THE REPRESENTATION OF MEANING
IN EPISODIC MEMORY

GILLIAN C. McIVOR

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University of Stirling,
Stirling, Scotland.

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ABSTRACT

In several models of long-term memory it is assumed, either explicitly or implicitly, that different meanings of homonyms and even different senses of nonhomonyms have separate representations in long-term memory. While evidence has accrued, particularly from studies employing lexical decision tasks, to suggest that homonyms are multiply represented in semantic memory, claims for multiple representation of homonyms in episodic memory have tended to be made on a purely post hoc basis. The aim of the present research was to determine the manner in which homonyms are represented in episodic memory. A series of experiments were conducted in which either one or two meanings of homonyms were encoded at input. Retention of the homonyms or their biasing nouns was tested in a variety of retrieval contexts. The results obtained were consistent with a conceptualisation of episodic memory in which successive encodings of the same item are represented within the same memory trace which was established on the first occurrence of the item. When two different meanings of a homonym are encoded at input the encoded meanings will be represented within a single memory trace, with each different meaning being represented by an independent set of encoded semantic features. The generality of the framework for episodic memory which is developed is demonstrated through its interpretive application to a wide range of episodic memory phenomena.

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CONTENTS

CHAPTER 1

ENCODING PROCESSES AND THE STRUCTURE OF MEMORY TRACES

Introduction

The emphasis in this first chapter is upon the development of the theoretical background under which the present research was undertaken. As such, the chapter presents a review of the theories, concepts and explanatory principles which have been instrumental in shaping the theoretical framework in which the present results are interpreted. In the second introductory chapter, several memory phenomena and theories are reviewed which are of direct relevance to the current research topic; the manner in which homonyms (words with more than one distinct dictionary meaning) are represented in long-term episodic memory.

Structural Theories of Memory

In recent years the field of human memory has been conceptualised in terms of an information processing framework where, until the last decade or so, the majority of models of memory have been concerned with the concept of stores and the transfer of information among them (e.g. Atkinson and Shiffrin, 1968; Broadbent, 1958; Waugh and Norman, 1965). Such models see man as a processor of information which is held transiently at various points in the memory system before eventually being transferred into and retained in a more permanent long-term store. Murdock (1967) included the earliest features of such models in his "modal model". The notion of a three-store memory system became widely accepted. This was conceptualised as including a modality-specific sensory store, a short-term store and a permanent or long-term store which could be distinguished due to differential capacity, coding and retention characteristics. Initially, the main emphasis was on the structural features of such models, with research focusing on the various properties of the three stores, such as the form in which information was maintained in them, the amount of information which could be held in them, and how information was eventually lost from them.

Although this approach seemed intuitively attractive - information was seen as being transferred in an orderly fashion between well-defined and specific stores - it eventually became clear that the various criteria which were said to distinguish between the three stores did not hold over a variety of experimental conditions. For example, different studies have obtained a wide range of capacity estimates for short-term storage which vary according to the paradigm and materials used (e.g. Baddeley, 1970; Craik and Masani, 1969; Murdock, 1972). Furthermore, while it was generally accepted that short-term coding was acoustic (Baddeley, 1966, 1968; Conrad, 1964) and long-term coding semantic (Kintsch and Buschke, 1969), evidence was obtained which showed that short-term storage could accept a variety of physical, and even semantic, codes depending on the particular paradigm used and the usefulness to the subject of different types of coding (e.g. Baddeley, 1972; Shulman, 1970).

Finally, estimates of retention were also found to depend very much upon the material and paradigm used. For example, estimates of visual sensory storage have varied from 0.5. seconds (Sperling, 1960) to 25 seconds (Kroll, Parks, Parkinson, Bieber and Johnson, 1970), and are even longer for recognition of pictorial stimuli (e.g. Nickerson, 1965; Standing, Conezio and Haber, 1970).

The Process View

Melton (1963) voiced one of the earliest objections against the multistore conceptualization. According to Melton, short-term memory operated on the same principles as long-term memory, with the two representing points along the same continuum rather than a dichotomy. Melton also argued for the importance of studying the processes involved in remembering which were, in his terms, trace formation, trace storage and trace utilization (or, to use more recent terms, encoding, storage and retrieval). In recent years interest has begun to focus upon the flexibility of the human memory system and correspondingly attention has shifted (through a disillusionment with the rigidity of the "box" approach) from the underlying structure to the underlying processes.

1. Attribute Encoding

Although Melton (1963) explicitly excluded trace formation from the domain of memory research, subsequent theorists have come to realise the importance of initial encoding processes for subsequent retention. Several researchers have adopted the view that memory consists of a list of the attributes of the words experienced. Support for this notion is forthcoming from studies which have demonstrated a higher false positive rate in recognition to synonyms, antonyms or close associates which share similar attributes to the to-be-remembered words (e.g. Anisfeld and Knapp, 1968; Underwood, 1965).

Underwood (1969) has proposed that memory is composed of a number of attributes, both task dependent and task independent, with encoding representing the process by which the attributes of a memory are established. A memory, Underwood argues, may contain the following attributes: temporal (see also, Underwood 1977), spatial, frequency, modality, orthographic, visual, acoustic, affective, context, verbal and class. Some attributes are considered to be independent of the other attributes while others, for example the orthographic attribute, may be reduced to other attributes. Certain attributes, notably the frequency attribute, serve primarily or purely as discriminative attributes, while others, in particular the verbal and class attributes, serve primarily to aid retrieval of the memory. Interference in recall is believed to occur when one or more attributes are contained in two or more target traces.

Wickens (1972) has studied the effect of the encoding of attributes on the retention of words. Wickens has shown that while the retention of words with some common attribute (e.g. category membership) declines over recall trials, changing the class of the item on the fourth trial leads to improved retention on that trial: the phenomenon of release from proactive inhibition. Wickens argues that the extent of the recovery indicates the extent to which the attributes which have been encoded have changed from the old to the new class of material. In an unpublished experiment, cited by Morris (1978), Eggemeier (1971) changed either one or two dimensions from the semantic differential, finding a greater release when two dimensions as opposed to one dimension were changed. This suggests that multiple encoding on several dimensions can take place at one time.

Finally, a theory of memory based on the encoding of attributes or features has been proposed by Bower (1967).

According to this "multicomponent" theory, the memory trace is conceived of as containing a number of components (or attributes) which have corresponding values. Forgetting is seen as a result of the change in value of one or more components. Thus, while the loss of information in any one component is all-or-none, forgetting will appear to be gradual since the memory trace is assumed to contain many components. The larger the number and value of the encoded attributes present in the trace at the time of test, the more likely it is that recall or recognition will be successful.

2. Levels of Processing.

Craik and Lockart (1972) formulated a process view of memory in which the memory trace was seen as the by-product of perceptual analyses, with qualitatively different memory traces resulting from qualitatively different forms of encoding. Essentially, what they proposed was that some encoding tasks require the use of information about stimuli which is stored deeper down in the semantic memory system (Tulving, 1972) than that required for other tasks. Initial, or shallow, processing tends to involve the analysis of structural characteristics which can then be encoded at deeper levels - phonemically and semantically. Trace durability was regarded as a positive function of the "depth" to which the stimulus has been analysed: in a given task the greater the degree of semantic analysis, or depth of processing, the longer the time taken for processing and the better the quality of the resulting memory trace. This view was modified somewhat by Craik (1973) who suggested that rather than all analyses necessarily proceeding from simple to complex, where the task is well-practiced or the stimuli are familiar, the deeper semantic analyses can be carried out automatically.

Memory performance will still, nevertheless, depend on the deepest level to which the event has been analysed.

3. Empirical Findings.

A large number of studies have demonstrated the superior retention resulting from deeper over shallower forms of encoding (e.g. Arbuckle and Katz, 1976; Craik and Tulving, 1975; Glanzer and Koppenaal, 1977; Goldman and Pellegrino, 1977; Parkin, 1979; Postman and Kruesi, 1977). Even before the Craik and Lockhart paper, the superiority of semantic over nonsemantic orienting tasks had been shown by Hyde and Jenkins (1969) who found that nonsemantic orienting tasks greatly reduced both the level of recall and the organisation in recall.

