from each category was used as a cue. For each cue, the subjects were asked to recall the other exemplar of the same category, and the list partner of each exemplar. For example, if CAT was given as the cue, the subjects were asked to write down the word that appeared somewhere else in the list that was related to CAT (DOG), and the words that CAT and DOG each appeared with. For twelve of the sets of words, both categorical exemplars had occurred with their label in the priming list; for another twelve, neither of them had been in that list. In the remaining twelve sets, one of the exemplars had been in the priming list; the recall cues varied as to whether or not they were the twice-presented exemplars.

The other half of the subjects were given a name cue test, in which the categorical labels were used as cues. Twelve of the labels had been presented with both of their exemplars in the first list; twelve had appeared with only one exemplar, and twelve with neither exemplar. Subjects were asked to recall the two exemplars of each category, and the list partner of each. For example, the label ANIMAL could have been given as a cue, and the subjects were asked to write down the two members of that category that appeared in the list (CAT and DOG), and the word with which each of them appeared. Test performance was subject-paced, usually taking between ten and twenty minutes, but with some subjects taking up to twenty-five minutes.

Some additional variables were included in the experiment which turned out to have minimal effects that were unimportant for the basic pattern of results. They will be explained briefly here, and their effects will be described at the end of the Results section.

One of these variables was the instructions for study of the list of unrelated pairs. Half the subjects were asked to think of differences between the two items in each pair; the other half thought of similarities between them. Begg (1978b) found that pairs of unrelated words are recalled better if they have been processed with regard to the similarities between them, because that task induces encoding of very distinctive features of the items, whereas contrasts can be made using very broad categorical features. The opposite is true of pairs of categorically related words. It should be expected, therefore, that subjects who were given instructions for similarity processing should show better recall of the studied pairs. What is not known, however, is whether there will be any effect of having drawn attention to categorical relations before study. As it turned out, the effects were small, probably because instructions had their primary effect on the recall of unrelated list partners, which was very low. The variable will therefore be given little emphasis here. However in a later experiment, similarity and contrast instructions will be examined again, under conditions of better recall.

Another variable was the nature of the categorical labels in the priming list. The 36 category names were chosen such that they could be reduced to more specific sub-categories; for example, the general category ANIMAL was reduced to the more specific sub-category FARM ANIMAL. Two versions of the priming list were constructed, with one containing general category labels (e.g. ANIMAL) and the other containing specific labels (e.g. FARM ANIMAL). The accompanying nouns were the same in the two lists. Each of the two versions was given to half the subjects.

On the test of recall that provided category names as recall cues, the relative generality of the labels was varied as a within-subjects factor. Half the cues were general labels, and half were specific. Cue generality was combined factorially with presentation history, so that half the items in each presentation condition were cued in each way.

The two manipulations of generality were included in an attempt to see how specific the effects of categorical priming might be. According to the encoding specificity principle (Thomson & Tulving, 1970; Tulving & Thomson, 1973), recall should be optimal if the information in the encoded trace and in the retrieval cue are closely matched. Begg (1982) suggested that encoding that is either more general or more specific than what is required by the retrieval context will reduce the effectiveness of the information in memory for performance on the test. We might ask whether the same could be expected of the effect of categorical information being made available before study, on the encoding of subsequent studied pairs. It is possible, moreover, that the nature of the relation between a categorical name and one of its exemplars might be different depending on the generality of the named category. That is, there might be slight differences in the relations as interpreted during encoding between ANIMAL and COW, and FARM ANIMAL and COW. One might expect, therefore, that performance would be best if the categorical information provided before study and the retrieval cue were either both general or both specific.

To review, the most important variables were the following. The priming history of the categorical exemplars was varied so that both, one, or neither of the exemplars of a particular category were seen with the name of their category. There were two different kinds of target for recall; recall of the categorical exemplars was tested, and the recall of the new list partners of those exemplars. Finally, recall was tested in two different ways; the names of the categories were given to some subjects as cues, and the other subjects were given a studied exemplar of each category as cues.

Results and Discussion

Although Experiment 1 was complicated, presentation of the results can be simplified. The main interest of the experiment concerns the effects of categorical priming on recall of exemplars and of unrelated words with which the exemplars were paired at study. These effects will be presented first. Other results will be discussed later, at which time full statistical analyses will be reported. Note that all differences discussed in the first section are reliable differences in the analyses of variance that will follow. Mean levels of recall are expressed as proportions.

Table 1 summarizes the major results of the experiment. The table uses the category INSECTS as an example, showing first which exemplars were primed in each condition, and below that what was shown in the study list. The top half of the table shows recall with exemplars as cues. For example, with BEE as the cue, correct recall would include CARTON (BEE's new partner), HORNET (BEE's categorical relative) and BOOK (HORNET's new partner). These three recall targets are shown in separate rows. The left column of data is for the 12 categories whose two exemplars were both primed with the name. The right column is for the 12 categories whose exemplars appeared only in the study list. The two middle columns are the 12 categories for which only one exemplar was primed; these are in two columns depending on whether the primed exemplar was the to-be-recalled item on the test (e.g., HORNET) or it was the cue (e.g., BEE). The bottom half of the table is for recall with the category names (e.g., INSECT) as the cues, in which case subjects were asked to recall both of the exemplars and their new

Table 1. Proportions of Correct Recall: Experiment 1

RECALL WITH EXEMPLAR CUES (e.g., BEE)

PRIMING LIST	INSECT + + BEE + HORNET	INSECT + xxx HORNET	INSECT + BEE xxxxxx	INSECT xxx xxxxxx
STUDY LIST	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book
Recall of Cue's New Partner				
e.g., carton	.12	.13	.14	.18
Recall of Cue's Old Relative				
e.g., HORNET	.59	.35	.08	.09
Recall of Relative's New Partner				
e.g., book	.06	.16	.06	.03

RECALL WITH CATEGORY NAME CUES (e.g., INSECT)

PRIMING LIST	INSECT + + BEE + HORNET	INSECT + xxx HORNET	INSECT + BEE xxxxxx	INSECT xxx xxxxxx
STUDY LIST	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book
Recall of Exemplars				
e.g., HORNET	.74	.70	.21	.27
Recall of Exemplars' New Partners				
e.g., book	.08	.19	.08	.08

partners. As with the exemplar cues, the left column is for categories whose exemplars were both primed and the right is for categories whose members were not primed. The categories with one primed exemplar are again in two columns, contrasting recall of the primed exemplars and their new partners with recall of the unprimed exemplars and their partners.

The data will be discussed more fully in a moment, but note first that the patterns in the three rows at the top are very different from each other, as are the two rows at the bottom. That is, priming had very different effects on recall of new partners of exemplars than it had on recall of those exemplars themselves. The remainder of the discussion of the data in Table 1 will consider those dissociations in more detail.

Consider first the top part of the table, which shows recall with exemplars as cues. The first row is recall of the new partners of the exemplars. Recall was no better if the exemplar cue had been primed with its name (.12 and .14) than if the only appearance of the exemplar was with its new partner (.13 and .18). Therefore, categorical priming has no consequence for the probability that an exemplar will become associated with a new partner with which it is studied once.

The second row is recall of the other exemplar of the same category as the cue. Primed exemplars were much better recalled (.59 and .35) than were unprimed ones (.08 and .09). Note the low level of recall of unprimed exemplars even though all the categorical names had been primed, and even if the cue exemplar had been primed. The implication is that categorical exemplars are not directly associated with each other sufficiently for the availability of one to ensure the recall of the other. Note as well that a primed exemplar is no better as a cue than is an unprimed exemplar for the recall of an unprimed exemplar of the same category: enhancing a name-exemplar relation is not sufficient to affect recall of a different member of the category. For that, a direct relation between the cue and target exemplars is necessary. Again, the result suggests that direct associations between exemplars of a category in permanent memory are not sufficient for one to ensure recall of the other; it is the relation between the exemplar and the category label that must be available. If the primed exemplar is the recall target, in contrast, recall is relatively good. Therefore, priming the name-exemplar relation is sufficient to make the exemplar a prominent or available member of its categorical family. Finally, note that priming both exemplars together leads to especially good recall. Maximal recall of one exemplar if both had been primed suggests that recall reflects not only enhanced name-exemplar relations, but also enhanced direct associations between the two exemplars.

The third row is for recall of the new partners of the target exemplars. Recall of these items can succeed only if the targets themselves are recalled. If recall reflects only the likelihood that the target exemplars are retrieved so that they can be cues, then these means should be parallel to those of the exemplars, shown directly above them. They were parallel, with one exception; the best-recalled exemplars were the ones that were both primed with their category names, but these exemplars were among the worst subjective cues for their new partners (.06). Instead, the best recall of the new partners occurred if only the target exemplars had been primed (.16). Whatever enhances recall of these exemplars does not provide access to memory for the event in which they appeared with new partners.

Turning to recall with name cues, we see again that primed exemplars were especially well recalled (.74 and .70), compared to unprimed ones (.21 and .27). Note that if only the target exemplar was primed, performance was particularly high in this condition. If only the other exemplar had been primed, however, performance was low (.21) relative to the control condition in which neither exemplar was primed (.27). The new partners, as above, were parallel to recall of the exemplars except that recall was very low if both exemplars had been primed. Note that even though the provision of names increased recall of exemplars substantially over exemplar cues, the recall of new partners did not increase much, implying that whatever increase in recall comes about when the categorical name is explicitly presented is in a form that does not enhance access to the new partners of the exemplars.

Other Results

The results will now be presented in more detail. Included in this section will be the results of the manipulation of study instructions, as well as the generality or specificity of the category names at study and on the test. In each analysis of variance, in this and the following experiments, α was .05 for all inferences, and simple effects were evaluated by critical differences from post hoc t-tests. Means are expressed as proportions, and MSe values are squared proportions. The results of the secondary manipulations will not qualify any of the conclusions presented above.

Exemplar Cues: Recall of Cues' New Partners. It was stated earlier that categorical priming has no consequence for the likelihood that an exemplar will become associated with a new partner. This was confirmed by an analysis of variance, which showed no main effect of priming history, nor of which exemplar was the cue for recall. The only effect of history was in a three-way interaction with instructions for study and the generality of the priming label; recall was unusually high (.31) in cases in which no exemplars were primed if similarity instructions were given and the names were general, $\underline{F}(2,72)=3.15$, MSe=0.025. This three-way interaction was also the only effect of the generality of the labels. It is not surprising that the generality or specificity of the categorical labels in the priming list had little influence on the recall of the new partners of the exemplars; the variable was expected to affect only the recall of the exemplars themselves.

The manipulation of instructions, on the other hand, was expected to affect the recall of the new partners, but not of the exemplars. In the recall of the partners of the cue exemplars, the similarity or contrast comparisons had been made between the items that were the cue and target on the test. There was in fact a main effect of instructions, with similarity leading to better recall than contrast (.19 vs. .09), $\underline{F}(1,36)=5.79$, MSe=0.112.

Exemplar Cues: Recall of Cues' Old Relatives. The results already discussed are based on the effects of priming history in interaction with which exemplar was the target for recall. An analysis of variance revealed a large main effect of history, $\underline{F}(2,72)=98.4$, $MSe=0.054$, and an interaction between the two factors, $\underline{F}(2,72)=20.7$, $MSe=0.024$.

The generality or specificity of the category names in the priming list had no effect on recall of exemplars, if they were cued by other exemplars. The mean level of recall was .26 with general labels, and .23 with specific labels. As expected, there was also no effect of the instructions for study; recall was .25 in both the similarity and the contrast conditions. The study comparisons were not made between the two exemplars of a category, which in this test condition were the cue and target items, but rather between each of them and a new partner.

<u>Exemplar Cues: Recall of Target Exemplars' New Partners.</u> An analysis including the recall of the partners of both the cue exemplars and the related target exemplars showed that recall was generally lower for the partners of the targets (.08 vs. .14), $\underline{F}(1,36)=20.9$, $MSe=0.034$. As mentioned above, recall of the partners of the targets can succeed only if the targets themselves are recalled. However, as shown in the previous discussion of the results, the pattern of recall did not exactly parallel the recall of the target exemplars. The best

condition was that in which the target exemplar had been primed, but recall was low if both exemplars had been primed with their label. This effect was shown in an analysis of the partners of the targets, in which there was a main effect of priming history, $\underline{F}(2,72)=11.42$, MSe=0.013, and an interaction of history with which exemplar was the cue, $\underline{F}(2,72)=7.65$, MSe=0.012.

There was no effect of instructions for study. The overall mean of recall after similarity processing was .08; after contrastive processing it was .05. The effect was very specific to the relation between the cue on the test and its partner; it did not extend to the relation between subjectively generated cues and their partners. As expected, there was also no effect of the generality of the cues.

<u>Name Cues: Recall of Exemplars.</u> The effect of priming history on the recall of exemplars that was discussed above was shown in a large main effect of history, $\underline{F}(2,72)=140$, MSe=0.065, and an interaction of history and which item was the target, $\underline{F}(2,72)=114$, MSe=0.021.

The only effect of instructions for study was in a three-way interaction with history and which exemplar was the target, $\underline{F}(2,72)=5.17$, MSe=0.021. In general, there was a slight tendency for contrastive processing to lead to better recall than similarity for items that had been seen with categorical labels (.75 vs. .71), and for processing of similarities to produce better recall of items that were seen only in the list of unrelated pairs (.28 vs. .22). The effects were small, however, and not reliable in every condition. The advantage for contrastive study in primed exemplars was reliable only if the target was the only member of the category to have been primed (.73 as opposed to .66 with similarities). It is not surprising that the effects of instructions were small; they were not expected to influence the recall of exemplars. However, they are not inconsistent with the usual effects of similarity and contrastive processing (Begg, 1978b). Pairs of unrelated words are generally better recalled if studied using similarity processing. Words sharing categorical relations benefit more from contrastive study; perhaps drawing attention to categorical membership when both exemplars were primed with their label induced categorical processing enough to have a small effect.

Specific test cues tended to produce better recall than general cues, with means of .53 and .45, $\underline{F}(1,36)=27.0$, $MSe=0.031$. This variable interacted with study history and the generality of the categorical names in the priming list, $\underline{F}(2,72)=5.21$, $MSe=0.018$, because the size of the advantage for specific cues varied over the conditions. However, specific cues were arithmetically better in every condition, including those with general priming labels, contrary to the prediction that recall might be best if the priming and cuing conditions were the same.

Name Cues: Recall of Exemplars' New Partners. The pattern of recall was the same as with exemplar cues, for the recall of the partners of the targets. An analysis of variance revealed a main effect of priming history, $F(2,72)=16.5$, MSe=0.010, and an interaction between history and which exemplar was the target in recall, $F(2,72)=17.2$, MSe=0.010.

There was no effect of instructions, with similarity processing producing a mean of .08 and contrastive processing a mean of .11. In the present case, the study comparisons had not been made between the words that were the cue and target on the test of recall: the specificity of the effect was noted earlier.

The generality or specificity of the categorical labels at study had an effect in interaction with study history, $F(2,72)=4.45$, MSe=0.010, and in a three-way interaction with history and which item was the target, $F(2,72)=3.08$, MSe=0.010. If only one exemplar had been primed, recall of that exemplar's partner was better if it had been primed with a general label (.21) than with a specific label (.16). For the recall of the other exemplar's partner, there was no difference (.07 and .08). In the other conditions, recall was better after study of specific labels than general ones; if both exemplars had been primed the respective means were .10 and .05, and if neither had been primed, they were .10 and .06.

Measures of Association

Associations between Exemplars and Episodic Partners. A measure of association was calculated from the results of the exemplar cue test, to determine whether the ability of an exemplar to retrieve the other categorically related exemplar was associated with its ability to retrieve its new list partner. For each score of each subject, the observed level of recall of the cue's categorical relative and its list partner together was compared with the level that would be predicted if we assumed perfect independence between the two events. The level predicted on the basis of independence was the product of the probabilities of recall of the two individual items. These two measures were also compared to the maximum number of joint occurrences that were possible given the recall of the individual items, based on the recall of the lower of the two.

In almost every comparison, the observed recall of the exemplar and the list partner together was close to the level predicted for independent events, and in the majority of cases, it was equal. An analysis of variance that compared the three measures with respect to their patterns over the various conditions of study showed a main effect of measure, $F(2,72)=39.0$, $MSe=0.003$. The effect occurred because the observed and predicted levels, which did not differ from each other (.04 and .05 respectively), were lower than the maximum possible level (.08). That is, although the levels of performance allowed more joint recall and thus left room for evidence of associations to be revealed, observed recall was still at the low level predicted to occur for independent events.

The effect of measures did not interact with any of the other variables. The degree of association between the recall of categorically related exemplars and unrelated list partners was unaffected by the priming history; the two types of recall were equal to the levels of independence in every condition. If both exemplars were primed, the predicted level was .08 and the observed level was .07, whereas the maximum possible was .11. If only one exemplar was primed the observed and predicted measures were both .03; the maximum was .08. If neither exemplar was primed the observed and predicted levels were both .02, with a maximum level of .06. Although the occurrence of joint recall of the two items was very low, and the maximum number possible was also low, the analysis provides further support for the proposed independence of the two types of recall.

<u>Associations Between Categorical Exemplars.</u> An analysis was conducted on the results of the name cue test, to determine whether the two exemplars of each category were directly associated with each other. The alternative would be that the exemplars were each associated with the category name in independent relations. The measure was calculated in the same way as the preceding measure of associations between exemplars and their new list partners.

The analysis shows that the exemplars were independent of each other. The probability of the two exemplars being recalled together (.28) did not differ from the probability predicted on the assumption of independence (.28), although it was less than the maximum possible probability of joint occurrences (.35). This was shown as a main effect in the analysis of variance, $\underline{F}(2,72) = 87.5$, MSe=0.004. The size of the effect varied, producing interactions with priming history, $\underline{F}(4,144) = 7.28$, MSe=0.003, instructions, $\underline{F}(2,72) = 7.24$, MSe=0.004, and a three-way interaction with priming history and the relative generality of the cues, $\underline{F}(4,144) = 4.20$, MSe=0.003. However, the effect was present in all conditions, showing that the various exemplars of a category are independent of each other. The analysis therefore supports the claim of Mathews (1977) and Mathews and Tulving (1973) of independent associations between each exemplar and the higher order categorical label.

Summary of the Major Results

The major point that can be made from the results is that priming had very different effects on the recall of categorical exemplars and the recall of the new partners of those exemplars. The two different patterns of recall can be summarized quite simply.

Recall of an exemplar was best if it had been studied previously with its category name. However, categorical priming of an exemplar did not make it a good cue for an unprimed relative; recall of an unprimed exemplar was low, whether or not its categorical relative had been in the priming list.

In the recall of new list partners, the best performance occurred if the exemplars with which they had been paired at study were available as cues. Thus on the exemplar cue test, recall of the partners of the cues was at a uniform level across the four study conditions. With either the other exemplar of the category or the category name as the cue, recall was very poor, with one exception. If only the exemplar with which the new partner was studied had been categorically primed, recall was as good as if that exemplar were provided as a cue. It is important to note, however, that if both exemplars of a category had been primed, which was the best condition for recall of the exemplars, recall of the new partners did not benefit.

Conclusions

The results of the first experiment indicate that the recall of items that are permanently related, and of items that are only newly related, are independent processes. This is suggested, first of all, by the different patterns in the two measures of recall. It is also suggested by the conditional analysis that showed the joint recall of the list partner of a cue and its categorical relative to be at the level expected for independent events in all conditions.

Consider first the recall of the permanently related categorical exemplars. Performance was clearly affected by the availability of permanent categorical information about the target items. If the exemplars had been seen with the names of their categories before study of the list, their recall was much better than if they had been seen only in the list of unrelated pairs. But previously available categorical information about one exemplar did not help the recall of the other exemplar of the same category. If only the exemplar that was given as a cue had been shown earlier with its label, recall of the other exemplar was as low as if neither of them had been primed. In either case, if an exemplar had been encountered only as a member of an unrelated pair, a categorical relative or the name of its category was not an effective cue for its recall. Thus, previous study of an item with its categorical label leads to good subsequent recall of that item, but does not make it a better cue for another, categorically related item.

In contrast to the unprimed exemplars, the recall of a primed exemplar was in some conditions affected by the priming history of its relative. The influence of permanent information about a categorical relative, when such permanent information was also available about the target item itself, was apparent in the results of the exemplar cue test. The recall of a primed exemplar, when cued by the other member of its category, was much higher if both items had been in the initial list with their label (.59) than if only the target item had been (.35). This argues against the effect of categorical priming being simply an effect of repetition. Primed items were studied twice regardless of what other information was primed, and so we would expect to see a comparable effect in any case in which the target word was repeated.

An alternative explanation to that of repetition effects is possible. If both exemplars have been studied together with the name of their category, and one is given as a cue for the recall of the other, there may be two routes available for retrieving the target item. The availability of two routes to retrieval might make successful recall more likely than in cases dependent on only one. One of the two routes is by direct access to an episodic trace containing the cue and target words together, as they appeared in the priming list. The other is by a generation-recognition process mediated by the category name. The presentation of one exemplar may lead to the generation of the name of the category. The name, if generated, would then allow recognition and production of the exemplar that is marked as having recently occurred, as the correct response.

If only the target exemplar was primed with the label, there would be no episodic trace of the cue and target items together. Given one exemplar as a cue for the other, recall must occur through the mediation of the category name in permanent knowledge.

If the target exemplar was not primed with categorical information, regardless of whether the cue was, neither means of recall is available. There can be no tag in the permanent knowledge system indicating its recent occurrence for use in a generation-recognition process, and no episodic trace containing it together with the cue. There was, accordingly, practically no recall in such cases.

According to this interpretation of the results, the forms of retrieval hypothesized by both approaches to recall as discussed in the introduction are possible, and the route used depends on what kind of information is available at the time of the particular test. Both kinds of links between items in memory are possible: direct links between the items themselves, and indirect associations through the mediation of the higher order category. The information that becomes available during study of the items, and the information provided by the test, determine what types of relational information can be used for the recall of a particular item.

This interpretation is supported by the results of the name cue test. All the levels of recall were higher with names as cues than on the exemplar cue test, and the difference between the cases in which both exemplars were primed, and only the target was primed, is almost eliminated (.74 vs. .70). With provision of the categorical name as a cue, successful recall by categorical mediation is much more likely. Recall no longer depends on the ability to access or generate the appropriate category, because that has been given. Further, the link between the category name and the target is strong, because it could have been encoded as a trace at the time of study of the priming list, as well as being tagged in permanent knowledge. Thus with priming of the target with the name and provision of the name as a cue, whether or not the other exemplar was also primed is irrelevant for successful recall of the target. Both routes to recall are available in either case.

In comparison to the recall of permanently related categorical exemplars, recall of episodically related list partners was much less influenced by earlier provision of categorical information. The use of episodic traces in recall is apparently independent of the use of permanently held information about the studied items. Recording an occurrence of an item that is a part of permanent knowledge is of little consequence for the retrieval of other items with which it occurred in the experimental list. Recall of words that are newly related to the item is an independent process.

Evidence for this independence lies in the fact that the cases of the best recall of permanently related items were not accompanied by good recall of new partners. Recall of exemplars was best in cases in which both members of a category had been primed with their label. But those same cases produced among the lowest levels of recall of new partners. Moreover, the improvement in exemplar recall from the exemplar cue test to the name cue test in conditions in which both exemplars were primed was not accompanied by improvement in episodic recall. The conditions that were beneficial for the recall of permanent knowledge, then, were not the same ones that aided the recall of episodically related items.

That episodic recall occurred by means of traces of the joint occurrence of the pairs, is supported by the fact that recall was best under conditions that could be expected to make such traces more accessible. On the name cue test, the name of the category would enable recall of the episodic partner of one of its exemplars only if it could provide access to the exemplar itself, which then would have to provide access to the trace containing the exemplar and its partner. The best recall on that test was if the exemplar with which the target item was studied had been previously seen with its name, and its categorical relative had not. Given the category name, the required exemplar should be the most readily available in that condition, and might thus allow the trace to be most easily accessed.

On the exemplar cue test, if the exemplar given as a cue is the one whose partner is required, the task can be done by accessing the appropriate trace directly. If the cue was the other exemplar, however, it was first necessary to get to the exemplar that was encoded with the target item. In this case, if the exemplar studied with the target had been categorically primed, making it perhaps more readily accessible, recall was then comparable with conditions in which it had been provided on the test. In the other conditions, recall was extremely low.

In summary, then, recall of categorical exemplars appears to have occurred either by retrieving traces of the items that had been studied together, or through the mediation of categorical information in permanent knowledge, or both, depending upon the kind of relational information that was available. Recall of episodically acquired partners appears to have been an independent process, and to have occurred by means of retrieval of the traces containing the cue and target items as they had been studied together.

Chapter 3

EXPERIMENT 2

In the first experiment it was found that permanent categorical relations among words in a list were more effectively used in recall if subjects had been made aware of the categorical relationships before study. The primed permanent relations did not improve the recall of other relations of which the same items were a part. Subjects were, however, better able to recall categorical relatives that had occurred in the studied list if they had previously seen those items with the names of the categories to which they belonged.

In the second experiment, the subjects were given the extra categorical information only after they had studied the list of words for which they would be tested. They first studied a list that contained pairs of words that were unrelated to each other, and in so doing learned a set of new relations. As in the first experiment, one member of each of the pairs was categorically related to a member of one of the other pairs. Thus there were permanent relationships present in the list, but they were not part of the new relationships being formed at study. After studying the list but before they were tested on it, the subjects were shown a list that contained some of the same items, together with the names of the categorical sets to which they belonged. Thus the events were the same as in the first experiment, but the order of their occurrence was reversed. Once again, after study the subjects were tested for their recall of the permanent relations among the items, and recall of the newly learned relations between the members of the pairs.

If the finding from the first experiment of the independence of permanent and newly acquired relational information is correct, we can expect the two measures to reflect independent processes in the present experiment as well. The prediction, therefore, is that performance on the measures of recall of exemplars and of new partners will be at different levels, and will be influenced in different ways by the experimental manipulations. However, the effect of the categorical list is less easy to predict. In the first experiment, that list can be said to have made relevant aspects of permanent knowledge more readily available for use in the interpretation of subsequently presented items. Alternatively, it might be said that the different sets of relational information were accumulated in the course of the experimental events, and that at the time of recall, the entire set of available information was used. In the current experiment, the items will already have been processed when subjects are "reminded" of the relations in permanent knowledge of which they are a part. Will the later tagging of permanent knowledge have any effect on the recall of items that have already been processed? If the memorial record, or "memory trace", is actually the entire state of the memory system at a specific time, and if recall depends upon the memory trace as it exists at the time of the test, then we should expect to see some effect of the categorical list on test performance. However, it is not clear whether the effect will be the same as if the list had been studied under the influence of the categorical information.

To examine these questions, the same lists were shown to subjects as those used in Experiment 1, but they were presented in the reversed order. Recall was then tested in the same way as in Experiment 1.

Method

Subjects

Forty introductory psychology students participated in the experiment for course credit, with ten students in each of four conditions. Subjects were tested in small groups, in sessions lasting approximately forty minutes. The groups were assigned to conditions at random.

Materials and Procedure

The same lists were used as in the first experiment, with the exception that only specific categorical labels were used. Because the relative generality of the category names had no important effects in the first experiment, it was not varied here.

The procedure was the same as in the first experiment, but with the order of list presentations reversed. The subjects first studied the list of 72 pairs of unrelated words by considering either similarities or differences between the members of each pair. They then saw the list of word pairs with categorical labels, and indicated the more typical member of the category on the paper provided. For an illustration of the presentation of the two lists, refer to Table 2. Recall of the pairs of unrelated words and the categorical associates was tested immediately following study of the second list, with either exemplars or category names as cues. Thus once again the important variables were whether or not an exemplar had been studied with the name of its category, whether recall of that exemplar or its new partner was being tested, and whether names or exemplars were given as cues.

Results and Discussion

As in the presentation of Experiment 1, the most important effects will be presented first. Other results will be presented later, along with full statistical analyses.

The main interest of the experiment, as in the first experiment, concerns the effects of categorical priming on the recall of exemplars, and the recall of unrelated words with which the exemplars were paired at study. In the present experiment, however, the categorical information was made available after the list of pairs had already been studied. It will be seen that the results closely resemble the patterns obtained in the first experiment. It should be noted when considering the results, however, that whereas in Experiment 1 the newly acquired relations had been learned most recently at the time of the test, in Experiment 2 the permanent relations were encountered more recently than the encoding of the new relations.

The major results of the experiment are summarized in Table 2. The table uses the category INSECTS as an example, following Table 1, and the measures are the same as those in Experiment 1.

Note that once again the patterns in the top three rows are very different from one another, as are the bottom two rows. As found in Experiment 1, categorical

Table 2. Proportions of Correct Recall: Experiment 2

RECALL WITH EXEMPLAR CUES (e.g.. BEE)

STUDY LIST	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book
PRIMING LIST	INSECT + BEE + INSECT + HORNET	INSECT xxx INSECT + HORNET	INSECT + BEE INSECT xxxxxx	INSECT xxx INSECT xxxxxx
Recall of Cue's New Partner				
e.g.. carton	.07	.18	.07	.17
Recall of Cue's Old Relative				
e.g.. HORNET	.73	.35	.07	.10
Recall of Relative's New Partner				
e.g.. book	.01	.14	.07	.03

RECALL WITH CATEGORY NAME CUES (e.g., INSECT)

STUDY LIST	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book	bee + carton, hornet + book
PRIMING	INSECT + BEE + INSECT + HORNET	INSECT xxx INSECT + HORNET	INSECT + BEE INSECT xxxxxx	INSECT xxx INSECT xxxxxx
Recall of Exemplars				
e.g.. HORNET	.82	.76	.12	.23
Recall of Exemplars' New Partners				
e.g.. book	.07	.15	.06	.07

priming had very different effects on the recall of exemplars of the categories, and on the recall of the new partners of those exemplars.

The top part of the table shows recall with exemplars as cues. The first row is recall of the new partners of the cues. It is clear that recall was worse if the exemplar cue had been primed (.07 in both cases) than if it had not (.18 and .17). In Experiment 1, in which the categorical priming had occurred before study of the list of pairs, it had no consequence for the recall of the list partners. In the present experiment the categorical information was seen after study of the pairs, and it appears to have had a negative consequence for the recall of the new partners.

The second row shows the recall of the other exemplar of the same category as the cue. As in Experiment 1, primed exemplars were much better recalled (.73 and .35) than were unprimed ones (.07 and .10). Once again, categorical priming of an exemplar led to good recall of that exemplar, but did not make it a good cue for the recall of its categorical relative. Note that the priming of both exemplars together again led to much better recall of the target exemplar than did the priming of only the target, suggesting that recall reflects both the name-exemplar relations and direct associations between the exemplars.

The third row shows recall of the new partners of the target exemplars. The same pattern is apparent as in Experiment 1. With one exception, the means are parallel to those of exemplar recall, upon which they depend. Recall was very low if the target exemplar had not been primed (.07 and .03) and somewhat better if it had (.14). However, if both exemplars had been primed, producing the best case of exemplar recall, there was no parallel improvement in recall of the new partner, which was very low (.01). It is once again clear that the factors that enhance recall of the exemplars are not sufficient to provide access to memory for the event in which they were studied with new partners.

The bottom part of the table shows recall with the categorical names as cues. Here, too, the pattern is the same as in Experiment 1. Primed exemplars were again much better recalled (.82 and .76) than unprimed ones (.12 and .23). Note that if only the target was primed, recall was especially high on this test, as compared to the same condition on the exemplar cue test. This was also the case in the previous experiment. Note also that of the unprimed cases, recall was particularly low if the unprimed exemplar had a primed relative, compared to the case in which there was no priming. This pattern was evident in the first experiment, but the difference is particularly marked here.

Recall of the new partners was again parallel to recall of the exemplars, with the exception of the case in which both exemplars had been primed. Once again, whatever it was that enhanced recall of the exemplars did not enhance access to their new partners. Neither did the enhancement of exemplar recall resulting from providing the categorical names as cues enhance access to the new partners.

Other Results

Exemplar Cues: Recall of Cues' New Partners. The effects of presentation history discussed previously, in which recall of new partners was better if the exemplars had not been primed than if they had, were based on a main effect of history, $F(2,36)=5.74$, $MSe=0.018$, and an interaction of history and which of the two exemplars of a category was the target for recall, $F(2,36)=9.39$, $MSe=0.018$. There were no effects of the instructions for study, with similarity processing producing an overall mean of .10 and contrastive study a mean of .13. The lack of effect of instructions is unlike the results of the same measure in Experiment 1, in which similarity processing led to better recall than contrast. It is also contrary to what was expected for the recall of the studied list partners.

Exemplar Cues: Recall of Cues' Old Relatives. The effects of presentation history on the recall of exemplars was confirmed by a substantial main effect of history, $F(2,36)=186.0$, $MSe=0.024$, of which exemplar was the target, $F(1,18)=10.73$, $MSe=0.020$, and an interaction between the two factors, $F(2,36)=10.9$, $MSe=0.03$. The presentation history also interacted with the instructions for study, $F(2,36)=4.64$, $MSe=0.024$. If both exemplars of a category had been primed, there was no difference between the two instruction conditions (.73 for similarity and .72 for contrast); but in all other cases contrastive study was better than similarity (.48 vs. .22; .14 vs. .00; and .15 vs. .03). Although no effects of instructions were predicted for the recall of the exemplars, because they were never directly compared with each other, an advantage for contrast is what we might expect for categorically related materials.