In a typical levels of processing study, Craik and Tulving (1975, Exp.1) presented words individually and required the subjects to perform one of five orienting tasks on each trial. The authors found that the recognition hit-rate increased with deeper levels of processing. In a further study (Exp.4) Craik and Tulving found that the typical levels of processing results did not depend critically upon incidental learning instructions; the superiority of semantic over nonsemantic processing persisted even when the subjects were forewarned of a subsequent free recall test.

4. Elaboration.

Within the general framework, Craik and Lockhart (1972) have proposed two distinct types of processing. The first, Type I processing or "maintenance rehearsal" corresponds to James' (1890) primary memory, being the rehearsal of an item at one level of processing. Once attention is drawn from the item it will be forgotten at a rate appropriate to the level to which it has been analysed. Rehearsal is seen as prolonging the item's high accessibility but does not result in the formation of a more permanent trace (eg. Craik and Watkins, 1973). Type II processing, on the other hand, involves processing of the item to a deeper level and has thus been termed "elaborative encoding". Only through this type of processing can a more durable memory trace be formed. Thus, information in long-term storage does not necessarily pass through short-term storage: short-term storage is an optional strategy rather than a structural feature of the framework.

A significant outcome of the series of experiments by Craik and Tulving (1975) was the proposal that, rather than there being a continuum of processing from structural to semantic (as the original "levels" paper had suggested), there are certain "domains" of encoding in which the basic perceptual encoding of the event can be elaborated in various ways. Depth of processing, therefore, refers to qualitatively different types of encoding, with the term "spread" of encoding being introduced to account for further elaborative processing within any broad domain.

Craik and Tulving (1975, Exp. 7) obtained evidence for the beneficial effects of elaboration on retention. In this study the subjects were required to encode words in three levels of sentence complexity, from very simple frames to complex, elaborate frames. It was found that the more complex, elaborate frames led to higher free recall and cued recall when congruous sentences were provided for the encoding of the target words. Fisher and Craik (1980) have shown that elaboration also improves recognition, when the initial study context is reinstated at test.

Anderson and Reder (1979) have suggested that typical depth of processing results can be explained in terms of elaborative processing. According to the authors, memory performance is a function of the number of propositions or elaborations encoded in the long-term memory network (e.g. Anderson and Bower, 1973).

Bransford, Franks, Morris and Stein (1979) have argued, however, that elaboration is effective only under certain conditions. Elaboration seems especially important for preserving information about relations among items (e.g. Stein, 1977). Furthermore, the quality of elaboration is more important than the quantity in facilitating memory performance. Stein, Morris and Bransford (1978) showed that providing elaborated sentence frames as cues at test only proved effective if the additional elaboration emphasised distinctive properties of the target word. Stein and Bransford (1979) found that subject-generated elaborations only facilitated performance when they helped to clarify the significance of the words in the acquisition sentences. While elaborative processing within a particular domain generally facilitates memory performance, both the quality of the elaboration and the nature of the subsequent retention test are important determinants of ultimate performance.

5. <u>The Sensory-Semantic Model</u>

A model which possesses many similarities to the levels of processing framework has been proposed by Nelson (1979). In the sensory-semantic model, processing is assumed to be continuous, proceeding through time, with several independent types of features being processed at any given moment in time. Some degree of independence is assumed between the specific encoding operations used to process events and the functional representation of those events in memory; encoding operations focused upon semantic features do not result in only semantic processing and, likewise, encoding operations directed towards sensory features do not result in only sensory processing. Nelson and Borden (1977), for example, showed that dual sensory-semantic cues were superior to single cues, with each feature contributing independently and additively to recall. Thus, both sensory and semantic features were activated during encoding, and both types of features acted together to facilitate redintegration of target information. Unlike the levels of processing approach, the sensory-semantic view emphasises that the sensory attributes of a word may be as functionally important as are its semantic attributes.

6. Problems with the Levels of Processing Approach.

While the levels of processing framework has generated a substantial body of research, mainly aimed at demonstrating the relative effectiveness of various forms of encoding, several justifiable criticisms of the approach have been voiced (e.g. Baddeley, 1978; Eysenck, 1979; Nelson, 1977). As Baddeley (1978) and Eysenck (1979) have pointed out, there does not yet exist an independent measure of depth of processing. Craik and Lockhart (1972) originally proposed processing time as an indicator of the level of processing attained, and several studies have found longer processing times for semantic as opposed to nonsemantic orienting tasks (e.g. Arbuckle and Katz, 1976; Goldman and Pellegrino, 1977; Mayes and McIvor, 1980; Mueller and Curtois, 1980). In an unpublished study, Wolters (1980), has provided evidence that processing time is a good independent measure of extensiveness of processing, and a useful predictor of subsequent memory performance. However, processing time has proved to be of limited usefulness as a satisfactory index of depth. Craik and Tulving (1975,Exp.5) showed that while a complex structural orienting task took longer to perform than a simple semantic task, retention was still superior following the semantic task. The circularity which results from the lack of an independent measure of processing depth places severe restrictions on the usefulness of the concept.

A further problem with the levels of processing approach is that it offers no explicit mechanism indicating why deep levels of processing should be better retained than shallow levels. While other criticisms of the levels framework have been voiced (e.g. Baddeley, 1976) it has become clear that one of the major shortcomings of the approach was its neglect of the effects of the retrieval environment on memory performance. In typical levels of processing studies, encoding conditions were manipulated while retrieval conditions were held constant. As Moscovitch and Craik (1976) have pointed out, memory performance is influenced by retrieval factors as well as encoding operations and, as such, the levels of processing account of memory is incomplete.

7. The Interaction of Encoding and Retrieval Processes.

The finding that retention depends not only on the initial encoding operations performed on an event, but also on the retrieval environment which prevails at the time of test illustrates Tulving and Pearlstone's (1966) distinction between availability and accessibility of memory traces. Tulving and Pearlstone proposed the above distinction to account for the superiority of category cued recall over free recall. Such superiority demonstrated that while the accessibility of information clearly depends on its availability, it is also dependent upon the nature of the available retrieval information at test. As such, inferences about what is available in memory cannot be made solely on the basis of what is accessible.

As noted above, the finding of encoding/retrieval interactions also demonstrates that memory test performance cannot be predicted on the basis of encoding operations alone. Fisher and Craik (1977, Exp.2) presented pairs of words which either rhymed or were associatively related and instructed the subjects to remember the member of each pair presented in uppercase letters. The subjects then received a cued recall test in which each cue either rhymed with or was associatively related to only one target word. In addition to there being a superiority of semantic over rhyme encoding and semantic over rhyme cues, they found an interaction between encoding and retrieval conditions: semantic cues were superior for semantic encodings whereas rhyme cues were superior for rhyme encodings.

Another interesting encoding/retrieval interaction was found by Thomson and Tulving (1970, Exp.2). In this study, target words were either studied alone or in the context of weakly related cues. Recall was cued either by weak cues or by strong extralist associates of the target words. While cued recall to the weak cues was significantly higher when the cues had been presented in the study phase, recall to the strong cues was reliably lower when the target words had been accompanied by weak cues at input.

8. <u>Transfer-Appropriate Processing.</u>

While the effectiveness of any particular form of encoding depends upon the retrieval environment, it has frequently been found that semantic processing/test conditions result in better memory performance than do nonsemantic processing/test conditions (e.g. Arbuckle and Katz, 1976; Fisher and Craik, 1977; Moscovitch and Craik, 1976) suggesting that initial processing depth is still an important determinant of subsequent memory performance. Morris, Bransford and Franks (1977), however, have challenged the assumption that semantic processing is inherently superior to nonsemantic processing by arguing that the apparent inferiority of nonsemantic forms of encoding may be due to the inappropriateness of the relationship between encoding and test situations rather than the inherent inferiority of the acquired memory traces. They demonstrated that while in a standard recognition test semantic processing was superior to phonemic (rhyme) processing, in a recognition test in which the targets were rhymes of the items originally presented, rhyme encoding generally proved superior to semantic encoding. Similarly, using a visual recognition test, McDaniel, Friedman and Bourne (1978) have shown that structural processing can result in better memory performance than deeper, conceptual processing when memory for structural information is tested.