Exemplar Cues: Recall of Target Exemplars' New Partners. The results discussed previously are reflected in a main effect of priming history, $F(2,36)=12.31$, $MSe=0.008$, and an interaction between history and target item, $F(2,36)=4.28$, $MSe=0.004$. In addition, history interacted with instructions, $F(2,36)=4.02$, $MSe=0.008$. The interaction with instructions was solely because of the primed members of categories in which only one member was primed, in which case contrastive study (.22) was better than similarity (.06). In all other cases, there was no difference between the two instruction conditions. Experiment 1 also showed no difference between the two instructions on this measure; it was concluded then that instruction effects did not extend to the relations between subjectively generated cues and their partners.

Name Cues: Recall of Exemplars. The effects of priming history were confirmed by a large main effect of history, $F(2,36)=128.8$, $MSe=0.055$, of the target item, $F(1,18)=211.13$, $MSe=0.014$, and an interaction between the two, $F(2,36)=91.86$, $MSe=0.028$.

As expected for cue and target items that were never compared at study, there was no effect of instructions, with overall means of .50 for similarity and .48 for contrast. There was, however, an effect of the nature of the cue provided on the test, $F(1,18)=34.74$, $MSe=0.026$. Although only specific category names were shown in the priming list, subjects received the same recall test as in Experiment 1, in which some of the name cues were specific and some general. Not surprisingly, specific cues, which were exactly the same as the labels with which the exemplars had been studied, were more effective cues than general ones (.55 vs. .43). The advantage for specific cues occurred in every comparison but one: the one exception, in the case of similarity instructions for the unprimed exemplar when the other exemplar had been primed, produced a three-way interaction of cue, history and target item, $F(2,36)=6.21$, $MSe=0.023$.

Name Cues: Recall of Exemplars' New Partners. The pattern was the same as for the partners of the targets on the exemplar cue test, as it was in Experiment 1. It was confirmed by a main effect of history, $F(2,36)=4.56$, $MSe=0.009$, of the target item, $F(1,18)=5.0$, $MSe=0.010$, and the interaction of the two, $F(2,36)=4.89$, $MSe=0.011$.

As on the previous measure, specific name cues (.09) were better than general cues (.06), $F(1,18)=8.51$, $MSe=0.006$. This variable interacted with history and target, $F(2,36)=10.23$, $MSe=0.005$, and with history and instructions, $F(2,36)=10.84$, $MSe=0.007$, because the effect was reversed in the case of the partner of an unprimed relative of a primed exemplar, with similarity instructions. The same reversal of the pattern was observed in the recall of the exemplars; the relative effectiveness of the test cue influenced all performance based on that cue.

Summary

Once again the major point to be made from the results is that categorical priming had very different effects on the recall of exemplars and of new list partners. Following is a summary of each of the two patterns of performance.

The recall of exemplars was good if they had been seen with their category names, but such categorical information did not help the recall of their unprimed categorical relatives. Unprimed exemplars were poorly recalled regardless of whether their relatives had been primed; in fact there was a tendency for recall to be better if they had not.

For new list partners, if the exemplars with which they had been studied were given as cues, recall was best if those exemplars had not been primed. If the exemplar with which the word had been studied had to be recalled first, as on the name cue test and for the partner of the cue's relative on the exemplar cue test, recall was best if the target exemplar had been primed. In such cases, recall was almost as good as if the exemplar had been provided as a cue. However, if both exemplars of a category had been primed, which produced the best recall of the exemplars themselves, recall of the partners did not improve correspondingly.

Conclusions

The pattern of results obtained in the second experiment is virtually identical to the pattern observed in the first. Again, recall of the categorical exemplars benefitted from an opportunity for study of those exemplars with their labels. Recall was even higher when the categorical labels were seen after study of the tested list, than it had been if they were shown before study. The enhanced performance in the second experiment was no doubt because of the recency of exposure to the categorical information. Recall was again lower for categorical exemplars that had not been presented with their labels. In this case, the scores were even lower than in Experiment 1. With the intervening list, which for these cases contained nothing but irrelevant information, study of the tested items was less recent at the time of test than it had been in Experiment 1.

Episodic recall was very low in all conditions, as it was in Experiment 1. The best performance, as before, occurred under two conditions, both of which maximize availability of the episodic trace of the pair. One was if the partner of the target had been shown in the categorical list after study. The other was if the partners of the targets were given as cues, but had not been categorically primed. The latter case represents a slight difference from the results of Experiment 1, in which the recall of new partners of exemplar cues was at a uniform level across all conditions of presentation history. Apparently, categorical information irrelevant to a newly related pair, presented after study of that pair, interfered with memory for the new relation.

It therefore appears that the important factor in recall of new partners is the availability of the item with which the target word was studied. This in turn determines the accessibility of the memorial record of study of the two words together, upon which recall seems to depend. If the appropriate exemplar was not given as a cue, priming made it sufficiently accessible to allow recall. However, unnecessary or irrelevant priming hurt the recall of the new relation.

The data from the first experiment that suggested independent recall of permanently known relations and newly acquired ones were replicated in Experiment 2. The evidence seems strong that recall of information of the different types is influenced by different variables. Indeed, the most important variable in the recall of permanently related categorical exemplars, study with their category names, had a negative influence on the recall of the new partners of those exemplars. Further, the pattern of exemplar recall on the name cue test, which was interpreted in Experiment 1 as evidence for mediation in the recall of related items by higher order categorical information in permanent knowledge, has also been replicated.

The conclusions that were drawn from the results of Experiment 1 have therefore all been upheld. Two kinds of links between items in memory are possible. They may be directly linked to one another by virtue of having been encoded together in a study episode, and they may share indirect associations through the mediation of higher order categorical knowledge. The information that is available at the time of study and at test determines what kinds of relational information can be used for a particular recall task.

It is interesting to note that the effect of presenting permanently known information about the categorical items is virtually the same, whether it is presented before or after study of the list. If the effect had occurred only if the information was shown before study, we could have concluded that the effect was to influence the way the studied pairs were interpreted and processed, thereby determining to some extent the nature of the records of the pairs. But the categorical information is also influential if it is seen after the pairs have already been processed. Perhaps, as was suggested in the introduction to the present experiment, this lends support to the notion of the memorial trace being the complete state of the system at the time of the test. It includes the newly encoded pairs of items, and also the permanent information that had recently been "tagged". If that tagged information is relevant to the newly encoded information and the test, it may help performance. If it is not, it will be of no benefit and perhaps will interfere with performance.

The first two experiments have established that all the information available in memory, whether it is known permanently, or has been newly acquired, can be used in recall, and that the two types are used differently. The remaining experiments explore the ways in which the entire set of information may be used together in the process of recall.

Chapter 4

EXPERIMENT 3

The first two experiments established that seeing relations that were already permanently known and learning new relations between items can have separate influences on recall. The results also suggested that recall can occur both through the use of newly encoded information about the particular episode of study, and through the mediation of higher order categorical information in the permanent knowledge system.

The route used depends on what information is available regarding the items that are to be recalled. If two words were unrelated before being processed together, as, for example, CAT and BOOK, recall might occur by means of the retrieval of the episodic memorial record of that processing event. If the words shared a permanently known relation, in this case a categorical one like CAT and DOG, that permanently held knowledge might be used to recall one of them, given the other as a cue. Finally, if both kinds of relation exist between two words, in that they are permanently associated with each other and they were processed together in a particular study episode, then it seems to be the case that recall can occur by both routes.

producing maximal performance.

In the first two experiments, the study of permanently known relations - the "reminding" or priming of permanent relations in memory - and the establishment of new relations occurred at different times, during the study of two separate lists. Under such circumstances, the two types of knowledge were found to be used independently in recall. One possible reason for the finding of independence is, as argued to this point in the thesis, that the two types of relation are in fact qualitatively different sources of information, existing independently within the memorial system at any particular time, and can be used separately in memory. An alternative explanation is possible, however. Perhaps whatever is in the system after a particular episode of study stands as an independent trace. Each trace, then, can be used independently in recall. An episode of study could include the study of a permanently known relation, or the establishment of a new relation between items, or both. If the different kinds of relational information were encountered in different episodes of study, they would exist in memory as separate traces and be independently accessible.

In the following experiments, the different kinds of relational information were present within single episodes of study. Single sets of items contained words that were permanently related to each other, and words that were not. This should enable us to distinguish between the two possible explanations of the observed independence. If entire episodes of study stand alone as complete and independent entities, with no differences among the information contained within them, then all components of a particular episode should be equally accessible, and should be affected in the same way by any variables that influence recall. If permanently related and newly related items again show different patterns of recall, and are again influenced by different variables, then we can conclude that the two types of relational information are in fact different, even if they are acquired in the same study episode.

The presence of both permanent relations and new episodic relations was therefore manipulated within studied sets of items. In the first two experiments, only one type of relation was varied. Tested items varied as to whether or not they had been seen with permanent categorical information, but their inclusion in new episodic relations did not vary. In every case, a categorical exemplar was studied with a previously unrelated word. And in every case, the two words were processed in relation to each other, creating a new relation between them. The way in which they were processed together was varied by using instructions for either similarity or contrast comparisons, but episodic recall was generally too low to see differential performance on that basis. In the third experiment, the presence of both permanent and episodic relations was varied among the sets of words.

The presence or absence of permanent relations was determined by varying the composition of the sets of words that were presented for study. Each of the sets contained three words. In some cases all three belonged to the same taxonomic category, thus presumably sharing a permanent association in memory. In some cases two of the words were categorically related and the third was not, and in the remaining cases all three were unrelated. By varying the combinations of words that are permanently related, associations in recall can be measured and compared between words with direct permanent relations, and words that are unrelated in permanent knowledge. Moreover, it can also be determined whether there is a mediating effect of the presence of one relation on the recall of other words in the set.

Episodic relations were manipulated by means of the instructions for study, using different types of mental imagery. The goal was to have some cases in which there was no episodic relation between the words in a set, and other cases in which such relations were formed.

However, it is possible that episodic relations could be acquired to some degree simply by virtue of the words appearing together in a set for study. To prevent the encoding of new relations in some cases, half the subjects were instructed to study the items using separate imagery. That is, they were told to form a separate image for each of the words in each set. In contrast, in other cases the instructions were to form images of the items interacting with each other.

Previous work (Begg, 1978a) has indicated that the use of separate imagery leads items to be encoded as isolated units. Interactive imagery, on the other hand, creates a relation between items that were not previously related, causing them to be encoded together as a unit in the same memorial record. Nicholson (1987) showed a dissociation between interactive and separate imagery in the recall of previously related and unrelated pairs of words; with interactive imagery, unrelated pairs were recalled better, but with separate imagery, related pairs were the better recalled. The two types of imagery thus provide a strong manipulation to vary the nature of the relations. The instructional variable in the present experiment enabled observation of the effects of newly acquired relations on recall, the effect of combining new and permanent relations, and whether episodic relations can play a mediating role in the recall of other, unrelated items.

In the first two experiments, then, some of the words can be said to have been tagged in permanent knowledge, and all were encoded in new episodic relations. In the remaining experiments, all the possible combinations occurred. Some words were related only episodically through joint processing, by means of interactive imagery. Some had permanent categorical relations between them, but no episodic record of having been processed together because they had been imagined separately. Some were related in both ways, being categorically related and having been interactively imaged. Finally, some were not related in either way.

In addition to the two types of relations and how they interact, another question considered in the first two experiments can be examined more closely in Experiment 3, concerning the existence and use of different routes for retrieval of items in memory. In the first two experiments, the comparison of recall on the exemplar cue test and the name cue test suggested that two different types of retrieval are in fact possible, with the type used depending on the information provided in the cue, and that available in memory. The data indicated that recall can occur both through the mediation of categorical information in memory, in a kind of generation-recognition process, and by the retrieval of episodic records of the cue and target items having been processed together.

In the third experiment, three different measures of recall allow us to examine the use of the different types of retrieval further. Each of the sets of words presented for study consisted of the name of a category and two exemplars; some exemplars were members of the named categories and others were not. On the tests, one of the items in each set was given as a cue for the recall of the other two. In this way, we can look at the recall of a categorical exemplar given the name of its category as a cue, and also the recall of the name, given an exemplar as a cue. These measures should give some indication of the use of higher order categorical information in the process of recall, with and without episodic relations between the items. Moreover, the recall of one exemplar with the other as a cue was tested, with no episodic relation existing between the two. Such recall must occur by means of mediation by the categorical name.

Several authors have suggested that higher order categorical information mediates recall. Estes (1975), for example, suggested that study of a categorical exemplar within a list not only creates a trace of the exemplar and its list context, but also activates a previously existing trace of that exemplar with the name of its category. Upon recall of the name, a new trace is then established that contains the exemplar, its label, and the list context all together.

Mathews and Tulving (1973), in a study of repetition effects, presented exemplars together with category labels. They found that repetition of the higher order categorical unit improved the level of recall, even without repetition of the exemplars. Moreover, the effect of repetition was not to improve the recall of particular exemplars, but rather to improve access to categories, as seen in the recall of exemplars from a greater number of categories. That is, it was not the overall number of recalled exemplars that was affected, but the number of categories from which exemplars were recalled. Their conclusion was that in recall, access to items occurs through the mediation of the higher order unit.

In a similar vein, Mathews (1977) found that after study of two nouns and a category name, one noun enabled recall of the other only if the categorical label was also recalled. He concluded that rather than the two nouns becoming directly associated with each other during study, each became associated with the name in the context of which it had been seen. Recall of the nouns was mediated by the category name.

It has also been suggested that mediation can occur with episodically formed relations. A study context common to two items has been shown to mediate cued recall if the items are unrelated to it or to each other, if study processes relate the items to the context. Winograd and Lynn (1979) showed that although cued recall of unrelated words that have been imagined separately is generally poor, the presence of a common context in which to imagine each of them, such as imagining each of the items in a restaurant, makes recall substantially better. Further, Begg and Sikich (1984) demonstrated that it was interactive imagery of each of the items with the context that helped recall. They had subjects study unrelated pairs of words either interactively or separately, and either interacting with a contextual item or not. Interaction with the context helped the recall of separately imagined pairs. That is, the episodic relation with the contextual word mediated in the recall of words that were not themselves related.

In the present experiment the combination of the different testing conditions and the variations in existing relations, both permanent and episodic, allow the examination of the ways in which the information in memory and the information provided in the task interact to determine the nature of retrieval.

Method

Subjects

The subjects were introductory psychology students who received course credit for participating in the experiment. The 127 subjects were tested in small groups, which were randomly assigned to twelve conditions, with from 10 to 13 subjects in each condition. The sessions lasted approximately fifty minutes.

Materials

Forty categorical labels were selected from the Battig and Montague (1969) category norms. The labels were changed, if necessary, so that they were all single words, such as CLOTHING and FURNITURE. Two exemplars of each category were also selected; they were all between the third and eleventh most frequent members of their categories.

The 40 categorical triplets were distributed at random into five types of sets. In one type, the sets remained intact, so that the three words that were presented together were all categorically related. Two other types of sets contained one exemplar that was related to the category name, and another that was a member of one of the other categories and thus unrelated to the rest of the set; the two sets differed as to whether the related word was on the left or right side of the display. In other sets, the two exemplars of each category were kept together, but reassigned to labels; the sets thus contained related pairs of exemplars with unrelated categorical names. Finally, in some sets all the words were redistributed so that each set consisted of a label and two unrelated words.

To increase the generality of the results, a second list was constructed by reassigning the 40 sets to the five item types; thus each categorical label appeared with different combinations of words in the two lists.

Each of the two versions of the list was videotaped and presented on a monitor in two different ways. In one presentation, the three words of each set were shown simultaneously in a triangular array, with the categorical name at the top and the other items below it to the left and right sides of the screen. The five types of sets were intermixed so that each was represented in all parts of the list. The triplets were shown at the rate of approximately ten seconds from onset to onset.

In the second type of list presentation, the same sets were broken up into 80 pairs, such that the category names were shown twice, once with each of the exemplars in the set. Each word appeared in the same place on the screen as it did in the triangular array, with the names at the top of the display, and the exemplars below them and either to the left or the right. For half the sets, the two pairs that contained the same categorical label occurred in immediate succession. For the other half, there were nine intervening pairs. The pairs were presented at a rate of five seconds from onset to onset, to equate the amount of time for study of each complete set in the two presentation conditions.

Three tests of recall were prepared for each list, each to be given to a third of the subjects. One word from each triplet was given as a cue, and spaces were provided on the test paper for the recall of the two words with which the cue had appeared. On a third of the tests the cues were the category name from each set, on another third the cues were the left items, and on the remaining tests they were the right items.

Procedure

Half of the subjects were shown one of the lists of words; the other half were shown the other list which contained a different combination of categories and exemplars. The subjects were instructed to study the lists by using either interactive or separate imagery. Half of the groups were asked to form one interactive image of the top and left items, and another interactive image of the top and right items. For the triplet array this required the formation of two images for each set; in the paired array, one image was formed for each pair. The remaining subjects were told to form a separate image for each word. In no case were subjects to imagine the two exemplars together.

Following study, the subjects were given a test of recall, in which they were given all the top, left, or right words and asked to write down the other two words from each set. For the triplet array, the recall targets were the two words that appeared on the screen with each cue. For the list of pairs, the targets were the word that was paired with each cue on the screen, and the word that appeared somewhere else in the list with the same category name. The subjects took about seven minutes to complete each test.

Results and Discussion

The results were analyzed by a series of analyses of variance, which included as factors the type of item, the instructions for study, the presentation array, whether the two items representing a particular category in the paired array were presented in that list in immediate succession (massed) or with nine intervening items (spaced), and which item was given as a cue on the test. The two versions of the list did not produce different results, and the results were collapsed in all analyses.

The first set of analyses to be presented concerns the cued recall measures, with different kinds of relations between the cue and target items and between them and the other members of the sets. The second set of analyses was dedicated to the measure of mediated recall; that is, cued recall in cases in which there was no association between the cue and target, except by means of a mediating item with which they were each related in various ways.

<u>Item Recall</u>

The first set of analyses concern the proportions recalled of words from the various types of items. The item types reflected the different combinations of relations present in the sets of words. They were defined according to whether or not the cue and target words in a set were permanently related, and whether or not each was related to the third word in the set. Five types of items resulted from this categorization, examples of which are shown in Table 3. For the sake of simplicity in the table, not all the cue conditions have been shown. However, all the possible combinations of relations are illustrated. In one item type, all three words were permanently related to each other. An example is the set shown in the top row of the table, FUEL - GASOLINE, KEROSENE. Consider the case in which the left exemplar is given as a cue for recall of the right exemplar; the cue (GASOLINE) and target (KEROSENE) are categorically related to each other, and they are both related to the third word in the set, being members of the category named FUEL.

Table 3. Examples of the Types of Item for Experiment 3

	TYPE OF RECALL MEASURED:		
RELATIONS IN SET:	EXEMPLAR to EXEMPLAR Cue: Left Target:Right	EXEMPLAR to NAME Cue: Left Target:Name	NAME to EXEMPLAR Cue:Name Target:Right
ALL WORDS RELATED	FUEL GASOLINE KEROSENE	FUEL GASOLINE KEROSENE	FUEL GASOLINE KEROSENE
CUE AND TARGET RELATED	ANIMAL MAYOR GOVERNOR	ALCOHOL VODKA PINK	FOOTWEAR SODIUM SLIPPERS
TARGET AND THIRD WORD RELATED	FOOTWEAR SODIUM SLIPPERS	FOOTWEAR SODIUM SLIPPERS	ANIMAL MAYOR GOVERNOR
CUE AND THIRD WORD RELATED	ALCOHOL VODKA PINK	ANIMAL MAYOR GOVERNOR	ALCOHOL VODKA PINK
NO WORDS RELATED	BOAT TENNIS SPINACH	BOAT TENNIS SPINACH	BOAT TENNIS SPINACH

In a second type of set, the cue and target were categorically related to each other, but they were not related to the third word. If we again consider the case in which the left exemplar was given as a cue for recall of the right exemplar, an example of this type of set would be ANIMAL - MAYOR, GOVERNOR, as shown in the left column of the second row. The cue, MAYOR, is related to the target, GOVERNOR; but neither is related, to the category ANIMAL. In another type of set, the cue and target were not related to each other, but the target was related to the other word in the set. For an example, look at the set FOOTWEAR - SODIUM, SLIPPERS in the left column of the third row. The cue and target, SODIUM and SLIPPERS, are not related to each other; but the target SLIPPERS is a member of the category named by the other word, FOOTWEAR. In the next type of set, the cue and target were again unrelated, but in this case the cue word was related to the third word. For example, in the first set in the fourth row, ALCOHOL - VODKA, PINK, the exemplar VODKA is the cue and is a member of the category ALCOHOL. Finally, sets in which none of the words share categorical relations served as a control. An example of this kind of set is shown in the bottom row of Table 3, BOAT - TENNIS, SPINACH.

Three measures of recall were analyzed. The first two are measures of associations between categorical exemplars and labels. One is the recall of categorical names given exemplars as cues, and the other is the recall of exemplars cued by the names with which they were presented. The third measure is of associations between categorical exemplars.

As in the first two experiments, there is a large amount of data to present, but the important points can be made quite simply. The major results will therefore be discussed first. They will be followed by a more detailed report of the full results, together with full statistical analyses.

The major point to be made is that there were very different effects on recall of the nature of the categorical relations available in a set, and of the newly formed relations as determined by imagery instructions. Very briefly, items sharing permanent relations were recalled better than unrelated items; and forming new relations by interactive imagery helped recall if there was no other relation, but not if the items had been related previously.

Consider first the recall of the category names with exemplars as cues, shown in Table 4. It is clear that the best recall occurred if all the items in a set were categorically related (.70), and somewhat lower levels of recall were observed if only the cue and target were related (.52). Many fewer names were recalled if

Table 4. Exemplar to Name Recall: Experiment 3

PERMANENT RELATIONS IN SET	EXAMPLE with left cue	SEPARATION INSTRUCTIONS	INTERACTION INSTRUCTIONS	M
NONE	BOAT TENNIS SPINACH	.05	.15	.10
CUE AND THIRD WORD	ANIMAL MAYOR GOVERNOR	.10	.21	.15
TARGET AND THIRD WORD	FOOTWEAR SODIUM SLIPPERS	.10	.21	.15
CUE AND TARGET	ALCOHOL VODKA PINK	.52	.51	.52
ALL WORDS	FUEL GASOLINE KEROSENE	.72	.67	.70

they were unrelated to the cue; the means were .15 if the names were related to the other exemplar in the set, and .16 if the cue was related to the other word. Recall was poorest in the completely unrelated sets (.10). Thus recall was good if the cue and target were permanently related to each other, and even better if the other word in the set was related to them as well. Without permanent relations between the cue and target, recall was much worse, but there was a small but reliable advantage of having a categorical relation between one of the words and the other member of the set.

Interactive imagery led to better recall than separate imagery, but only if the cue and target were not otherwise related. Thus in the completely unrelated sets, interactive imagery led to a mean level of recall of .16, as opposed to .05 with separate imagery. In both cases in which one of the words shared a categorical relation with the third word, the means were .21 with interaction and .10 with separation. In contrast, if the cue and target were permanently related, there was no difference between the two instruction conditions (.51 with interaction and .52 with separation), and if all the words in a set were related, separate imagery led to better recall (.72) than interactive imagery (.67). Although the latter difference is small, it is statistically reliable, with a critical difference of .05 in a post hoc t-test. Thus if there was no permanent relation between the cue and target, creating a strong episodic one by means of interactive imagery helped recall. But if there was already a relation between the two words, adding a new one did not help, and in some cases even hurt performance.

Turning now to the recall of exemplars with the category names as cues, shown in Table 5, we see a similar pattern of performance, although at somewhat lower levels. The best performance occurred after study of the words in completely related sets (.57), followed by recall of items that were related only to the cues (.43). Recall was again very low if the cue and target were not permanently related; in the present case, sets in which either the cue or the target were related to the third word (both .10) were not reliably different than completely unrelated sets (.07). Thus the categorical names were effective cues only for members of their categories, regardless of what else was present in the set. They were especially effective cues, however, if they had been presented at study with both of their exemplars.

Once again, interactive imagery produced better recall than separation if the cue and target were not otherwise related. Mean levels of recall were .11 for interaction and .03 for separation in the completely unrelated sets; .13 and .07 respectively if the cue was related to the third word, and .14 and .07 if the target

Table 5. Name to Exemplar Recall: Experiment 3

PERMANENT RELATIONS IN SET	EXAMPLE with right target	SEPARATION INSTRUCTIONS	INTERACTION INSTRUCTIONS	$\bar{X}$
NONE	BOAT TENNIS SPINACH	.03	.11	.07
CUE AND THIRD WORD	ALCOHOL VODKA PINK	.07	.13	.10
TARGET AND THIRD WORD	ANIMAL MAYOR GOVERNOR	.07	.14	.10
CUE AND TARGET	FOOTWEAR SODIUM SLIPPERS	.41	.46	.43
ALL WORDS	FUEL GASOLINE KEROSENE	.60	.55	.57

and the other word were related. There was also a slight advantage for interactive imagery in the case in which the cue and target were related (.46 as opposed to .41 for separation). This was only because of an advantage in the paired presentation condition (.50 for interaction and .30 for separation). In the triplet presentation array, there was a substantial advantage for separate imagery over interaction (.52 vs. .41). If all the items in the set were related, separate imagery (.60) was better than interactive imagery (.55).

Thus with no permanent relation between the target word and the cue, recall was helped by the establishment of a new relation between them by means of interactive imagery. If they were already related categorically, the establishment of new relations had mixed effects. In the paired array the new relations did help recall, but in the triplet array they seem to have interfered.

Finally, consider the recall of one of the exemplars in a set, with the other as a cue, shown in Table 6. The pattern of performance is essentially the same as those already discussed. Recall was once again best in cases in which the cue and the target were permanently related, with a mean of .25 if that was the only permanent relation in the set, and a substantially higher mean (.54) if all the words in the set were related. Mean levels of recall were again much lower if

Table 6. Exemplar to Exemplar Recall: Experiment 3

PERMANENT RELATIONS IN SET	EXAMPLE with left cue	SEPARATION INSTRUCTIONS	INTERACTION INSTRUCTIONS	$\underline{M}$
NONE	BOAT TENNIS SPINACH	.04	.06	.05
CUE AND THIRD WORD	ALCOHOL VODKA PINK	.07	.12	.10
TARGET AND THIRD WORD	FOOTWEAR SODIUM SLIPPERS	.08	.15	.11
CUE AND TARGET	ANIMAL MAYOR GOVERNOR	.25	.25	.25
ALL WORDS	FUEL GASOLINE KEROSENE	.58	.50	.54

the cue and target were not permanently related, but the cue was related to the third member of the set by being a member of the named category (.10) or if the target was a member of the named category (.11). Sets in which the words were all unrelated again produced the worst recall (.05).

As in the other measures, instructions had different effects for different types of items. It is important to keep in mind that interactive images were never of the two exemplars; thus in the present cases the interaction was never between the cue and target. If the cue and target were not permanently related, recall was better after interactive processing than after separation, although the difference was not reliable in the completely unrelated sets (.06 vs. .04). The small size of the effect is not surprising, because of the fact just mentioned that the cue and target in this measure were never studied in interaction with each other. The small benefit of interaction appeared if each of the words had been processed in interaction with the same categorical label (.12 vs. 07 for interaction and separation respectively in sets in which the cue was related to the name; and .15 vs. .08 if the target was related to the name). Such mediation by the category name will be discussed in more detail in a later section.

If the cue and target were related, study instructions had no effect on recall, with mean levels of .25 in both conditions. If all the items in the set were related, recall was better after study by separate imagery (.58) than after interactive imagery (.50), as in the previous measures.

Thus a fairly consistent pattern can be drawn from the results of the three measures. Recall is always most likely if there is a permanent relation between the cue and target words, and is especially good if all the items in a studied set are related. If they are not related, there is a slight advantage from the presence of other permanent relations within the set. If there is no permanent relation between the cue and target, the establishment of a new relation by means of interactive imagery helps recall, although it does not bring it up to the level of recall of permanently related words. New relations generally do not help, however, if the words were already related categorically.

There are other variables that had effects on performance which complicate the pattern, although they do not change the basic story as described above. These will be presented in detail in the next section, along with full results of the statistical analyses.

Other Results. The results will now be presented in more detail. Included in this section will be the effects of the manipulations of presentation array, spacing, and which item was the target, as well as the interactions of these factors with the others previously discussed.

Recall of Category Names. The different levels of recall for words from the different types of items, described in the previous section, were based on a large main effect of item type, $F(4,316)=228.4$, $MSe=0.013$. The effects of instructions were revealed in an interaction between instructions and item type, $F(4,316)=5.04$, $MSe=0.013$.

The type of item also interacted with the presentation array, $F(4,316)=5.45$, $MSe=0.013$. In most types of items, the simultaneous and paired arrays did not differ, but there were two exceptions. If the only permanent relation in the set was between the cue exemplar and the name, the paired array produced better recall of the names (.60) than did the triplets (.44). With a strong relation between the cue and target, then, recall was better if studied in the absence of any unrelated items. The more narrowly focused study may have produced more precise records for recall; Begg (1982) has suggested the analogy of a narrow bandwidth producing high fidelity. If there was a relation only between the cue and the other exemplar, the name was better recalled if it was studied in the triplet list (.18) than in pairs (.13); the permanent relation helped only if the related words were seen together.

There was also an effect of spacing on the recall of the names, $\underline{F}(1,79)=6.30$, $MSe=0.0013$, with spaced presentations (.34) producing better recall than massed presentations (.31). The difference was reliable only in the completely related sets, producing an interaction between spacing and item type, $\underline{F}(4,316)=3.10$, $MSe=0.034$.

<u>Recall of Exemplars with Category Names as Cues</u>. The effect of the different types of item in which the words were studied was confirmed in a substantial main effect, $\underline{F}(4,144)=143.8$, $MSe=0.0038$. The effects of instructions, which were different for the different types of items and in the two presentation arrays, are based on an interaction between instruction and array, $\underline{F}(1,36)=4.50$, $MSe=0.0003$, and a three-way interaction between those two factors and item type, $\underline{F}(4,144)=2.73$, $MSe=0.0038$. The interactions occurred because in the list of pairs, interactive imagery always led to better recall than separate imagery; but in the triplet array, words that were permanently related to the cues were recalled better with separate imagery than with interaction.

The presentation array itself had an effect in interaction with the type of item, $F(4,144)=5.37$, $MSe=0.0038$. Unlike recall of category names, if the cue and target were related, performance was better after study of the sets in triplets than in pairs (.70 vs. .48 for completely related sets, and .47 vs. .40 if only the cue and target were related). For the other types of sets, there was either no reliable difference between the two arrays, in the case of completely unrelated sets and sets in which the third word was a member of the named category, or, in the cases in which the target was related to the other word, the paired array was slightly better (.12 vs. .08). If there was no permanent relation between the cue and target, then, the presence of a third word in the study episode did not help, and sometimes interfered with the formation of an association between the tested items.

Finally, in the paired array, there was a tendency for words presented on the left side of the screen to be recalled better than words shown on the right (.28 vs. .20), resulting in a target by array interaction, $F(1,36)=7.12$, $MSe=0.0003$, as well as a main effect of target, $F(1,36)=12.4$, $MSe=0.0003$. In the list of pairs, the pair with the exemplar on the left was always encountered earlier in the list than the corresponding pair with the exemplar on the right; the effects therefore mean that given the category name as a cue, subjects were slightly better able to recall the first word they saw with it.

Recall of Exemplars with Exemplar Cues. The effect of item type as described previously was based on a large main effect, $F(4,316)=195$, MSe=0.0087. The effects of instructions were revealed in an interaction with item type, $F(4,316)=4.20$, MSe=0.0087. Instructions also appeared in a three-way interaction with item type and spacing, $F(4,316)=2.80$, MSe=0.022, because in the completely related triplets, and in spaced items in the paired array, interactive imagery was worse than separation, but in massed items there was no difference.

Performance was better if the sets had been studied in triplets than in pairs (.28 vs. .14), $F(1,79)=30.4$, MSe=0.0013. In the paired array, the cue and target were never on the screen together: they were never included in the same episode of study and so there was no chance for an episodic relation to be formed between them. Not surprisingly, then, the patterns of recall over the different item types differed slightly in the two arrays, producing an interaction between item and array, $F(4,316)=5.6$, MSe=0.0087. There was no difference in the paired list among the three types of item in which the cue and target were not permanently related. Recall was extremely low in every type, ranging from .02 to .07, with a mean of .04. Moreover, if the two exemplars were related to each other but not to the category name, recall was much lower (.15) than in any other case of recall in which the cue and target were related. It was, however, higher than if the cue and target were not related, suggesting that there was in fact some benefit from the permanent relation, although very small. Only in cases in which both of the exemplars were studied with the name of their category was recall relatively good in the paired array (.45).