A series of studies by Nelson and his colleagues have also demonstrated that nonsemantic processing can result in retention levels as good as, or better than, those resulting from semantic encoding (Nelson and Brooks, 1974; Nelson and McEvoy, 1979; Nelson, Walling and McEvoy, 1979; Nelson, Wheeler, Borden and Brooks, 1974). Nelson and Brooks (1974) found that when the a priori similarity between synonym cues and their targets was equated with that between rhyme cues and their targets synonyms and rhymes proved to be equally effective as extralist retrieval aids. Nelson, Wheeler, Borden and Brooks (1974) showed that when rhyme and synonym cues were available at both study and test, the synonyms were more effective than the rhymes as cues, whereas the reverse was true when the cues were available at test only. While Nelson, Walling and McEvoy (1979) found semantic cues to be superior to rhyme cues, ending cues were as equally effective retrieval aids as the semantic cues. Nelson et al concluded that the semantic superiority may have been produced more by interference generated by the rhyme cues than by the qualitative superiority of semantic information per se.

Bransford and his colleagues (Bransford, Franks, Morris and Stein, 1979; Morris, Bransford and Franks, 1977) argue that 'meaningfulness' of encoding must be defined relative to the learner's skills and goals. Typical levels of processing studies have found semantic processing to be superior to non-semantic models of processing because the retention tests employed in these studies have been dependent upon semantic processing. The above authors stress the importance of study/test interactions, emphasising that assumptions about the value of particular encoding operations can only be made by considering the appropriateness of the test situation. Even then, however, the value of various acquisition-test relationships must include reference to relationships between the to-be-acquired information and the skills and cognitive state of the learner.

9. Encoding Specificity Principle

Findings of encoding/retrieval interactions such as those of Fisher and Craik (1977) and Morris, Bransford and Franks (1977) are compatible with Tulving and Thomson's (1973) encoding specificity principle which states that "specific encoding operations performed on what is perceived determine what is stored, and what is stored determines what retrieval cues are effective in providing access to what is stored".(p.369). In other words, a retrieval cue is effective only to the extent that its informational content overlaps with the episodic trace of the target item. The memory trace of an item is assumed to consist of a number of features which are activated during encoding. At retrieval, the cue is encoded and the resulting activated features compared with those present in episodic memory. Encoding/retrieval interactions can be understood by assuming that the retrieval information provided in one condition overlaps to a greater extent with the encoded representation of the target item than does that provided in another.

The above principle was originally proposed as the encoding specificity hypothesis by Tulving and Osler (1968) who found that weak associates aided recall when presented at input and test, but had no beneficial effect when presented only at test. In addition, there was no benefit to recall if different cues were presented at the study and retrieval phases. Forgetting, according to Tulving (1974a),is the result of a mismatch of information in the trace of the item and in the retrieval environment.

Like Bransford and his colleagues Tulving (1979) has emphasised the futility of describing retention in terms of encoding or retrieval conditions alone; both must be taken into consideration when making inferences from data. Memory performance, he argues, is always determined by the compatibility between encoding and retrieval conditions (or between the trace information and cue information). Such compatibility alone is sufficient to account for memory performance, without placing additional emphasis on the qualitative nature of the encoding task as the levels of processing theorists have proposed (e.g. Fisher and Craik, 1977). As such, Tulving is in agreement with Morris et al (1977) and Nelson (1979) in proposing that semantic orienting tasks do not result in inherently stronger or "better" memory traces than do nonsemantic tasks.

While the encoding specificity principle has been criticised for its circularity and empirical untestability (Baddeley, 1976) it is a general principle covering all memory retrieval which provides a useful framework in which to interpret the outcome of experiments. Only time will tell whether or not it will eventually prove theoretically fruitful.

10. Distinctiveness.

Recently researchers have begun to realise the importance of distinctiveness in determining memory performance. Moscovitch and Craik (1976), for example, found that recall was poorer when several words shared the same encoding question/ retrieval cue than when each word was encoded uniquely. Performance, they argued, is influenced by the uniqueness or distinctiveness of the link between the retrieval cue and the encoded event, an idea similar to Watkins and Watkins' (1975) cue-overload theory. Moscovitch and Craik and Lockhart, Craik and Jacoby (1976) have suggested that while semantic encodings are distinctive (i.e. share few common features with other encoded events), phonemic encodings are nondistinctive due to the relatively small number of phonemes in the English language, which results in a great deal of overlap of encoded features in a list encoded phonemically. Packman and Battig (1978) have attributed the superior memorial consequences of pleasantness ratings over those of other semantic dimensions (e.g. meaningfulness, imagery) to the greater distinctiveness of pleasantness processing.

The concept of distinctiveness has also been invoked by Klein and Saltz (1976) to explain their findings. They demonstrated that processing a word on two attribute dimensions (such as happy-sad, big-little) led to better recall of the word than processing it on a single dimension. Furthermore, with incidental learning instructions, when a word was processed in two semantic dimensions recall was inversely related to the degree of correlation between the two dimensions. In Klein and Saltz's view, uncorrelated dimensions specify an event's encoding more precisely and distinctively in "cognitive space".

Eysenck (1979) has suggested that deeper processing facilitates memory performance (and, in particular, recognition) primarily by making the study encoding dissimilar to previous encodings (i.e. by making it distinctive). Eysenck has presented empirical evidence for the importance of prior encoding on resulting memory performance. According to Eysenck, a distinctive encoding is represented by a minimal overlap of previous encodings, but while elaborate encodings will tend to be more distinctive than nonelaborate encodings, this is not inevitable.

Jacoby and Craik (1979) have also argued for the importance of distinctiveness. In their view, distinctive encodings are beneficial to memory performance because at retrieval they allow the event to be discriminated from a larger set of alternatives. Jacoby and Craik have emphasised the context-dependency of distinctiveness; an encoding which is highly distinctive in one context is not necessarily distinctive in another. Like Eysenck 1979), Jacoby and Craik suggest that the levels of retention associated with structural, phonemic and semantic processing may reflect differences in the underlying descriptive dimension of distinctiveness.

Although the concept of distinctiveness has been endorsed by other researchers (e.g. Nelson, 1979; Tulving, 1979), several problems associated with the concept have been highlighted. Baddeley (1979), for example, suggests that it is not clear how one could measure the distinctiveness or discriminability of a set of traces. Eysenck (1979) too, points out that there is as yet no satisfactory independent index of trace distinctiveness. Furthermore, prediction of memory performance is difficult since distinctiveness is relative rather than absolute: encodings can only be considered distinctive relative to some set of encodings. As such, the concept of distinctiveness is at present a vague, though plausible, explanatory principle.

<u>The Structure of Memory Traces</u>.

The previous theoretical approaches have placed emphasis on the importance of initial encoding operations for subsequent retention. They have also stressed the necessary compatibility of encoding and retrieval situations for successful retrieval of the to-be-remembered information. With the main emphasis being on process, there has been little work aimed at determining, in a more precise manner, the qualitative characteristics of the acquired memory traces. The present section presents a review of recent research, the aim of which has been to describe, in some systematic way, the structure of memory traces.

Within the current theoretical climate, the memory trace is generally seen as comprising of a number of encoded features or attributes. In the present section the focus of concern is upon the manner in which relevant features comprising the memory trace are conceptualised as being represented in relation to one another, in general terms, and on various empirical approaches which have been developed to assess, in a more detailed fashion, the nature of episodic memory representation.