Thus a permanent relation between two words in a list is not of much help in their cued recall if the two words are studied neither with each other, nor with the name of their shared category. Perhaps, then, it is not sufficient that the two categorical exemplars be tagged in memory; rather, the occurrence of the relation between them may have to be tagged. Note that if related cue and target exemplars were studied together in the triplet array, recall was relatively good (.36). The results are consistent with those of the first two experiments, in which recall was very poor for semantic relatives that were not primed with their categorical labels but only appeared separately, each with an unrelated item. If the cue and target did not occur together and so the occurrence of the relation could not be tagged in permanent knowledge, other tagged relations may have mediated in recall to some degree. This can be seen in the good recall in the paired array if all three items in the set were related, so that the cue and target were each seen with their categorical label. In such cases, the category name may play a mediating role, as will be examined in the next section.

Another difference between the two presentation conditions should be pointed out. Whereas in the paired condition the various items with unrelated cues and targets did not differ from each other, in the triplet presentation, recall was slightly better if one of the items was related to the third member of the set (.14 if the cue was related, and .19 if the target was, as opposed to .08 if none of the words were related). This is further evidence that having the entire set present in a single study episode could allow recall to occur by means of mediation by other items. However, the additional routes for recall were not nearly as effective as a direct association would have been.

As in the other measure of exemplar recall, the words that were shown on the left side of the screen were recalled better than the words on the right (.24 vs. .18), $F(1,79)=5.4$, $MSe=0.0013$. The difference was more pronounced if the cue and target were related, or if the target was related to the other member of the set, producing an interaction with item type, $F(4,316)=3.6$, MSe=0.0087.

Spaced items in the paired array were recalled more poorly than the massed items (.13 vs. .16), in spite of the fact that the same items were the better recalled in the simultaneous presentation (.29 vs. .26). The interaction was reliable, $F(1,79)=6.4$, MSe=0.0011. Spacing also interacted with instructions, $F(1,79)=5.99$, MSe=0.0011, with massed better than spaced (.23 vs. 20) with interactive imagery, and spaced better with separate imagery (.22 vs. .19). This was the case only for recall of the left words, however; for right exemplars, there was no effect of spacing, producing a three-way interaction with recall target, $F(1,79)=7.6$, MSe=0.0011.

Summary of Item Recall

The results quite clearly point to the presence or absence of permanent relations as the primary factor in associative recall. In all measures of recall, performance was much better if the cue and target items shared a permanent relation, and recall was better still if all the items in the set were permanently related. This was true whether the entire set had been seen together, in the triplet array, or it had been broken up and seen in different parts of the list, in the paired array.

If the cue and target were not permanently related, the establishment of a new relation between the items by means of the interpretive process at study helped recall. In all such cases, performance was better after interactive imagery than it was after separate imagery. The addition of a new relation between items did not help if they were already related. Recall of related items was in many cases better after separate imagery than if interactive imagery had been used. In the other cases, there was no difference between the two types of study.

Many authors have said that relational information is necessary for successful cued recall (e.g. Begg, 1982; Einstein & Hunt, 1980; Hunt & Einstein, 1981). Here, we can see that the most useful kind of relational information -- whether because it is the most important, or because it is the most easily used -- is that which is a permanent part of knowledge. In its absence, newly established relational information regarding the two items helps. In the following section, it will be seen that additional benefit may be obtained from a mediating influence of other relational information.

Mediated Recall

The question to be considered in this section concerns whether relational information, of either type, that relates the cue and target to other available knowledge can be used in the process of associative recall. That is, if both the cue and the target are related to something else in memory, can that common piece of information be used to mediate in the retrieval of one from the other?

Mediated recall was examined by analyzing exemplar recall with the other exemplars as cues, in cases in which the two exemplars were not permanently related to each other. There were also no newly established relations between the cue and target items, because interactive images never included the two exemplars in a set. Thus there was no relation at all between the cue and target items in the associative recall task. However, the two items had been seen with the same categorical label. Any successful recall can therefore be assumed to have occurred through the mediation of the category name.

Three types of item fit the requirements for inclusion in the analysis. Refer back to Table 3 for an example of each; exemplar to exemplar recall is shown in the column on the left. One type of set is those in which the cue exemplar was related to the category name but the target word was not. The example of this type of set is ALCOHOL - VODKA, PINK, in which the cue, VODKA, is a member of the named category, ALCOHOL. A second type of set includes a target item that is related to the category name and an unrelated cue; for example, FOOTWEAR - SODIUM, SLIPPERS. The third type is the sets containing no permanent relations, such as BOAT - TENNIS, SPINACH.

There were three measures of interest. The proportion of sets in which both the category name and the target exemplar were recalled indicates the degree of successful mediated recall. Sets in which only the name was recalled suggest that although the name could be retrieved given the cue, it did not provide a mediating link to the other exemplar. Sets in which only the target exemplar was recalled indicate a direct association between the two exemplars without any mediation by the categorical name. The latter measure is expected to yiel the lowest performance, because such an association could be based neither on permanent relations, nor on interactive study. It can be best seen as a baseline measure.

Because in the paired condition recall in the appropriate types of sets was so low, the more dedicated analysis seemed unlikely to provide meaningful data. Therefore, only the items studied in intact triplets will be discussed in this section.

Table 7 shows the levels of mediated recall. The columns for total recall show that overall, the most recall occurred in the sets with permanent relations between the category names and the cues, followed by sets

Table 7. Mediated Recall in the Triplet Array: Experiment 3

SET TYPE: NAME AND CUE RELATED e.g.. ALCOHOL - vodka. pink*

RECALL OF:

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.08	.34	.03	.42	.11	.05
INTERACTION	.13	.32	.04	.45	.17	.02

NAME AND TARGET RELATED (FOOTWEAR - sodium, slippers)

RECALL OF:

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.11	.02	.02	.13	.13	.02
INTERACTION	.17	.07	.07	.24	.24	.05

NO WORDS RELATED (BOAT - tennis, spinach)

RECALL OF:

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.03	.01	.03	.04	.06	.00
INTERACTION	.05	.13	.04	.18	.09	.02

* Examples are cases in which the left exemplar was given as the cue.

in which the targets were related to the names. The lowest total recall, consistent with the previous measures, was for completely unrelated sets. The effect of item type was reliable, $\underline{F}(2,76)=40.4$, MSe=0.0011.

There was a main effect of instructions, $\underline{F}(1,38)=6.6$, MSe=0.0002, with interactive imagery generally leading to better recall than separate imagery. There was also a reliable difference among the three measures of recall, $\underline{F}(2,76)=23.7$, MSe=0.0018. Names were recalled alone in more cases (.15) than together with the target exemplars (.09), and, as expected, the exemplars were rarely recalled alone (.04).

More importantly, the measure interacted with the type of item studied, $\underline{F}(4,152)=24.5$, MSe=0.013. In the sets with cues related to the names, the most recall (.33) was for the names alone. The names and the target exemplars were less often recalled together (.11), and the exemplars were hardly ever recalled alone (.03). Thus if the categorical name is related to the cue but not to the target exemplar with which it was studied, mediated recall does not often occur. Recall is relatively good for words that are permanently related to the cue, as always, but that does not necessarily help in providing access to anything else. The lack of a relation with the target prevented it from being accessed. Mediated recall was somewhat more likely to occur after interactive imagery provided a new relation (.13), than after separate imagery (.08). Interactive imagery did not produce better recall of the name alone, and recall of the exemplar alone was not better after interaction than separation (.04 vs. .03). Thus the benefit of forming a new relation was specifically for mediated recall.

The pattern was different if the targets were related to the names. Although recall was generally lower than for the former items, subjects were relatively more likely to recall the name and cue together. That is, the names were recalled much less often in total than if they were related to the cues (.19 vs. .44). But if they were recalled, they were more likely to be produced together with the other exemplar. All of the measures of recall were somewhat higher after interactive imagery than separate imagery. The episodic relation created by interactive imagery benefitted recall of the mediator, which had no semantic relation with the cue (.24 in total after interaction vs. .13 with separation). In turn, it also allowed greater recall of the target exemplar (.24 vs. .13).

In the completely unrelated triplets, with separate imagery recall was uniformly low across the three measures; in fact, there was very little recall at all, as was expected. Recall was slightly higher after interactive imagery; particularly the recall of the names alone (.13), which was better than recall of the exemplars (.04) or of the two together (.05). Despite the difference between the two instructional conditions in the recall of isolated names (.13 vs. .01), there was virtually no difference in recall of isolated exemplars (.04 vs. .03). The creation of episodic relations, then, did not lead to mediated recall; the only effect was to increase recall of the mediator itself. Perhaps if an item is included in two different images, interacting with a different item in each, it may in fact act as two different items. It has been suggested elsewhere (Begg, 1983; McGee, 1980) that a word may lose its separate identity to some extent when imagined in interaction with another item. Thus the same word imagined as interacting with two different items may take on two identities that are sufficiently different to prevent it from performing a mediating role. The name interacting with one exemplar may not be seen as the same thing as that in the image with the other exemplar, and so, although accessed by the first, may be unable to provide access to the second. The reason this was not a problem for mediated recall in the other two sets may have been because the mediator was permanently related to one of the words, and so reliance on the episodic relation was necessary only for recall of the other word. In the absence of any permanent relation, the process relied upon both interactive images.

For illustrative purposes, the levels of joint recall of the name and target exemplar that would be predicted if the two were independent are shown in the last column of Table 7. Each predicted proportion was calculated from the product of the total levels of recall of the name and the exemplar for that condition, as they are shown in the fourth and fifth columns of the table. A look at the actual levels of joint recall, and at the predicted levels, suggests that the only cases in which the two items clearly were recalled together more than would be expected if they were independent, are the cases in which the name and target shared a permanent relation.

In summary, mediated recall was most likely to occur if the mediating word and the target were permanently related. If, instead, the mediating word was related to the cue, it was well recalled itself but did not often provide access to the target word. Mediated recall, then, depends upon permanent relations. New relations provide some benefit in getting to the mediator if it is not already related to the cue, but the benefit is not enough to make up for the lack of permanent associations.

Conclusions

The results of the third experiment showed that the primary determining factor in recall was a permanent relation between the cue and target words. Furthermore, if all three items in a set were permanently related to one another, recall was even higher than with a relation only between the cue and target. This finding is consistent with the results of the first two experiments. There, recall of the target item was good if it had been seen with its categorical label, but was even better if both members of the category had been seen with the label. Access to other, relevant relational information in permanent knowledge appears to be of benefit for the recall of the target item. Further evidence of this in Experiment 3 is the fact that in the absence of a permanent relation between the cue and target, membership of either of those words in a permanent relation with the third word in the set was of some benefit to recall.

The establishment of a new relation between items did not help recall if those items were already related. In fact, if the permanent relational information was particularly strong, as in cases in which the whole set was related, the addition of a new relation often hurt recall to some extent. However, if the cue and target did not share an association in permanent knowledge, recall was improved by the establishment of a new relation between them at the time of study.

Once again, then, the two types of relational information show very different patterns in their effects on associative recall. What is interesting about the result in the present experiment is that the two types of information were encountered within the same episode of study. In the introduction to Experiment 3, the possibility was raised that the independence observed in the first two experiments might be due to independence of different study episodes. But the present results show clearly that even when the two types of information are present in the same studied set, they show very different levels of recall. Moreover, the pattern of recall of items within a set differs substantially as a function of the pattern of relations among the items within that set. The present results allow us to conclude with more confidence that the two kinds of information are in fact different, and are used differently in recall.

The levels of performance in the measures of mediated recall were in general very low, which might place some constraints on interpretation of the results. We can say that mediated recall was most likely to occur if the mediating item and the target word were permanently related. If the mediating word was related only to the cue, it was well recalled itself, as in any case in which the recalled word is permanently related to the cue. But it was unlikely to provide access to the other exemplar in the set, the target word. Mediated recall, then, seems to be determined by the nature of relational information in permanent knowledge. A newly acquired relation improved access to the mediator if it was not permanently related to the cue. But it is difficult at this point to say any more about its effects. In the next experiment, the question of mediated recall is examined further.

Chapter 5

EXPERIMENT 4

The purpose of the next experiment was to examine in a more dedicated way the process of mediated recall. The interest was in the role of a common study context in creating an association in recall between words that were not themselves related. The same basic methodology was used as in Experiment 3, but an attempt was made to increase recall to levels better suited for comparisons among different conditions of study. To this end, shorter lists were used, and each subject saw only one type of set; the different possible relations among the three words in a set were varied between subjects. In addition, the sets were always presented with the three words on the screen simultaneously. In the previous experiment, performance was too low to enable meaningful comparisons if the mediation occurred across different studied pairs.

Finally, because the interest was primarily in recall mediated by the common context of a categorical label, the labels were never used as cues on the tests of recall in the present experiment. Rather, one of the exemplars was provided as a cue in each case, and the measures of interest were the proportion of cases in which both the name and the other exemplar were recalled, or either one alone.

The goal was once again to determine the probability of mediated recall, given different kinds of relations among the items. In some cases, the cue and target were directly related to each other. If they were not, there was sometimes a permanent relation between the cue and the category name with which it was seen, and sometimes a relation between the name and the target exemplar. In addition, in some cases a new relation was formed, by means of interactive imagery, between the name and the cue, and between the name and the target. Thus we can see whether recall can be mediated by means of either permanent or newly formed relations between one of the words and another item present in the study episode. Balota and Lorch (1986) have found that permanent semantic relations can play a mediating role in some cognitive tasks, but not others. The purpose here is twofold. We will look at whether such permanent relations can serve to form a mediating link in the recall of items that are not otherwise related. We will also determine whether the same role can be fulfilled by newly acquired relational information.

Method

Subjects

One hundred and thirty-four students in the introductory psychology course participated in the experiment for course credit. They were tested in groups, which were randomly assigned to sixteen conditions, with from 7 to 9 in each condition.

Materials and Procedure

Twenty of the categorical triplets from the previous experiment were used. Four lists were constructed, each containing all twenty of the categorical names, and the two exemplars of each category that were used before. Each list corresponded to one of the types of item in the previous experiment. In one list, the three words from each category were always presented together. In another list, each pair of related exemplars was presented with the name of a different, unrelated category. In a third list, the words were all rearranged, so that the sets consisted of three unrelated words. In the fourth list, the category name and either the left or the right exemplars were related; the third item in each set was a member of one of the other categories.

Each list was recorded on videotape from a computer-generated display, and shown on a television monitor at the rate of 10 seconds for each set. The sets were shown in a triangular array, with the categorical label at the top of the display, and the two exemplars below it to the left and right.

Two groups studied each of the lists. For each list, one group studied the sets by forming a separate mental image for each word. The other groups were instructed to form two interactive images for each set, one including the category name and the exemplar on the left, and another for the name and the exemplar on the right.

Two tests of cued recall were prepared for each group. Half the subjects were given the word that appeared on the left of each set as a cue and were asked to write down the other two words in the set. For the other half, the cues were the words that had been on the right. The test took about five minutes to complete.

Results and Discussion

In the first part of the section, the total recall of the categorical contexts, and of the target exemplars will be briefly considered. Following the measures of total item recall, the results of the more dedicated analyses of mediated recall will be presented. The important effects are those resulting from the manipulation of the presence of permanent relations within the sets, and the results of the different imagery instructions. In general, the changes in the design that were aimed at improving recall were effective; the levels of performance are substantially higher than in Experiment 3. However, the pattern of results is very similar.

Item Recall

Two separate sets of analyses were conducted. One was for the two types of sets in which the category name was permanently related to just one of the exemplars. The other analysis included the sets in which all the words were permanently related, none were related, and only the two exemplars were related.

Recall of Category Names. Table 8 shows the recall of the category names. As in the third experiment, recall was best for items studied in completely related sets, with a mean of .86. Also as before, recall was somewhat lower, but also very good, if only the cue and target were permanently related, with a mean of .77. Recall was, as usual, much lower in any case in which the word given as a cue was not a member of the tested category. Names were recalled at a mean level of .26 in unrelated sets, .33 if the cue was related to the other exemplar, and .27 if the other exemplar was a member of the target category. The main effects of item type in the two analyses were substantial; $F(2,95)=119.3$, $MSe=0.030$ in the analysis

Table 8. Exemplar to Name Recall: Experiment 4

PERMANENT RELATIONS IN SET	EXAMPLE with left cue	SEPARATION INSTRUCTIONS	INTERACTION INSTRUCTIONS	M
NONE	BOAT TENNIS SPINACH	.16	.35	.26
CUE AND THIRD WORD	ANIMAL MAYOR GOVERNOR	.12	.53	.33
TARGET AND THIRD WORD	FOOTWEAR SODIUM SLIPPERS	.18	.36	.27
CUE AND TARGET	ALCOHOL VODKA PINK	.74	.79	.77
ALL WORDS	FUEL GASOLINE KEROSENE	.89	.82	.86

including completely related items (labelled "all" on the table), unrelated items ("none") and items with related exemplars ("cue and third word"); and $F(1,31)=72.2$, MSe=0.056 in the analysis of items in which the name was related to one of the exemplars ("target and third word", and "cue and target").

Adding a new relation by means of interactive imagery had different effects for different types of items, as in Experiment 3. In the first three item types shown on the table, in which the cue and target were unrelated, interactive imagery produced better recall than was obtained after separate imagery. This was also the case arithmetically in the fourth row, where only the cue and target were related, but the difference was not reliable (.79 vs. .74). In the bottom row, however, with all the items in a set permanently related, separate imagery was better than interaction (.89 vs. .82). The analysis showed main effects of instructions, $\underline{F}(1,95)=26.3$, MSe=0.030 in the first and $\underline{F}(1,31)=4.66$, MSe=0.048 in the second, and an instruction by item interaction in the first which included "all", "none", and "cue and third word" items, $\underline{F}(2,95)=16.44$, MSe=0.030.

Thus the pattern of recall of the categorical names is the same as it was in Experiment 3. If there was no relation between the cue and target, recall was relatively low; but it was substantially better if a new relation had been created by means of interactive imagery. If the cue and target were permanently related, the imagery instructions made little difference; and if all the words in the set were related, recall was better after separate imagery than it was after interaction.

Recall of Exemplars. The pattern was somewhat different for the recall of one exemplar in a set, cued by the other exemplar. Once again, the data were analyzed in two separate analyses, although they are shown together in Table 9. The items in the first analysis are labelled on the table as "none", "cue and target", and "all". The second analysis included the "cue and third word" and "target and third word" items.

As always, mean recall was worst in sets in which none of the words were related (.10). Recall was somewhat better if either the cue (.25) or the target (.28) was related to the third word in the set, meaning it was a member of the named category; the two did not differ from each other. Performance was, as always, substantially better if the cue and target were permanently related to each other (.64) and better yet if all the words in the set were related, with the cue and target both being members of the named category (.76). The pattern was confirmed with a large main effect of item in the analysis

Table 9. Exemplar to Exemplar Recall: Experiment 4

PERMANENT RELATIONS IN SET	EXAMPLE with left cue	SEPARATION INSTRUCTIONS	INTERACTION INSTRUCTIONS	X
NONE	BOAT TENNIS SPINACH	.10	.10	.10
CUE AND THIRD WORD	ALCOHOL VODKA PINK	.23	.27	.25
TARGET AND THIRD WORD	FOOTWEAR SODIUM SLIPPERS	.17	.39	.28
CUE AND TARGET	ANIMAL MAYOR GOVERNOR	.62	.66	.64
ALL WORDS	FUEL GASOLINE KEROSENE	.80	.72	.76

of "all", "none", and "cue and target" items, $F(2,95)=133.1$, $MSe=0.031$, and no main effect of item in the analysis of sets in which one exemplar was related to the name.

Instructions had a different effect on the recall of exemplars than it had on the recall of names. This is not surprising if one considers the nature of the imagery task. Recall that in the interactive imagery condition, subjects formed images of each of the exemplars in interaction with the category name. They never imagined the two exemplars interacting with each other. Thus in the present measure, interactive imagery did not encode the cue and target together, as it did in the previous measure of the recall of the names. There was no effect of imagery instructions in the sets in which none of the words were related (.10 in both conditions) or in the sets in which the cue was related to the name (.27 for interaction and .23 for separation; not a reliable difference). The only case in which interactive imagery produced better recall than separation (.39 vs. .17) was if the target exemplar was related to the name. If the cue and target were related, the results were the same as in the other measure: there was no reliable difference if that was the only relation (.66 with interaction and .62 with separation) and a small advantage for separation if all the words were related (.80 with separation vs. .72

with interaction). The first analysis, then, showed no effects of instructions. The second analysis showed an interaction between instructions and the item types, $\underline{F}(1,31)=13.70$, MSe=0.009.

We can conclude that forming a new relation by means of interactive imagery does not help if the words were already permanently related. If the cue and target are not related permanently, interactive imagery is of no help if the image does not include the cue and target words. The only exception is if the target exemplar is permanently related to the name, in which case interactive imagery of the exemplars and the name together helped recall of the target exemplar as much as it helped recall of the name; this parallels the effect found in the analysis of mediated recall in Experiment 3, and will be discussed in the next section.

Finally, it should be mentioned briefly that two analyses were conducted which included recall of both the exemplar targets and the category names. Because the patterns were different for recall of the two different targets, there were interactions between item types and targets, $\underline{F}(2,95)=93.4$, MSe=0.012 in the first analysis and $\underline{F}(1,31)=76.3$, MSe=0.030 in the second. Further, because of the different effects of instructions on the two recall targets for some types of items, there was, in the first analysis, an instruction by target interaction,

$\underline{F}(1,95)=39.0$, MSe=0.012, and a three-way interaction with item type, $\underline{F}(2,95)=11.7$, MSe=0.012.

Summary of Item Recall. As in the previous experiment, it is clear that recall was most successful if the cue and target shared a permanent relation. The probability of recall was particularly high if all the words in a set were categorically related. Performance was much worse if the cue and target were not permanently related, although in the recall of exemplars there was a small advantage if either of the words was related to the category name. If the cue and target were not related permanently, recall was helped if they had become related in the course of study by means of interactive imagery. The formation of a new relation did not help recall, however, if there had already been a permanent relation.

Mediated Recall

The data will be discussed in terms of two analyses. As in the analysis of item recall, the first compared related triplets, sets with related exemplars, and unrelated triplets. In the second, the two types of items with a relation between the name and one exemplar were compared. The three measures of interest were the proportions of cases in which the category names were recalled alone, the exemplars were recalled alone, and both were recalled together.

Table 10 indicates that the different types of items showed very different patterns of recall over the three measures, producing reliable interactions in both analyses, $F(4,190)=98.0$, $MSe=0.02$ in the first, and $F(2,62)=80.5$, $MSe=0.021$ in the second. The related triplets, as always, showed the highest overall levels of performance. This condition provided alternate ways to retrieve the target exemplar, using either the direct categorical relation between the cue and target, or mediation by the name that was seen with both. The bulk of the recall in the related triplets was of both the name and the target exemplar together (.72). Subjects seldom recalled the name without also producing the exemplar in this condition (.14), and recall of only the exemplar was even more rare (.05).

In the items with related exemplars, recall of both the name and the exemplar had a mean of .27, and the exemplars were recalled alone with a mean of .38; the names were rarely recalled alone (.05). Clearly the strong relation between the cue and target exemplars allows direct retrieval without the use of the context, with which they were not semantically related.

In the unrelated triplets, the highest level of recall was for the names alone (.18). Recall of the exemplars was poor, whether alone (.03) or together with

Table 10. Mediated Recall: Experiment 4

SET TYPE: NO WORDS RELATED e.g., BOAT - tennis, spinach

	RECALL OF:					
	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.08	.08	.03	.16	.11	.02
INTERACTION	.08	.27	.02	.35	.10	.04

NAME AND CUE RELATED (ALCOHOL - vodka, pink)

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.19	.56	.04	.75	.23	.17
INTERACTION	.19	.59	.08	.78	.27	.21

NAME AND TARGET RELATED (FOOTWEAR - sodium, slipper

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.16	.02	.00	.18	.16	.03
INTERACTION	.30	.06	.09	.36	.39	.14

EXEMPLARS RELATED (ANIMAL - mayor, governor)

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.10	.00	.52	.10	.62	.06
INTERACTION	.44	.09	.23	.53	.67	.36

ALL WORDS RELATED (FUEL - gasoline, kerosene)

	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	PREDICTED JOINT RECALL
SEPARATION	.77	.12	.03	.89	.80	.71
INTERACTION	.66	.16	.06	.82	.72	.59

the names (.08). Apparently mediated recall did not occur in these items, and the better recall of names than exemplars that has been observed elsewhere is again apparent.

If only the cue and the name were related, recall of the name was very good (.58). Recall of the unrelated target was very poor (.06 alone, and .19 with the name). This is the usual pattern of good associative recall with related items, and very little recall if they are unrelated. Clearly, then, mediation did not occur if the target was not permanently related to the name, as was the case in Experiment 3.

In contrast, if the name and the target exemplar were related but the cue was not, although recall was fairly low, the name and the exemplar were almost always recalled together (.23, as opposed to .04 for the name alone and .05 for the exemplar alone). Recall of the target exemplar in such cases did appear to be mediated by recall of the name, again replicating the pattern in the comparable sets in the previous experiment.

As in the previous chapter, the last column of the table shows the levels of joint recall of the name and exemplar predicted on the basis of independence. As before, they were calculated from the proportions shown in the table, simply for illustrative purposes. Once again, the only clear difference from independence can be seen in the two cases in which the name and the target were permanently related.

Item type and measure interacted with instructions in the analysis of the first three types of item, $\underline{F}(4,190)=17.9$, MSe=0.02. Instructions for interaction led to slightly lower recall of the two targets together than separation in related triplets (.66 vs. .77), but led to substantially better recall of both together in the sets with a relation only between the two exemplars (.44 vs. .10). Interaction also improved recall of the two together if the target was related to the name but the cue was not (.30 vs. .16). As usual, then, interaction helps if there is no permanent relation between the cue and target, but is of no added benefit if there is one. Similarly, as in Experiment 3, in the unrelated sets recall of the mediator was higher after interactive imagery (.27) than after separation (.08), although it did not help recall of the exemplar (.02 vs. .03) or of the two together (.08 vs. .08). In all other comparisons interaction was slightly, but not reliably higher, with one important exception. Recall of the exemplar alone in cases in which that exemplar and the cue shared the only permanent relation was much higher in the separate imagery condition (.52) than after interactive study (.23). Once again, an episodic relation was of no benefit in comparison with cases with no new relation, if a permanent relation already existed; particularly if the episodic relations brought in another word. Any relations with a mediator were unnecessary if there was a direct permanent association between the cue and target available for use: in this case such a relation interfered substantially.

Summary of Mediated Recall. In summary, for mediated recall to occur, there had to be a permanent relation between the mediating contextual item and the target word. There also had to be some kind of relation between the contextual item and the cue. The relation including the cue could be a permanent categorical relation, as in the completely related triplets. It could also be a newly established relation, as in sets in which the name and the target were permanently related and each of the exemplars had become related to the name by means of interactive imagery. Under any other conditions, a relation of either type between the cue and target led to good recall of only that target; mediated recall did not occur.

Conclusions

The results of the fourth experiment confirm those of the third. The higher levels of performance allow a better look at the use of mediating contextual items in cued recall. Although many of the scores were substantially higher in Experiment 4, the cases in which there was virtually no recall in Experiment 3 were again extremely low. The fact that providing an opportunity for maximal performance was successful under some conditions suggests that in the other cases there really was no way to recall the items. Alternatively, those cases may require very different conditions to allow recall; in either case, they are clearly different. The very low recall was generally in cases in which there were no relations of either type between the cue and target items.

A permanent relation between an item and the cue allowed relatively good recall of that item, but had little effect on the recall of the third word. Thus if the categorical relation was between the two exemplars, recall of the target exemplar was good, but the category name was poorly recalled. If the cue was a member of the named category, the name was recalled often, but the other exemplar was much less so.

The effect of creating new relations between items was generally to improve cued recall only of those items. Interactive images always contained one exemplar and the category name; therefore, interactive imagery improved the recall of names. The only case in which the creation of an episodic relation led to mediated recall of the other exemplar was if the target item was a member of the named category. In such cases, the newly formed relation between the cue and the name provided access to the mediating name; with the mediator thus accessed, the permanent relation with the target ensured that it too was recalled.

The conclusions concerning mediated recall that were made tentatively on the basis of data from Experiment 3 have been confirmed. Mediation in recall appears to depend upon the availability of relations in permanent knowledge. The effect of newly established relations is to increase the likelihood of access to the common contextual items. They do not, however, enable the contextual items to act as mediators and provide access to the other items. Perhaps, as suggested earlier, this is because of encoding variability. A category name imagined in two different images with different items may be encoded quite differently in each case. For the contextual items to act as mediators, they must share permanent associations with the target items in memory.

In Experiment 1, an analysis was presented which showed that exemplars that were associated with category names, and thus recalled when those names were provided as cues, were not associated with other exemplars of the same categories. The conclusion was that the exemplars of a category are independent of each other, each of them being associated with the higher order category name in an independent relation. The measure of mediated recall in Experiment 4 supports that analysis, giving evidence of the existence of associations in memory between categorical items and the higher order categorical labels, and their mediating role in recall.

The results are consistent with the ideas of people such as Mathews (1977), Mathews and Tulving (1973), and Estes (1975), cited previously. They and others have proposed a system in which categorical items are associated in memory with the higher order categorical names, and in which recall of an exemplar is mediated by that higher order unit. The present experiment provides an example of how a relation with a category name in permanent memory can mediate in the recall of an exemplar

The pattern of results observed in Experiment 4 also shows the use of the two different kinds of relations together in recall. Although the mediated recall of one exemplar given the other, unrelated, exemplar as a cue required a categorical relation between the target and the mediating name, mediated recall was most likely to occur if there was also an episodic relation linking that name with the cue. The pattern shows clearly that relations in permanent memory, and new relations acquired at study, can work together to provide all the information needed for maximal recall.

Chapter 6

EXPERIMENT 5

Interactive imagery is just one way of processing items together and encoding them in a common trace. Any type of study in which items are interpreted in relation to each other should have the effect of creating a new relation between them, by causing them to be encoded in a common trace.

One such type of processing is to consider similarities or differences between the items in a set. Similarity and contrastive processing have been investigated in the past (Begg, 1978b; Epstein, Phillips & Johnson, 1975), and the effects on recall have been found to differ depending on whether the words in each comparison were permanently related, such as CAT - DOG, or unrelated, such as CAT - TREE.

Instructing subjects to study items by making similarity or contrast comparisons therefore provides us with another way of controlling the formation of new episodic relations. In this way, Experiment 5 tests the generality of the previously reported results. In some cases of cued recall in the present experiment, judgments of similarity or contrast have been made at study between the target word and the cue; presumably, interpretation of the two in relation to each other established a new relation between them. In other cases, the two words remained unrelated, because they were not the two words that were compared in the judgment at study. The design also allows us to compare the effects of relatively stronger or weaker episodic relations. We can expect, following the results of Begg (1978b), that the relation between previously unrelated items will be a strong one if the instructions are for the processing of similarities, and weaker if they are for contrastive study.

In Experiment 1, the items were studied by means of similarity and contrast judgments. In that experiment, recall of newly associated pairs was so low that the differences between the two types of study were not meaningful. The present paradigm, however, as used in Experiments 3 and 4, has been more conducive to the establishment of new relations and their recall. It therefore offers an opportunity to observe the effects of these types of study.

The first four experiments clearly established the difference in the effects of adding a new relation between words that were already related, and between words that were previously unrelated. In the present experiment, the focus is entirely on words that share no relation in permanent knowledge. The similarity or contrastive processing was always done for unrelated words, and so the tested relations are newly established ones. In some cases, however, one of those words was related categorically to the third word in the set, allowing the possibility of mediation by both well known and newly learned relations.

Method

Subjects

The subjects were the same students who participated in Experiment 4. They were given the new lists after having performed an intervening task. The intervening task consisted of learning two short lists of pairs of unrelated words and completing tests of cued recall for them. The groups were randomly assigned to sixteen conditions. Altogether, the experimental sessions lasted approximately 50 minutes.

Materials and Procedure

Two new lists were constructed from the 20 categorical sets from Experiment 3 that were not used in the fourth experiment. In one list, the three words from each of the 20 sets were all rearranged so that each triplet contained the name of one category, and exemplars of two different categories. An example of such a set would be BOAT - TENNIS, SPINACH. In the other list the categorical name in each set and either the left or right exemplar were related, and the other exemplar was a member of a different category (e.g., ALCOHOL - VODKA, PINK). In all cases, therefore, the two exemplars in a set were unrelated at the outset of the experiment.