The main problem in attempting to describe the structure of individual memory traces lies in the fact that the informational content and characteristics of the memory trace are not directly observable. As such, inferences must be made about the nature of the representation in terms of the relation between the retrieval situation and the resultant memory performance. Tulving and Bower (1974) have presented a comprehensive review of a variety of experimental techniques which have been used to assess the nature of episodic memory representation and which generally assume that the memory trace can be conceived of as a collection of encoded features or attributes. The numerous experimental techniques which have been employed in the study of memory traces include: the use of orienting tasks that are assumed to determine the characteristics of the memory trace (e.g. Craik and Tulving, 1975; Till and Jenkins, 1973); Feature probing, in which the subject is required to retrieve information about specific features, such as presentation modality or serial position. Here the assumption is that if the subject can provide the relevant information, then it must have been stored as part of the memory trace of the item (e.g.Hintzman and Block, 1971); Madigan and Doherty, 1972); the analysis of recall intrusions which are assumed to reflect properties of the stored information (e.g. Conrad, 1964; Wickelgren, 1965); the analysis of false positive recognition errors which are assumed to arise because the test item shares features in common with a list item. The analysis of false positive recognition errors has been applied both to individual words (e.g. Anisfeld and Knapp, 1967; Eagle and Ortof, 1967; Elias and Perfetti, 1973) and to sentence materials (e.g.

Kosslyn and Bower, 1974); finally, the study of the phenomenon of release from proactive inhibition which is assumed to reflect changes in the attributes encoded from one trial to the next (e.g. Wickens, 1970, 1972).

While problems unique to each of the above techniques exist, and have been discussed by Tulving and Bower, the findings of recent research indicate a more general problem that is applicable to each of the techniques. Given that successful retrieval involves the interaction and compatibility of retrieval information and trace information, memory performance will be greatly affected by the nature of the retrieval information available at test. Testing memory performance in a single retrieval environment will necessarily lead to a rather limited description of the underlying memory trace. A fuller description of the memory representation can be achieved through the use of different retrieval cues, each directed at the same functional representation of the target word.

Tulving and Watkins (1975) have incorporated the technique of successive probing of the to-be-remembered item in their method of analysing the structure of the memory trace. It is assumed that the resultant patterns of cue effectiveness reflect the composition of the underlying memory trace, since memory traces are defined in relation to the interaction of encoding and retrieval conditions. The principle of encoding specificity is implicit in this trace theory. Tulving and Watkins' reduction method involves successive probing, and with two cues two different cueing orders are required. For each cue order, a separate 2x2 contingency table, or cue matrix, is constructed which represents the pattern of cue effectiveness for that particular cue order. A trace matrix, which represents the overall pattern of cue effectiveness and correspondingly the structure of the underlying memory trace,is obtained through combining the cue matrices for the different cueing orders. Since it is possible that retrieval of the trace to the first cue may induce recoding of the trace, resulting in the second cue being directed at a different functional representation from the first, the trace matrix is constructed using the overall probabilities of recall to the first cues and the probabilities of recall to the second cues given that recall to the first cue has been unsuccessful, from the two cue matrices. Ogilvie, Tulving, Paskowitz and Jones (1980) have extended the reduction method to incorporate three retrieval cues.

Hintzman (1980) has criticised the reduction method on the grounds that it is susceptible to "Simpson's Paradox"; the observation that combining two contingency tables may result in a summary table which indicates different relations between the elements from those exhibited in either of the original tables. Consequently, contingency analyses of the memory trace should be carefully interpreted. In none of the examples provided by Tulving and his colleagues, however, were paradoxical results found in the data. The successful application of the reduction method to situations in which the a priori relationship bewteen the cues can be stated with some certainty demonstrates the validity and usefulness of the reduction method as a means of assessing the nature of the underlying memory representation.

The reduction method has been employed by several other investigators. Arbuckle and Katz (1976), for example, found evidence via the reduction method that recall relies on predominantly semantic information while recognition utilises both semantic and nonsemantic information contained in the memory trace. Bruce (1980) used the reduction method to establish parameters for testing various hypotheses concerning the effectiveness of double probes. The data he obtained were most compatible with the additive components model (e.g. Jones, 1976), which states that retrieval will be successful if information provided by either or both cues is present in the memory trace.

At a more general level, Bower's (1967) multicomponent theory has already been mentioned with respect to the encoding of attributes. It also represents, however, a formalised description of the nature of memory representation. According to Bower, the memory trace consists of a vector of ordered components which are assigned a certain value. Relational information is represented in this system by a compound vector linking the constituent elements. Forgetting occurs as a result of a change in value of one or more components of the vector. Bower has suggested that the components of a vector are hierarchically ordered according to importance, with the most important components being the most resistant to forgetting.

The notion that the memory trace is composed of a collection of features or attributes has also been adopted by Horowitz and Manelis (1972). Horowitz and Manelis were concerned mainly with redintegrative memory, (also, Horowitz and Prytulak 1969) which occurs when a unitized structure (e.g. an idiomatic adjective-noun phrase) is more likely to be remembered than either of its constituent parts alone. One distinguishing feature of redintegrative memory is that one component of the unit is recalled with a higher probability and in cued recall is a better cue for eliciting the entire structure. Horowitz and Manelis have, however, also presented a broader theory of memory representation based on the relative salience of features comprising the trace. According to Horowitz and Manelis the memory trace is comprised of features which may vary in salience. The salience of the different features will change as a function of the particular encoding context. Words become unitised in memory when they have features in common, and it is these shared features that tend to become most salient. In recall it is features that are recalled and then translated into words. The more salient features will be the most easily recalled, since they are assumed to be more persistent. In cued recall the features of the cue can retrieve the entire unit, with the probability of successful recall increasing as a function of the number of encoded features common to the constituents of the unit. If the overlapping features are forgotten, the components of the unit will be represented as two separate subsets of meaning features, and one component will prove ineffctive as a cue for recall of the other.

Jones (1976) has proposed a similar theory to that of Horowitz and Manelis. According to Jones' fragmentation hypothesis, the memory trace represents a fragment of the nominal stimulus and is composed of a number of features, both focal and nonfocal (e.g. Nelson and Borden, 1977). Any feature or attribute in the fragment can provide access to the remainder of the fragment in an all-or-none fashion. As a consequence, additional cueing will prove redundant, although multiple cueing may prove numerically superior to single cueing over a number of fragments since the fragment may be inaccessible to the first cue. While the fragmentation hypothesis was originally based on the results of orthogonal cued recall of pictorial stimuli, its applicability to memory for sentence material has been demonstrated by Jones (1978) and Bruce (1980), using a double-probing technique, demonstrated that memory for conceptual and associated name information was best explained in terms of the fragmentation hypothesis.

The Present Research

While a large number of the studies mentioned in the preceding sections have been concerned with comparing memory performance following encoding in qualitatively different domains, the concern of the present research is confined to processing within the semantic domain. Although semantic orienting techniques which induced incidental learning were employed in the majority of experiments to be reported, such tasks have been demonstrated to result in comparable memory performance to that obtained under intentional learning conditions (e.g. Hyde and Jenkins, 1969). Thus, it would appear that subjects typically process items semantically when given instructions to learn. In the majority of the studies to be reported, the to-be-remembered items were homonyms presented in the context of two biasing nouns which biased either one or two meanings of the homonym. The subjects were required to indicate on each trial whether or not they could perceive a semantic relationship between the homonym and each encoding stimulus. The semantic orienting task was employed to ensure that the homonyms were encoded with reference to the biasing nouns, thereby ensuring that on the appropriate trials, two different meanings of the homonym would be encoded. The use of incidental learning procedures eliminates, or at least reduces, the possible introduction of confounding factors, such as differential rehearsal of list items, which typically occur when the subject is instructed to learn a list of items, and consequently provides a more precise picture of the effects of various experimental manipulations.

The major aim of the present research was to determine the manner in which different meanings of homonyms are represented in long-term episodic memory. Homonyms are an especially suitable class of verbal items for studying the effects of semantic processing: the orthographic and phonological features remain a constant factor while the semantic features that are encoded may differ completely across experimental conditions. For this reason, it should be possible, using homonyms, to determine whether the representation of individual items in episodic memory is based upon commonality of semantic or nonsemantic features. In the former case, each different meaning of the homonym will be separately represented in episodic memory and in the latter case each meaning of the homonym will be represented within the same memory trace.