Each of the two lists was studied in four different ways, by separate groups. The four types of study resulted from a factorial combination of two variables. One of the variables was the instructions for study. Half of the subjects were instructed to think of as many ways as they could in which the two words in question were similar to each other. The other half were instructed to think of ways in which the words were different. The other variable was the two words from a set that were included in the new relation formed at study. One group in each instructional condition made the comparison between the two exemplars; in the examples above, subjects would make the similarity or contrastive decisions for TENNIS and SPINACH, or for VODKA and PINK. The other group compared one of the exemplars with the category name. In all cases, the similarity or contrast judgments were made for two unrelated words. Thus in cases in which the name was related to one of the exemplars, subjects were asked to compare it with the other, unrelated word; in the set ALCOHOL - VODKA, PINK, for example, they compared ALCOHOL and PINK. In unrelated triplets such as BOAT - TENNIS, SPINACH, they were told to compare the name with whichever exemplar they chose.

To summarize, eight study conditions resulted from a factorial combination of two types of item sets (unrelated, or with one exemplar belonging to the named category), similarity or contrast instructions for study, and comparison of an exemplar with either the categorical name or the other exemplar.

After they had studied one of the lists, the subjects were given a test of cued recall in which one exemplar from each set was given as a cue, for the recall of the other exemplar and the category name. Thus in the example given above, the cue might be TENNIS, and the subjects would be asked to recall SPINACH and BOAT. Half the people in each group were given the left exemplar of each set as the cue; the other half received the right exemplars as cues. They spent about five minutes writing the test.

Results and Discussion

The first part of the section presents the total levels of recall of the categorical context items, and of the target exemplars; as in the previous chapters, the two types of recall targets will be considered separately. Following the presentation of total item recall, more dedicated analyses of mediated recall will be discussed. The data seem complicated, but the message is quite clear, and consistent with the previous findings: recall was best if the cue and target shared a well known categorical relation. Without such a relation, recall was aided by a newly established relation between the cue and target, by means of a comparison made at the time of study. Thus recall was relatively good in most cases if the target item had been a part of the study comparison, as opposed to cases in which it had not. As in the preceding experiments, exemplar recall mediated by the category name was most likely to occur if the target was permanently related to the name, and a study comparison established a new relation between the name and the cue.

Item recall

Two separate analyses were conducted for the recall of each type of target. One compared the completely unrelated sets with the sets in which the category name and the cue were related. The other analysis compared the unrelated sets with sets in which the name and the target exemplar were related. Both types of analysis included as factors the type of item, the instructions for study, and whether the comparison at study had been between an exemplar and the category name or between the two exemplars.

Recall of Category Names. Name recall is shown in Table 11. The effect of item type was substantial in both analyses, $F(1,126)=273.0$, $MSe=0.029$, and $F(1,126)=51.91$, $MSe=0.040$. As always, completely unrelated sets, shown in the top row of the table, produced the worst recall, with a mean of .17. Also as always, the best recall occurred if the cue and target words were related (.66). If the cue and target were not related but the other exemplar was a member of the target category, recall was relatively good, although not as good as it was with a direct cue to target relation (.42). Recall was helped, then, if a member of the target category had been presented in the set. Note that the latter item is the same type of item that showed successful mediated recall in Experiments 3 and 4; it is possible that the relation with the other word mediated in the recall of the target in the present case. The possibility of mediated recall will be examined in a later section.

Recall was always better if the sets had been studied by means of judgments of the similarities between items, than if the items had been contrasted, with one exception. If the cue and target were permanently related (that is, if the cue was a member of the named category) contrast judgments led to better recall than similarities

Table 11. Exemplar to Name Recall: Experiment 5

PERMANENT RELATIONS IN SET	COMPARISON BETWEEN NAME & EXEMPLAR		COMPARISON BETWEEN EXEMPLAR & EXEMPLAR		M
	SIMILARITY	CONTRAST	SIMILARITY	CONTRAST	
NONE	.25	.21	.17	.06	.17
e.g. BOAT tennis spinach*					
TARGET AND THIRD WORD	.53	.38	.38	.38	.42
e.g. FOOTWEAR sodium slippers					
CUE AND TARGET	.64	.71	.59	.70	.66
e.g. ALCOHOL vodka pink					

* Examples are cases in which the left exemplar was given as the cue.

(.70 vs. .61). Thus in the analysis comparing the unrelated sets with sets in which the third word was related to the target, there was a main effect of instructions, with similarity (.33) better than contrast (.26), $F(1,126)=5.0$, MSe=0.040. In the analysis that included items in which the cue was related to the target name, there was an interaction between instructions and item types, $F(1,126)=8.63$, MSe=0.029, with similarity (.21) better than contrast (.13) in the unrelated triplets, and contrast (.70) better than similarity (.61) with related cues and targets. The pattern is as expected on the basis of previous experiments; unrelated items are recalled better after similarity judgments, and related words are recalled better if they have been contrasted (Begg, 1978b; Epstein et al., 1975).

Not surprisingly, recall was better if the comparison made at study included the recall target than if it did not. Thus with the category name as the target for recall, a comparison between an exemplar and the name was better than a comparison of the two exemplars (.45 vs. .38). This was shown as a main effect of the comparison item in each of the two analyses; $F(1,126)=6.49$, MSe=0.029 in the analysis including items with the cues related to the names, and $F(1,126)=7.79$, MSe=0.040 in the analysis with items in which the target exemplar was related to the name. Study comparisons, as suggested in the introduction to this experiment, cause the words to be processed in relation to each other, thus providing an opportunity for a new relation to be formed between them. The present result is therefore consistent with the results of the previous experiments. If the cue and target items on a test of recall are not permanently related, recall is helped if a new relation is established between them at study.

Recall of Exemplars. Table 12 shows the recall of one of the exemplars in a set, with the other exemplar as a cue. Recall that the two exemplars were never categorically related directly with each other: what varied over the different item types was whether either of them was related to the category name with which they were presented.

As always, there was a large effect of whether there were permanent relations present in the set, in both analyses, $F(1,126)=14.92$, MSe=0.058, and $F(1,126)=25.07$, MSe=0.054. The lowest recall occurred for words that had been studied in unrelated triplets, with a mean of .24. Recall was better in the other two types of sets, in which either the cue exemplar (.40) or the target (.44) was related to the third word in the set. Note that the latter two levels of exemplar recall are the same as the level in the preceding measure of recall of

Table 12. Exemplar to Exemplar Recall: Experiment 5

PERMANENT RELATIONS IN SET	COMPARISON BETWEEN NAME & EXEMPLAR		COMPARISON BETWEEN EXEMPLAR & EXEMPLAR		M
	SIMILARITY	CONTRAST	SIMILARITY	CONTRAST	
NONE	.17	.05	.49	.24	.24
e.g. BOAT tennis spinach*					
CUE AND NAME	.47	.33	.45	.34	.40
e.g. ALCOHOL vodka pink					
TARGET AND NAME	.48	.35	.49	.43	.44
e.g. FOOTWEAR sodium slippers					

* Examples are cases in which the left exemplar was given as the cue.

the name, when the name was related to the third item (.42).

There were main effects in both analyses of whether the study comparison was of the cue and target exemplars or one exemplar and the name, $F(1,126)=8.70$, MSe=0.058 and $F(1,126)=12.29$, MSe=0.054; mean recall was better if the comparison included the cue and target (.40) than if it did not (.31). However, the effect occurred primarily in the items that contained no relations, producing comparison by item interactions, $F(1,126)=8.99$, MSe=0.058 and $F(1,126)=6.92$, MSe=0.054. In the unrelated triplets, mean recall was .3[illegible] if the comparison was between the two exemplars, and only .11 if it was between one exemplar and the name. Clearly, words that previously had no relations in the set were recalled better if they became related through the processing of the cue and target in relation to each other. But if the cue was related to the name, it made no difference whether the comparison was between the cue and target exemplars (.40), or between the target exemplar and the name (.40). That is, with a permanent relation already present, there was no benefit in adding a new relation. If the target exemplar was related to the name, there was an advantage for a comparison between the cue and target exemplar over a comparison between the cue and name, but it was small (.46 vs. .42). These results are clearly consistent with those of the previous experiments.

Consider the effect of study comparisons with the category names in the latter two cases, in which the name shared a well known relation with one of the other items. Recall that the comparisons were always made between two items that were previously unrelated. In the cases in which one of the exemplars was related to the name, the comparison was between the name and the other, unrelated exemplar. Following study there would therefore be a permanent categorical relation between one of the exemplars and the name, and a new episodically formed relation between the other exemplar and the name. The cue and target items on the test, then (the two exemplars), although not directly related to each other, are both related to the third item with which they were presented. As in Experiments 3 and 4, this provides an opportunity for the common contextual item to act as a mediator in recall. Recall can therefore succeed, just as it did if the cue and target were directly compared to each other and thereby newly related. Further discussion of such mediation in recall will follow in the next section.

Finally, similarity judgments always led to better recall than contrastive judgments, as reflected in main effects in the two analyses, $F(1,126)=13.47$, $MSe=0.058$ and $F(1,126)=11.23$, $MSe=0.054$. The effect is consistent with the previous results, as well as other research, in which similarity instructions are the more successful with items that are unrelated to each other.

Summary of Item Recall. The pattern of recall over the different types of items was consistent with the results of the other experiments. The probability of recall was highest if the cue and target words were categorically related to each other, and lowest if none of the words in the set were permanently related. If the cue and target were not permanently related, recall was helped by a relation between either of them and the third word in the set. The categorically unrelated cue and target were recalled best if joint processing had created a new relation between them. Instructions to study the words by making similarity comparisons led to better recall than instructions for contrasts, unless the cue and target were related. In most cases, recall was better if the study comparison included the target word than if it did not; the only exception was no difference between the two comparison conditions in the recall of the exemplar if the cue and the name were related.

Mediated Recall

As in the previous experiment, the measures of interest for examining mediated recall were the proportions of cases in which the category names were recalled alone, in which the exemplars were recalled alone, and in which both were recalled together. Full analyses were done which included this variable in addition to all of the ones discussed with respect to item recall. However, most of the results have already been discussed in the preceding section. In the present section, only the measure of interest for mediated recall, as described above, will be considered, with the other factors discussed only as they affect it. As before, two separate analyses were done comparing the unrelated sets with each of the other two types of sets. An additional analysis compared the two types of items containing permanent relations directly with each other. The results are shown in Table 13.

There were main effects of the measure in all three analyses, $\underline{F}(2,252)=8.63$, MSe=0.039, $\underline{F}(2,252)=30.2$, MSe=0.022, and $\underline{F}(2,136)=40.0$, MSe=0.057. Overall, the most recall was of the two words together (.25), followed by recall of the names alone (.17), and recall of the exemplars alone (.11). However, the patterns were, as always, different for each of the types of item, resulting in item by measure interactions in all three analyses, $\underline{F}(2,252)=29.8$, MSe=0.039, $\underline{F}(2,252)=56.8$, MSe=0.022, and $\underline{F}(2,136)=46.0$, MSe=0.024. In the unrelated sets, shown on the table in the panel on the left, recall of all types was quite low,

Table 13. Mediated Recall: Experiment 5

SET TYPE: NO WORDS RELATED e.g., BOAT - tennis, spinach

		RECALL OF:					
INSTRUCTION	COMPARISON	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	P*
SIMILARITY	NAME	.12	.13	.05	.25	.17	.04
	EXEMPLAR	.11	.07	.38	.18	.49	.09
CONTRAST	NAME	.05	.16	.00	.21	.05	.01
	EXEMPLAR	.03	.02	.21	.05	.24	.01

NAME AND CUE RELATED e.g., ALCOHOL - vodka, pink

		RECALL OF:					
INSTRUCTION	COMPARISON	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	P*
SIMILARITY	NAME	.37	.27	.09	.64	.46	.29
	EXEMPLAR	.33	.26	.13	.59	.46	.27
CONTRAST	NAME	.28	.43	.05	.71	.33	.23
	EXEMPLAR	.28	.42	.06	.70	.34	.24

NAME AND TARGET RELATED e.g., FOOTWEAR - sodium, slippers

		RECALL OF:					
INSTRUCTION	COMPARISON	NAME AND EXEMPLAR	NAME ONLY	EXEMPLAR ONLY	TOTAL NAMES	TOTAL EXEMPLARS	P*
SIMILARITY	NAME	.41	.12	.07	.53	.48	.25
	EXEMPLAR	.35	.02	.13	.37	.48	.18
CONTRAST	NAME	.32	.06	.04	.38	.36	.14
	EXEMPLAR	.34	.04	.09	.38	.43	.16

Examples are cases in which the left exemplars were given as the cues.

* P represents the predicted level of joint recall of the name and the exemplar if they are independent.

and there was not much difference among the measures. When the cues were related to the names, the name and the target exemplar were recalled together relatively often, with a mean of .32, but the names were recalled alone equally often (.35), whereas the exemplars rarely were recalled alone (.08). That is, although recall of the name was quite high (altogether, .66) it brought with it the exemplar in only .60 of the cases. On the other hand, in the sets in which the target exemplars were related to the names, in almost every case in which the name was recalled, the exemplar was recalled as well. Recall of the two together was almost the same as in the other sets with relations (.36), but names and exemplars were almost never recalled alone (.06 and .08 respectively). Once again, as shown in the last column of the table, the clearest cases in which recall of the name and target together was more than would be expected if they were independent, occurred if the two shared a permanent relation. Thus a permanent relation between the contextual item and the target for recall increases the likelihood of mediaton; this is consistent with the results of the previous experiments.

The measure interacted with instructions in the analysis of the unrelated and the related cue sets, $\underline{F}(2,252)=6.59$, MSe=0.039, and the analysis of the two types of sets with relations, $\underline{F}(2,136)=3.37$, MSe=0.057. Similarity instructions were better than contrast instructions for the recall of exemplars and names together, and arithmetically better for the recall of exemplars alone. However, if the cues were related to the category names, recall of the names alone was better after contrastive processing than similarity processing, consistent with the findings of Begg (1978b); this produced a three-way interaction between measure, instructions, and items in the analysis comparing the two types of item with relations, $F(2,136)=4.61$, MSe=0.024.

The most interesting results can be seen in the interactions between the measure (that is, recall of the name alone, the exemplar alone, or the two together) and whether the study comparison included the name or the exemplar, in the two analyses comparing the unrelated sets with the sets with related cues and related targets, $F(2,252)=9.43$, MSe=0.039 and $F(2,252)=22.3$, MSe=0.022 respectively; and between measure, comparison and item type, $F(2,252)=6.42$, MSe=0.039 and $F(2,252)=7.03$, MSe=0.022. In the unrelated sets, the word that had been part of the comparison was better recalled than the other word, and they were seldom recalled together. In contrast, in sets in which the cue and the name were related, the name was recalled better than the other word, no matter what the study comparison was. The permanent relation clearly overrules any effect of the study instructions, as was the case with imaginal processing in Experiments 3 and 4. In the sets in which the name and the target exemplar were related, if the exemplar was a part of the comparison at study, it was recalled somewhat more often than the name. A new relation had been established directly between the cue and target exemplars in those cases, whereas the name shared no relation with the cue. If the name was the item compared with the cue, however, it and the exemplar were recalled equally often and usually together; further evidence of mediation. This condition once again creates the ideal situation for mediated recall, found repeatedly over the series of experiments: a newly formed relation between the cue and the mediating word, and a permanent relation between the mediator and the target.

Summary of Mediated Recall. As in the previous experiments, mediated recall was most likely to occur in cases in which the target word was related to the category name; in such cases the target and name were often recalled together, but were seldom recalled alone. The best case of mediated recall was in items in which the target was related to the name, and the study comparison had been made between the cue and the name. Thus, as in the other experiments, mediated recall is most likely to occur if two conditions are fulfilled. The target must share a permanent relation with the mediator, and an episodic relation between the cue and the mediator allows access to that relation containing the target.

Conclusions

Experiment 5 shows that the conclusions drawn previously about the different kinds of relations are, at least to some extent, general. Certainly, the conclusions about the use of newly acquired relations in recall are not specific to relations formed by means of interactive imagery. The effects found in Experiment 5 of relations formed by means of similarity and contrast judgments are comparable to the effects of interactive imagery. The patterns of recall were therefore not attributable to some characteristic of the imagery task itself. Rather, they were the result of having studied two items in relation to each other, thereby creating a new relation between them.

The effects of permanent relations found in the present set of experiments may also be more general. Data that have been reported elsewhere in the literature suggest that the effects of permanent relations, obtained here by using categorical membership, may be generalizable to other kinds of permanent relations among items. Lupker (1984) found semantic priming effects both with items that shared membership in semantic categories, and with items that were associatively related but not members of the same taxonomic category, such as AUTHOR - BOOK or STORK - BABY. He suggested that the commonly found effects of semantic relations may in fact be due to associative relations between the items.