A major theoretical assumption of the present research concerns the nature of episodic memory representation. It is assumed at the outset that the episodic memory trace consists of a collection of semantic and nonsemantic features or attributes, which have been activated during the encoding phase. At encoding the representation of the item in semantic memory (the knowledge system) is accessed and a subset of the semantic and nonsemantic features associated with the item are transferred to episodic memory (the storehouse of temporally dated events or episodes). Tulving's (1972) distinction between episodic and semantic memory will be discussed in the following chapter. The function of orienting tasks, it is suggested, is to direct the subject to activate a particular subset of features, although other nonfocal features may be activated too. Words may be stored together in episodic memory if some subset of features common to the two words is activated at encoding.

An important distinction which is endorsed in the present research is that between item availability and item accessibility (Tulving and Pearlstone, 1966). While the representation of an item may be present in episodic memory, and thus available, its accessibility will depend upon the appropriate retrieval information being provided at test. At retrieval the cue (be it a copy cue or a recall cue) is encoded in a similar manner to that at study. The activated features are matched against those in episodic memory. If a successful match occurs, then the to-be-remembered item will be retrieved, otherwise retrieval will fail.

The results of the experiments to be reported will be interpreted within the following general framework for episodic memory representation. The framework contains significant ideas from several of the approaches which have been discussed in this chapter. It can be conceptualized in terms of four major assumptions.

The first basic assumption to be made concerns the nature of the memory representation and the relative importance of semantic and nonsemantic features in that representation. It is assumed that the episodic memory representation of a verbal item consists of a collection of orthographic, phonological and semantic features which specify the item and which are activated during the encoding phase. Episodic representation is seen as consisting of a subset of the total set of features specifying the words which are stored in semantic memory. It is suggested that while some subset of encoded orthographic and phonological features necessarily form the basis of representation, the most important subset consists of the semantic features. The significance of the semantic features lies in their unique defining qualities, differentiating verbal items which may share common orthographic and/or phonological features. The importance of the semantic features is further emphasised in the present experiments by the use of encoding instructions which direct the subjects to actively encode the semantic features of the presented words as opposed to their orthographic or phonological features. As a consequence, the resulting memory traces are assumed to contain a high proportion of semantic features.

The second assumption to be made is that when required to determine the presence or lack of a semantic relationship between pairs of words, the subject will search their entries in semantic memory for some subset of semantic features which are shared by the two words. If no such subset is found, the subject will decide that the two words are unrelated in meaning and the two words will be represented as separate units in episodic memory. If, on the other hand, the two words are found to share some subset of semantic features, then the words will be perceived to be semantically related. In such cases, the pair of words will be represented in episodic memory as a unit, where the unitisation is mediated through the subset of shared semantic features.

The third assumption to be made pertains to the relative salience of unique and shared encoded features. In line with Horowitz and Manelis (1972) it is proposed that shared semantic features, which are common to both words, are more salient than unique semantic features, which define only one member of the pair. By salience, it is simply meant that such features are more strongly represented in long-term memory. Consequently, the more salient features contained in the memorial representation of a verbal item, the more accessible will that word be. The greater salience of shared semantic features, it is argued, results from the focal, and thus more extensive processing of these features, at input. Such salience, in turn, leads to these shared features being more highly accessible at retrieval. Finally, it is proposed that, for the above reason, semantic features shared by more than two words will be somewhat more salient than features which are common to only two words, although it will be shown in a later experiment that subjects tend not to recode features which have been encoded on the first comparison.

The fourth and final, general assumption concerns the nature of the retrieval process. It is argued that at retrieval the information contained in the retrieval cue is matched against the information contained in episodic memory. Just as the initial encoding context determines which subset of the total set of possible features comprises the episodic representation of the word, so the retrieval context will determine which features of the cue are encoded and matched against that representation. Successful retrieval will occur if a match is obtained between the encoded features of the retrieval cue and the features present in the episodic trace of the to-be-remembered word.

The above four assumptions provide a general framework for episodic memory representation within which the representational consequences of the qualitatively different types of encoding employed in the following studies can be conceptualized.

The present theoretical framework represents a contextualist approach to the study of episodic memory (Jenkins, 1974). The manner in which items are functionally represented in episodic memory is assumed to be influenced by the encoding context. Likewise, the subsequent accessibility of the items will be strongly influenced by the retrieval context that prevails at test. Within such a theoretical framework it is evident that testing retrieval in a single context will necessarily provide only limited information about the nature of the underlying memory representation. In the experiments to be reported, the memorial effects of various qualitative manipulations of the encoding context were assessed in a variety of retrieval contexts in order to obtain a more precise description of the nature of the episodic memory representations resulting from each form of encoding.

Determining the manner in which different meanings of homonyms are represented in episodic memory was chosen as the present research topic for two main reasons. First, no direct systematic work has been carried out to date which has been aimed at assessing how this class of verbal items are represented in episodic memory. Any previous reference to the way in which different meanings of homonyms are represented in episodic memory has been made on the basis of somewhat circumstantial evidence that is equally interpretable in terms of a single trace as it is in terms of trace multiplexing (e.g. Light and Carter-Sobell, 1970). Consequently, the present research was aimed at clarifying this rather cloudy area.

The second, and perhaps more important, reason for the present research is closely tied to the first. Certain researchers (e.g. Reder, Anderson and Bjork, 1974) have suggested that each different meaning of a homonym has a separate 'node' in long-term memory. Since episodic memory consists of the attachment of an occurrence tag to the long-term memory representation, the different meanings of a homonym will be separately represented in episodic memory too. It has also been suggested that even different senses of non-homonyms are represented separately from one another. The second aim of the following studies, then, was to determine if such a conceptualization of episodic memory representation is valid and useful, since the above formulation, posited to account for various episodic memory phenomena, was based largely upon post hoc assumptions. In alternative conceptualizations of the nature of episodic memory representation (e.g. Tulving, 1976) no explicit reference has been made to the qualitative nature of homonym representation, although different senses of nonhomonyms are generally considered to be represented within a single trace (Kintsch, 1974).

Accordingly, the findings of the studies to be reported should fill a significant gap in the understanding of the nature of episodic memory representation.

With respect to the above two aims, the first six experiments to be reported were concerned with determining, in general terms, the nature of homonym representation and the utility of the proposed framework for episodic memory representation. The second experimental section is concerned more directly with the second of the two aims. In this section, the experiments to be reported are concerned with determining whether different encoded meanings of homonyns are represented within the same single trace or across different memory traces.

The following chapter presents a critical review of several pertinent episodic memory phenomena and the manner in which they have influenced conceptualizations of how different meanings of homonyms and different senses of nonhomonyms are represented in long-term episodic memory.

CHAPTER 2

EPISODIC MEMORY PHENOMENA: A SELECTIVE REVIEW

1. Introduction

The manner in which ambiguous words are represented in the "internal lexicon" is of interest to linguists and memory researchers alike. The majority of linguists operating in the field of semantics agree that separate lexical entries (representations) are likely to exist for each distinct meaning of a homonym (Baldinger, 1977; Katz, 1972; Katz and Fodor, 1963, Kempson, 1977; Leech, 1974; Lyons, 1968; Weinreich, 1966). For linguists the main point of contention would appear to be whether or not such separate representations exist for the less obvious differences in meaning which are manifest in polsemy. For example, while Weinreich (1966) has proposed that a polysemous word will have as many entries as it has meanings, others, such as Katz (1972) and Lyons (1968), would argue that only homonyms have a separate lexical reading for each meaning.

In the field of human memory, too, it is widely believed that each distinct meaning of a homonym has a separate representation in semantic memory, part of which generally corresponds to the linguists' internal lexicon. Using a lexical decision task, Rubenstein, Garfield and Millikan (1970) showed that with word frequency controlled subjects were quicker at recognising homonyms than non-homonyms suggesting that homonyms have several representations in the lexicon. Furthermore, response latencies decreased with increases in the number of meanings which the homonyms possessed. Rubenstein, Lewis and Rubenstein (1971) compared decision latencies to systematic and unsystematic homonyms, the former of which correspond to polysemous words and the latter to true homonyms. They found that while reaction times to unsystematic homonyms were faster than those to nonhomonyms, the subjects were no faster at recognising systematic homonyms than non-homonyms. These results suggest that polysemous words have a single representation in semantic memory, while homonyns have several. Jastrzembski (1981) has also demonstrated faster lexical access times for words with several meanings but found,in addition,that words with a large cluster of meanings were recognised more quickly than those with smaller clusters of meanings. Jastrzembski has also proposed that different meanings of ambiguous words have separate representations in semantic memory.

Using a lexical decision task Simpson (1981) has shown that if no disambiguating context is present the most frequent meaning of a homonym is accessed, while with a strong biasing context provided the meaning that is biased is retrieved. The finding that a single meaning tends to be accessed would suggest separate representations of the different meanings in semantic memory.

Several models of long-term memory have been proposed in which it is assumed that different meanings of homonyms are represented separately. In Morton's (1970) logogen model,which was originally proposed as a model of word recognition,each word is represented by a logogen. A logogen is a counting device which gathers information of various types - visual, phonemic, semantic, contextual etc. The logogens are incremented when relevant information enters the system, with a response being made available when a certain threshold is reached. Morton has suggested that the logogens are defined semantically such that a separate logogen exists for each distinct meaning of a homonym. Jastrzembski (1981) has argued that homonyms are recognised faster than nonhomonyms because the more logogens that a word has, the more likely it is that one of them will reach threshold.

Kintsch (1970, 1974) has proposed a model in which semantic memory is conceived of as an associative network where each word is defined by its relationship to other words in the network. The entry for a word consists of a list of semantic, phonemic and sensory markers. Kintsch has suggested that each meaning of a homonym will have a separate representation in the network, with the meaning of each entry defined by the context of semantic relationships with other words.

While earlier versions of Anderson and Bower's Human Associative Memory (HAM) made no explicit reference to the manner in which homonyms were represented in the semantic memory network (e.g. Anderson and Bower, 1972, 1973), later versions incorporated the notion that homonyms were multiply represented. Anderson and Bower (1974) and Reder, Anderson and Bjork (1974) have suggested that there exist in a long-term memory network idea nodes which correspond to different senses of words - even nonhomonyms are assumed to be multiply represented. Semantic, context is assumed to determine which sense is activated at input and associated with a context tag.

While in each of the above models it is assumed that there are as many entries in long-term memory as there are different meanings of a homonym, these models are essentially concerned with the representation of homonyms in what Tulving (1972) has termed semantic memory. General knowledge about words and concepts, in the form of laws and rules extracted from past events, is stored in semantic memory. As such, the internal lexicon forms part of semantic memory. Episodic memory, on the other hand, consists of information about temporally dated events and the relationships among these events. Episodic memory is the storehouse of specific events or episodes which have personal reference. Knowledge that the word DOG appeared in a certain list and was preceded by the word HOUSE is an example of episodic storage. Although Tulving has suggested that the episodic system may operate independently of semantic memory,the latter system must exert a strong influence over the former since comprehension of a word must necessarily involve accessing its representation in semantic memory. The majority of experiments in the field of human memory involve the learning of lists and consequently fall in the domain of episodic memory. While it is generally agreed that each meaning of a homonym has a separate representation in semantic memory, there is no compelling evidence to suggest that the same is true of episodic representation. The results of the majority of pertinent studies could be interpreted in terms of either a single or multiple representations. The finding of a single representation for each meaning of a homonym in episodic memory would seriously challenge those theories, such as Anderson and Bower's (1974) which assume that episodic memory consists of the "tagging" of discrete idea nodes in long-term memory, where the idea nodes correspond to different senses of words.

The remainder of the chapter presents a review of studies which have had an influence, directly or indirectly, on conceptions of how ambiguous words are represented in long-term episodic memory and discusses the implications for various theories of single versus multiple representations of homonyms in episodic memory.

2. Context Effects in Recognition Memory

A large number of studies have been reported which have demonstrated the detrimental effect upon recognition performance of changing the context of the to-be-remembered items from study to test. Three types of context change can be identified, all of which have been shown to lead to a reduction in recognition performance compared to when the study context is reinstated at the test phase. In context deletion studies the test item is studied in a given context but tested alone. In context addition studies the test item is studied alone, but context is added at test. Finally, in context substitution studies different context words are provided at the study and test phases.

In a study by Tulving and Thomson (1971) study words were presented alone or in the context of a strong associate. Recognition performance for items studied in the context of strong associates was considerably impaired when the study context was absent at test, and recognition of items studied alone was somewhat reduced when the items were tested in the context of a strong associate. Thomson (1972) found that both addition and deletion of context had detrimental effects on recognition performance. Context addition, however, only impaired performance when study lists containing both pairs of words and single words were used. The deleterious effects of context change increased with increasing retention intervals suggesting either that with longer retention intervals the test context is more likely to determine the cognitive environment for the word or that with longer retention intervals access to the trace of the word can only be gained through the matching of semantic features. Underwood and Humphreys (1979) found little effect of context addition on recognition memory and have concluded that context addition does not influence recognition performance except under very special conditions where mixed study lists are used. The studies by Tulving and Thomson (1971) and Thomson (1972) have demonstrated that context deletion reliably reduces recognition performance.

Context substitution also exerts a strong influence on recognition performance. Several studies have demonstrated the deleterious effect of providing different contexts at study and test. Pellegrino and Salzberg (1975) found that in both cued recall and context recognition, performance was better for homonyms tested in the same context as at input than for homonyms whose test context differed from the study context. Davies, Lockhart and Thomson (1972) demonstrated that homonyms were better recognised when tested in their input categories than when tested in nominally and semantically different categories. Hunt and Ellis (1974) showed that an unrelated word, a homonym and a word which maintained the same study meaning all resulted in the same amount of loss in retention, suggesting that any context word produces a decrement if it differs from the one occurring on the study trial.

One of the clearest demonstrations of the detrimental effects on recognition of changing the context of an item from study to test has been provided by Light and Carter-Sobell (1970). Light and Carter-Sobell found that changing the semantic interpretation of a homonym impaired performance considerably compared to a condition in which the semantic interpretation remained the same and to a condition in which no context was provided at test. The best recognition performance was obtained when the same biasing adjective was paired with the homonym at study and test.

The finding of context effects in recognition memory indicates the need for a distinction between nominal and functional stimuli. If what is stored in episodic memory is a nominal copy of the target item,then re-presentation of that nominal stimulus at test should result in the same level of recognition of the target item, regardless of the prevailing test context. Rather, changing the study context at test would appear to induce the encoding of a different set of features from that encoded during the study phase, resulting in a different functional representation of the study and test items. The observation that changing the context of an item from study to test impairs recognition also indicates the implication of retrieval factors in recognition, a point which will be taken up later in the chapter.

Light and Carter-Sobell (1970) have interpreted their results as indicating that homonyms have more than one representation in long-term memory: at least one representation for each meaning. The authors have suggested that when one meaning of a homonym is encoded the long-term memory representation corresponding to that meaning is tagged for recency. When a different meaning is biased at test, the representation tagged at input is not the one which is accessed and examined for recency information. The finding of recognition context effects with nonhomonyms would seem to suggest that even different senses of nonhomonyms are separately represented in long-term memory. The theoretical implications of context affects in recognition will be discussed following a review of another pertinent memory phenomenon; that of recognition failure of recallable words.