Chapter 7

GENERAL DISCUSSION

Let us begin this section with an overview of the findings of the thesis. The first two experiments established the distinction between well known associations between concepts in knowledge, and new relations formed between items when they are studied together. The two forms of relational information were shown to be used separately in recall, in two ways. The first is the fact that the conditions that were beneficial for the recall of categorical knowledge were not the same ones that aided the recall of experimentally arranged list partners. Second, conditional analyses revealed independence between the two measures.

The patterns of results in the first two experiments suggested that recall can occur in two different ways, and that the route used depends upon the nature of the available relational information. Recall of episodically acquired list partners appears to have occurred by means of the retrieval of memorial records containing the cue and target items as they were studied together. The important factor for successful performance is the availability of the item with which the target item was studied and hence the accessibility of the memorial record. The recall of well known categorical sets can occur in the same way if the appropriate information is available. It can also, however, occur through the mediation of categorical information in permanent knowledge, in a kind of generation-recognition process: performance is maximized by recent study of the items with their categorical labels and thus the availability of the relevant set of knowledge.

Experiments 1 and 2 also established that the order in which the different kinds of information were acquired did not affect subsequent recall. In Experiment 1, when the study list was learned, the categorical information had already been made available; in Experiment 2, the categorical information was not shown until after the study list of unrelated pairs had been seen. The lack of difference in recall lends support to the conclusion that it is the entire set of information available in memory at the time of the test that is used in the process of recall.

In the first two experiments, the distinction was established largely by the fact that a variable influencing the availability of permanently known information affected measures of categorical recall, but not the recall of episodic partners. In the remaining experiments, it was supported by the fact that the method used to study the items influenced the recall of newly related words, but had a very different effect on the recall of permanently known relations.

Experiment 3 examined the use of the two kinds of relational information as they occurred together in sets of items. It showed that a permanent relation between the cue and target was the most effective factor for recall; but that in the absence of such a relation, recall was helped by the formation of a new relation between the two items at the time of study. The establishment of a new relation did not help if the items were already related at the time of study; in fact in many cases it hurt recall somewhat. Thus if they are available, the process of recall relies upon existing relations in memory. If they are not available, relational processing at the time of study improves the probability of successful recall. The process, then, requires relations between the items. If they already exist in permanent memory, those permanent relations are used to retrieve the required item. If there is no known relation between those items, the creation of one at the time of study allows the process of retrieval to occur. Moreover, the availability of additional relational information relevant to the cue or target can be of benefit to recall. A triplet in which all the words were pre-experimentally related produced better recall than if only the cue and target were related to each other; and if the cue and target were not related, recall was helped to a small extent if one of them shared a categorical relation with the third item in the set. There was evidently some benefit of having a relevant subset of knowledge available at the time the items were studied. Thus Experiment 3 showed that even within a single episode of study, the two kinds of relation are qualitatively different, and are used differently in recall.

Experiment 4 examined how the different relations can be used together for mediated recall, in which a target with no direct relation with the cue is recalled through the mediation of an item to which they are both related. The results showed that mediated recall requires a well known relation between the target and the mediator. Newly established relations, however, are effective in providing access to the mediator and its associate. That is, if the cue is newly related to the mediator, there is some probability that it will enable recall of that mediator; if it does, the mediator's relation with the target exemplar in permanent knowledge will ensure that the exemplar will be recalled as well. A new relation between the mediating item and the target, on the other hand, was not always sufficiently effective to ensure that mediation would occur. Because of the lower probability of recall based on a newly established relation, the mediator gave access to the target in only some cases: in many more cases, the mediator was recalled alone. Once again, then, the two types of relations behaved very differently. The interesting result of this experiment, though, was that they could be used together in particular circumstances to maximize performance. The combination just described of relations within a set, of an episodic relation between the cue and the mediating label and a permanent one between the label and the target, produced the highest probability of mediated recall. Thus although they have been shown to be separate and independent, if the circumstances require both types of information, they can both be used for maximal recall.

Finally, in Experiment 5, the conclusions were generalized to a different kind of study task. It became clear that the observed patterns of recall were not simply due to some characteristic of the imagery tasks used previously, but were in fact attributable to the establishment of relations between the tested items.

The results of the present experiments thus lead to the conclusion that permanently known relations and newly established relations provide different kinds of information, which are used differently in recall. It is clear that the difference is not simply a quantitative one, because the two kinds of relation consistently showed different patterns of results over the various experimental conditions. Factors that affected the recall of permanently related items did not influence the recall of newly acquired relations; whereas factors that improved the recall of newly learned relations had very different effects on permanently known ones.

The data do not allow us to say exactly what is occurring in each type of recall. However, the recall of a permanently known relation, such as that between CAT and DOG, appears to be mediated by the categorical knowledge already in memory. Part of the knowledge available about each of those words is their membership in the category ANIMAL. When one of the words is presented as a cue for recall, it is as if all the members of its category are activated in memory. The response decision would therefore entail the recognition of the particular member that was studied with the cue word in the experimental list. On the other hand, the processing of newly related pairs, such as CAT and BOOK, can be conceptualized as the establishment of a new unit in memory. Until they were studied in relation to each other during the experiment, there was probably nothing to link the concepts of CAT and BOOK in memory. There is therefore no previously existing set of knowledge upon which to base recall. Upon presentation of one of the words as a cue, recall of the other must depend on accessing the specific record of study of the two words together.

In the introduction to the thesis, it was suggested that both types of information and process are needed to completely account for the process of recall, and therefore neither of the two predominant accounts of memorial processes are sufficient. The thesis has provided evidence for both types of recall. Further, it has shown that the two work together in the functioning of the complete system. Let us now turn to the final goal of the thesis as stated in the introductory section: to form a synthesis of the two approaches to recall.

As suggested previously, neither of the approaches in their extreme forms accounts easily for all the phenomena of recall. It seems that the only way in which either approach can give a complete account of recall is to become less extreme, with each approach incorporating components of the other. In the discussion to follow, it will be suggested that there is really no substantial difference between the two ways of describing memory. Although they appear very different on the surface, and in fact arise out of different research traditions, there is functionally little difference in terms of the operation of memory. The difference, rather, is in the emphasis placed on each of the types of knowledge in the different descriptions. Consider what happens to each of the accounts when they have been adjusted to address the problems that were discussed in the introductory chapter.

It was pointed out in the introduction that semantically related pairs are generally recalled better than unrelated pairs, and that the different patterns over various measures suggest that the difference is not simply one of degree. In order for a trace account to explain differences in the recall of related and unrelated pairs, some traces must be stronger than others; the account must include something like well-established or permanent traces for pairs that are semantically or conceptually related. How does this differ from a semantic network account, in which semantic relations are permanently held in memory? The only difference, it seems, is whether we call the permanent representations "nodes" with links between them, or "traces". Functionally, the memorial processes would be the same.

Now consider a permanent network approach, with modifications to account for new relations. It was suggested earlier that the only way to account satisfactorily for new relations, and the flexibility that is often required in encoding, is by saying that something like new traces must be formed when needed. Watkins and Gardiner (1979) have asked why, if we allow for the creation of traces, we need to hypothesize a tagging mechanism at all. We can go even further to say that except for slight differences in terminology, this becomes exactly the same account as a trace theory with some permanently held information. Once again, the two are functionally identical.

Thus we can conclude that the two approaches to explaining memory, which upon first consideration seem to be directly opposed, are not necessarily contradictory. Neither one is sufficient in its most extreme form. If they are modified to accommodate all the phenomena of recall, the result is a synthesis of the two. Let us consider further the nature of the memory system that such a synthesis suggests. It is a system that is able to make use of both types of relations between the items it is required to retain. If semantically related items are processed together, it should be able to make use of the relational information in permanent memory in forming a record of that processing event. If the previously stored information is not appropriate for remembering the occurrence of a particular set of items, the system should have the capability to add records of new relations acquired in the interpretive study of the items.

The different types of information about the studied items would then be available for use in retrieval. The process of retrieval could make use of permanent semantic information, to aid access with the appropriate sets of items, thereby narrowing the search.

In fact, the experimental evidence shows that this is the more effective of the two types of relational information; throughout the experiments, the effects of permanent relations were larger than those of newly learned relations. The use of permanent semantic information, then, is evident in the relatively good recall of permanently related pairs throughout the experiments. It is also indicated in the mediating role of the names of the categories in recall, particularly as seen in the comparisons of exemplars and names as cues in Experiments 1 and 2. Recall was more likely if the names of categories were given as cues than if exemplars of the categories were used. With names given as cues, access to the appropriate subset of knowledge is given; the only thing that remains for the recall process to accomplish is recognition of the correct response within that set. One step in the process is eliminated, thereby increasing the probability of successful completion.

If permanent categorical information is unavailable, the recall process could make use of the newly acquired information resulting from the interpretation of the items as a unit at study. The use of such information is evident in the recall of unrelated pairs in the experiments. In Experiments 1 and 2 for example, recall of newly related pairs was best under conditions that could best be expected to make the traces of the study episodes accessible.

The idea that the process of recall makes use of both kinds of information depending on their availability suggests that the different types work together in an interactive system. This can be seen in mediated recall, as examined in Experiments 3, 4 and 5 in cases in which the cue and target words shared no relation. It was found in all three experiments that the condition that was most conducive to mediation by a contextual item in recall included a combination of the two types of relation. That condition was if the target item was permanently related to the mediator, and a new relation was established between the cue and the mediator to allow access to the mediating item. Mediation, then, requires a permanent relation between the target item and the mediator. It was noted previously that permanent relations have stronger effects than newly established ones; only permanently known relations were strong enough to ensure that if the mediating item was recalled, it would in most cases bring recall of the target exemplar with it. Mediated recall also requires that the conditions of study are such that this permanent relation can be accessed; to the extent that newly established relations fulfilled this function, mediated recall occurred.

Given the evidence of an interactive system using all available information, we might define the memorial record, or the commonly used term "memory trace", as being the state of the entire system after a particular event. After study of an item, the memory trace would be the contents of the entire memorial system, including the information that was there previously, and whatever was added in the course of interpretation at study. This interpretation is supported by the results of Experiment 2, which showed that the important factor was the total set of information available at study, and not the order in which it was acquired. If the studied items were ones that were already known, they may have been "tagged" or somehow activated in the system, and so the memorial record includes the tag or record of that item's occurrence. If the studied items were not already known or associated with each other, then they or their shared relation could have been added, in which case they are now part of the system and thus a part of the memorial record, or the trace.

The distinction, then, would not be between different kinds of structural components or mechanisms in memory. The memorial record would always be of the same sort: the total set of knowledge contained in the system after study of the items in question. The distinction, rather, is between different ways of acquiring, and gaining access to, those items. The difference is that some of the information that is encountered at study and required for recall is already known, whereas other required information is not known at the time of study and has to be newly added for the purposes of the specific task. The process of recall makes use of whatever information is available in memory. Of course some information, the permanent semantic information, is more effective in producing recall than the less well-established new relations. But either or both can be used, depending on which are available. That is, recall depends upon the state of the memorial system at the time it is tested.

Perhaps then the distinction can be accounted for by the processing, or procedural, accounts of memory (Kolers & Roediger, 1984; Kolers & Smythe, 1984; Roediger & Blaxton, 1987; Roediger & Weldon, 1987). The difference in the two conditions of relational information might be in the differential need for relational processing. It is whether the relational information in question was a well established component of the set of knowledge, or whether it had to be added at the time of study. Permanent parts of the system might have networks of associations built up over time that can be used in the process of recall; but newly added knowledge would more likely have to stand on its own in its use in recall. Perhaps, then, permanently related items best lend themselves to the processing of relational information, whereas with unrelated items the need in recall for item-specific distinctiveness is best met. If this is the case, then the importance of both types of relation for recall is clear. A number of studies have shown that for maximal recall, both item-specific and relational information are necessary (Einstein & Hunt, 1980; Hunt & Einstein, 1981).

Encoding and retrieval would therefore be processes that make use of the information already available, and add whatever is lacking. The encoding of studied items could be described as an interaction of the information about the items currently available in permanent knowledge, and that which is newly obtained from the interpretive process at study. The retrieval process, in turn, depends upon an interaction of the type of information required for, and provided by, the retrieval task, and the information available in memory at the time of the test. Retrieval would make use of the total state of the memory system, with whatever information is available in it.

Extensions

It has been shown that the use of various relations within a set of items, whether of the same or different kinds, can be combined in the process of recalling that set. An obvious question to pose next would be whether this is also true of information present in different sets of items. That is, can the available information be combined across episodes of study, so that the knowledge necessary for a particular recall task could be drawn from previously encountered sets? Intuition suggests that this must be the case; clearly, we are able to combine knowledge acquired over different study episodes. An important follow-up to the work presented in this thesis would be to examine the effects of relations, of either kind, between items appearing in different studied sets.

Experiment 3 attempted to do just that, by breaking the triplets of words up into pairs and presenting them separately for study. However, as noted, performance on the tests was so low under those circumstances that they did not yield useful data. Attempts in Experiment 4 to raise the levels of recall were successful, but the paired study condition was not repeated. Given that it is possible to elicit greater levels of recall, it would be interesting now to return to the problem of the interaction of information across different episodes.

Throughout the thesis, only two states of relational knowledge have been acknowledged: items either share a well-established association in permanent memory, or they have just become related after having shared no relation at all. It seemed necessary to study these two states in order to establish the distinction. It is quite possible, however, that they are only the two extremes, and that there are in fact different degrees of relatedness between them. Perhaps, then, the phenomena of recall reported here would be found to vary as a function of the degrees of relationships. It is therefore likely that subjects could be given pairs that were initially unrelated and be trained to varying degrees, so that the items acquired more or less well known relations. Or perhaps artificial stimuli could be used, for which some associations could be very well trained and others only weakly trained. It would also be possible to use categorical exemplars that vary in their typicality as members of their categories. Ideas from a number of sources lead to the expectation that performance measures might differ with different degrees of relatedness. The network models of semantic knowledge, for example, suggest that the more similar two concepts are, with more properties in common, the more links there are joining their nodes in memory (Collins & Loftus, 1975). Moreover, it has been reported that the speed, accuracy and confidence of making categorical judgments have been found to vary with the typicality of the items as members of their categories (Rips, Shoben & Smith, 1973; Whittlesea, 1987).

It is clear that there is a limit on the kinds of generalizations that can be made from the present data. It would, at this stage, be an unjustifiable leap to apply the results to other kinds of cognitive tasks. There is evidence to suggest that patterns of performance observed in tasks requiring the recall of single words are not the same as the patterns in tasks requiring the processing of text (Levy & Kirsner, in press). The patterns of use of different kinds of information found here apply to some very basic level of memorial functioning.

For example, the results of the present series of experiments suggest that permanently known relations provide the most effectively used type of information. Recall is by far the best when such relations are available, and is not improved any further if new relations are added. New relations improve recall only if there was no relational information available without them. (It cannot be said whether that is because permanent relations are for some reason more appropriate or important for recall, or simply because they are most easily accessed and used.) This is not, however, to suggest a less important status for new relations acquired on the basis of the particular interpretive event. The use of the different kinds of information depends upon what is available in the system at the particular time, and what is required for the task at hand. In the present context of learning isolated pairs or sets of words, given both types of relational information, the permanently known relations are the more readily usable. In other contexts, the relative use of information of the different types would in all likelihood be different, depending on the information available and what is required in those particular circumstances.

It remains to be seen how the knowledge gained here can be applied to an understanding of other kinds of cognitive functioning. To this end, an important follow-up to the present work would be to incorporate the different kinds of relational information into segments of text, to be studied by subjects and recalled.

At the root of much of our interest in permanent knowledge is a desire to understand how it affects current learning and memory. The present work has interesting implications for an understanding of the optimal use of different kinds of information for gaining new knowledge. The results of the experiments confirm the notion that information that we already possess is very influential in new learning. They suggest that new concepts or events are best learned and remembered if they are related to other available knowledge at the time they are encountered. Further, they suggest that the learning of new facts might be most successful if, first of all, the learner is reminded of knowledge he or she already has about the same topic, and if the incoming facts are related to each other in some meaningful way.

Current research in the field of education has been concerned with the effect of prior knowledge on the recall of text. It has been found that the amount of information recalled from a text is increased by prior knowledge of the topic. Further, the effect of prior knowledge has been found to be independent of reading ability (Recht & Leslie, 1988). Good readers recall more from a text than do poor readers if the topic is unfamiliar, but recall of familiar material is the same in both groups. If that is the case, familiarization of the relevant topic should increase recall for all readers, and be particularly beneficial for people with reading difficulties. On the basis of findings such as this, there is interest currently in the use, and establishment, of prior knowledge in the pre-reading activities of school children. The results of the present series of experiments provide support for such ideas, and perhaps can be used to suggest specific ways in which information can be used to improve the recall of read materials.

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