3. Recognition Failure of Recallable Words

The phenomenon of recognition failure of recallable words, or simply recognition failure, can be considered a special instance of context effects in recognition. While Tulving (1968) first demonstrated that subjects could fail to recognise words which they could nevertheless recall, the first systematic demonstration of recognition failure was provided by a set of experiments by Tulving and Thomson (1973). Tulving and Thomson (exp.1) presented weakly associated pairs of words, such as ground-COLD and instructed the subjects to learn the capitalised member of each pair with reference to the other member. Following presentation of each of two set-establishing lists,recall of the target words was cued by the weak cues. Following presentation of the third, critical, list the subjects were required to free associate to a strong extralist associate of each target word (e.g. HOT) and to circle those words from their generated responses which they recognised as target words. The recognition hit-rate was 24%. The subjects were then provided with the weak list cues encoded at input and performance on the cued recall test rose to 63%. Thus, the subjects could not recognise many generated copies of target words although they could produce them in the presence of intralist cues.

The robustness of the phenomenon has subsequently been demonstrated by several researchers (e.g. Watkins and Tulving. 1975; Wiseman and Tulving, 1975, 1976). In a series of experiments using the basic recognition failure paradigm, Watkins and Tulving (1975) found that recognition failure occurred with experimenter-generated and subject-generated recognition tests, with free and forced-choice recognition, for both generated and nongenerated targets in the free association task, without the free association task, with related and unrelated lures in the recognition test, and with or without previous set-establishing lists. Rabinowitz, Mandler and Barsalou (1977) have found recognition failure even with well-practiced subjects and unrelated study pairs. While Santa and Lamwers (1974) have orgued that the free association task leads to list discrimination problems in the recognition test, Wiseman and Tulving (1975) have demonstrated recognition failure for nongenerated list halves and Bowyer and Humphreys (1979) found recognition failure when list discrimination problems were eliminated through not using set-establishing lists or the free association task. Bawyer and Humphreys also eliminated priming as a cause of recognition failure since priming effects were found to be small in those experiments in which recognition failure was large.

The magnitude of recognition failure of recallable words is indexed by the conditional probability that a to-be-remembered item is not recognised given that it is recalled. Tulving and Wiseman (1975) found a systematic function between P(Rn), the probability of recognition, and P(Rn/Rc), the probability of recognition success (the complement of recognition failure). As the overall level of recognition increases, the probability of recognition failure decreases. The finding of higher recall than recognition is a sufficient, but not necessary, condition for recognition failure, since words may be recalled but not recognised even when overall recognition performance is higher than that of recall. While certain studies have shown a superiority of recognition over recall, there has still been some recognition failure in these studies and the data have conformed to the Tulving-Wiseman function (e.g. Postman, 1975; Reder, Anderson and Bjork, 1974).

As Wiseman and Tulving (1976) have pointed out, the fact that an item can be recalled to the list cue indicates that information about that item must have been available at the recognition test. The failure to recognise the item must, therefore, be a consequence of inadequate retrieval information in the copy cue in the recognition test. Bartling and Thompson (1977) have shown that in the recognition failure paradigm the list cue is a better cue for recall of the target word than vice versa. They attribute recognition failure to the memory trace for the word pair being less accessible through the copy cue in recognition than through the list cue in recall and have provided evidence that the free association task increases this retrieval asymmetry. Rabinowitz, Mandler and Barsalou (1977) have also argued that recognition failure is due to failure to access the holistic pair encoded at study. Recall of one member of the pair, given the other member as a cue, requires accessing of the entire unit, with successful retrieval of the unit producing the other member of the pair. Rabinowitz et al demonstrated that recognition failure is most likely to occur for those pairs for which forward retrieval is superior to backward retrieval. If backward retrieval is attempted during recognition and fails, then the item will not be called "old". The authors have shown that over ¾ of all recognition failures in their studies were due to a failure in backward retrieval.

Exceptions to recognition failure have been found with abstract word-pairs and digit-word pairs (Gardiner and Tulving, 1980) but seem to be due, at least in part, to the nature of the study encoding rather than to the nature of the to-be-remembered material per se.

4. Generation-Recognition Theory

The implication of retrieval processes in recognition is counter to the class of theories which assume that there is no access problem in recognition i.e. that presentation of the copy cue at test should result in automatic access to the marked representation of the target item. According to these generation-recognition theories (e.g. Anderson and Bower, 1972, 1974; Bahrick, 1970; Kintsch, 1970, 1974), recall is seen as involving the generation of a set of possible response candidates upon which a recognition check is carried out to select the correct alternative. Only the generation subprocess is assumed to involve retrieval. While Kintsch (1974) has postulated separate semantic and episodic memory representations, in the Anderson-Bower theory it is proposed that encoding involves the marking with occurrence tags of existing nodes in the long-term memory network: episodic memory is seen as the tagging of idea nodes in semantic memory. At recognition the copy cue provides automatic access to the appropriate node in long-term memory, which is examined for the presence of an occurrence tag containing relevant contextual information pertaining to the earlier presentation of the item. The phenomena of context effects in recognition and recognition failure of recallable words demonstrate that a retrieval problem does exist in recognition. According to generation-recognition theory, if the relevant occurrence information is available in memory, then recognition should be successful regardless of the test context of the item. The occurrence of recognition failure of recallable words suggests that while the occurrence information is available in memory, it is not accessible via the literal copy of the target item.

Another phenomenon which poses problems for generation-recognition theory is the ineffectiveness of strong associates as retrieval cues under certain conditions (e.g. Murphy and Wallace, 1974; Tulving, 1974b). While Postman (1975) demonstrated that strong intralist and extralist cues were more effective than weak intralist and extralist cues, and Santa and Lamwers (1974) showed that strong extralist cues can facilitate recall, Thomson and Tulving (1970, exp.3) found that when strong extralist cues were provided for recall of words encoded in the context of weak cues, performance was no better than that obtained in free recall. Strong associates are assumed to facilitate recall by guiding the search through long-term memory and the generation of response candidates. If a strong extralist cue does not produce an expected enhancement in recall, the locus of failure must be in the recognition phase.

In a modification of their original theory, Anderson and Bower (1974) and Reder, Anderson and Bjork (1974) have suggested that what are tagged when encoding occurs are different senses of words, rather than words per se - the multinode assumption. The initial study context is assumed to determine which sense will be tagged. When the context of a target item is changed from study to test, recognition may fail because at test a different sense of the word is examined for occurrence information from that encoded at input. Extralist cues are assumed to fail because the sense of the target word generated to the cue differs from that encoded during the study phase, and recognition failure is said to occur because the intralist cue is more likely than the copy cue in a different context to access the tagged sense of the target item. Martin (1975) and Santa and Lamwers (1976) have argued that in the recognition failure paradigm the subjects are required to recognise and recall different senses of the to-be-remembered word. The importance of the initial study context has been demonstrated by Baker and Santa (1977) who showed that the better integrated the representation the more difficult it is to break the original context and to retrieve with different cues.

The results of several studies employing homonyms have demonstrated that the encoded sense of a homonym can be more easily retrieved at test than a nonencoded sense (e.g. Light and Carter-Sobell 1970; Murphy and Wallace, 1974). Goldstein, Schmitt and Scheirer (1978), for example, found same meaning cues to be more effective than different meaning cues in the recall of homonyms encoded in the context of a biasing noun. Roediger and Adelson (1980) have shown that retrieval cues are more effective when they are similar in meaning to the encoded sense of a homonym. Furthermore, when the encoding and retrieval contexts induced the same interpretation of the homonym, recall was better when the context was more synonymous with the target and extralist cue than when it was less synonymous with these items. These studies suggest that the retrieval information at test provided access to a different representation of the homonym from that encoded at input.

While it seems reasonable that homonyms may have separate representations for each meaning, Reder et al (1974) have suggested that even nonhomonyms are multiply represented in long-term memory. If this were the case, however, the number of nodes required in semantic memory would become unmanageably large. Anderson and Ortony (1975) have demonstrated subtle effects of polysemy in sentence memory which, if handled in the way that Anderson and his colleagues suggest, would require the postulation of a separate idea node for each of the many fine gradations in meaning that a word in context can have. The postulation of separate idea nodes for each sense of nonhomonyms would also render meaningless the distinction between homonyms and nonhomonyms.

There are several other problems with the multinode assumption of generation-recognition theory. While Reder at al (1974) have suggested that low-frequency words are represented by fewer nodes in long-term memory than high-frequency words, Tulving and Watkins (1977) found recognition failure for low-frequency words with a single meaning and, presumably, a single representation in long-term memory. Watkins and Park (1977) obtained recognition failure even when dictionary definitions were provided for the target words. In these studies, the levels of recognition failure obtained conformed to the Tulving-Wiseman (1975) function. Recognition failure at the functional level has been demonstrated by Watkins, Ho and Tulving (1976) who found recognition failure when the target items were unfamiliar faces. It seems unlikely that there are multiple representations in long-term memory of items that were unknown to the subject before their occurrence in the study list (such as unfamiliar faces).

As Watkins and Gardiner (1979) have pointed out, recent variations of generation-recognition models cannot satisfactorily cope with the phenomena of context effects in recognition memory and recognition failure of recallable words. In one such variation, Santa and Lamwers (1976) have suggested that the state of the occurrence tag may fluctuate randomly so that a word may be in a recognisable state at one moment and in an unrecognisable state at the next. However, to explain the phenomenon of higher recall than recognition would require an increase in the number of recognisable items from the recognition to recall phases, which could not be accounted for by simple random fluctuation. In a second variation of the generic generation-recognition model, Kintsch (1978) has proposed that the recognition stages in recall and recognition may involve different decision criteria. However, recognition failure of recallable words has been observed with forced-choice recognition tests which have presumably ensured equal decision criteria at the two test phases (Watkins and Tulving, 1975).

Although generation-recognition theory has provided a plausible explanation of several memory phenomena (e.g. the general superiority of recognition over recall; the effectiveness of recall cues; the differential effects of certain variables on recognition and recall) and has provided an elegant conceptualisation of the distinction between episodic and semantic memory, the theory would appear to be of limited usefulness. Rabinowitz, Mandler and Barsalou (1979) have suggested that generation-recognition should not be considered a general principle of recall, but would appear, rather, to function as an optional auxiliary retrieval strategy in recall.

5. Episodic Ecphory and Cue Theory

Tulving (1976) has outlined a framework for episodic memory retrieval which incorporates the encoding specificity principle. According to Tulving, episodic memory retrieval, or episodic ecphory, involves a matching of ecphoric (retrieval) information with the information contained in the episodic trace of the target item. Retrieval will succeed only if a match between the two sets of information is obtained. Ecphoric information is provided by retrieval cues at test. No functional distinction is made between the processes of recognition and recall; the difference between recognition and recall is assumed to lie, rather, in the generality of the retrieval information provided by the two types of test. In recognition, the retrieval cue is a literal copy of the to-be-remembered word, while in recall more general, contextual information serves as a cue for retrieval of the target item. Watkins and Watkins (1975, 1976) have suggested that recall is mediated by retrieval cues which are subject to overload. As a cue is shared by more and more events, its probability of being effective in the recall of any one particular event declines. Watkins (1979) has extended the cueing approach to induce the recognition situation and like Tulving (1976) has argued that recognition should not be considered a qualitatively different process from recall. While a cue is generally considered to be a recognition cue if its relation to the target item is one of identity, at the functional level phenomena such as context effects in recognition memory indicate that the concept of a recognition cue is difficult to define. In terms of episodic ecphory, the copy cue is only a recognition cue at the nominal level, since encoding of the copy cue renders it functionally distinct from the encoded representation of the target item in episodic memory.

Within the episodic ecphory framework the findings of context effects in recognition memory, recognition failure of recallable words and apparent ineffectiveness of strong extralist associates as recall cues can be easily interpreted. In the case of recognition context effects, it is argued that the change of context at test induces a different encoding of the target item from that at the study phase. Since successful retrieval is dependent on the matching of retrieval information with that contained in episodic memory, recognition may fail when the context is changed because the retrieval information provided in the changed context may fail to access the episodic representation of the to-be-remembered word. Similarly, strong extralist associates may be ineffective in facilitating retrieval since they may induce a different test encoding of the to-be-remembered item from that induced at study, as when the target item is initially encoded in the context of a weak associate. Lack of facilitation of recall is seen as being a result of a mismatch of episodic and ecphoric information. Recognition failure of recallable words is accounted for in a similar manner. In this case, the retrieval information provided by the copy cue, since it is presented in a different context from that at study, is assumed to overlap less with the information comprising the episodic representation of the target item than that provided by the re-presented intralist cue. The intralist cue is assumed at test to induce a more similar encoding of the target item to that at study than the recognition copy cue. Consequently, the target item may be more accessible to the recall cue than to the recognition cue.

To briefly summarise the two opposing viewpoints which have been presented, the generation-recognition theorists regard verbal learning as involving the attachment of occurrence information to existing modes in an LTM network. In the modified version of the theory (e.g. Anderson and Bower, 1974) each node in the network corresponds to a different sense of a word. Such a formulation, however, would require the postulation of an unmanageably large number of idea nodes, and moreover has difficulty coping with memory for novel events and the effects of context upon subsequent retrievability. The encoding specificity viewpoint, however, can deal more effectively with the effects of context upon memory performance by assuming that the functional memory trace consists of a set of contextually determined encoded features. Successful retrieval depends upon the matching of these trace features with features which are present at retrieval. Again, context is assumed to determine the qualitative nature of the retrieval information at test.

The main problem with the encoding specificity principle lies in its being empirically untestable. The concept of episodic ecphory does, however, represent an intuitively attractive general framework within which a wide range of episodic memory phenomena can be interpreted. It is unclear, however, how different meanings of homonyms would be represented within such a formulation. Studies which have found impaired memory performance when different meanings of homonyms are biased at study and test (e.g. Goldstein, Schmitt and Scheirer, 1978; Light and Carter-Sobell, 1970; Murphy and Wallace, 1974) could be interpreted either in terms of separate episodic representations for each encoded meaning of a homonym, or in terms of a single trace in which different meanings of homonyms are represented by nonoverlapping sets of semantic features. Winograd and Conn (1971) have shown that the most frequent meaning of an unbiased homonym tends to be the one encoded and Warren and Warren (1976) have suggested that while more than one meaning of a homonym may be accessed in semantic memory, only the encoded meaning is represented in episodic memory. There has been no evidence from this class of studies, however, to indicate how more than one meaning of a homonym would be reperesented in episodic memory if each meaning was encoded during the study phase.

Like Warren and Warren (1976),Kintsch (1974) has suggested that different meanings of homonyms are separately represented in semantic memory. In Kintsch's formulation,as in Tulving's, the episodic memory trace consists of a subset of features sampled from the semantic memory representation of the study item, with the study context determining which features will comprise the episodic trace. While still a generation-recognition theorist, in his model Kintsch has abandoned the tagging notion of other generation-recognition models and consequently avoids many of the previously mentioned problems associated with such models. As such, Kintsch's formulation represents a 'half-way house' between the positions adopted by Anderson and Bower on the one hand and Tulving and his colleagues on the other. It is unclear in this model too, however, whether different meanings of homonyms would be represented within a single trace or whether trace multiplexing would occur, although with regard to item repetition Kintsch has suggested that either type of representation may occur depending upon whether or not the trace of the first occurrence of the item is accessed on its second occurrence.

In the following section a review of research which is concerned with the above problem is presented. One important question addressed by studies of repetition effects in memory and the spacing effect is whether a separate memory trace is established for each occurrence of a repeated item. The question can be adapted to the present research topic: is a separate episodic representation formed for each different meaning of a homonym which is encoded at study?

6. The Effects of Repetition on Memory

It is a well-established fact that an event which occurs twice is more likely to be remembered than a single event. Of greater theoretical interest is the observation of distribution effects and lag effects with repeated events. With regard to distribution effects, Underwood (1970) has shown that distributed presentations of an item lead to better retention than do massed presentations, with the superiority of the former increasing as a function of frequency of presentation. The lag effect refers to the observation that the benefit of repetitions increases with increasing spacing between the two presentations of an item (Melton, 1967, 1970). Both phenomena represent a breakdown of the total time law which states that the amount learned is a direct function of study time, regardless of how the study time is distributed. More importantly for the present purposes, the results of research into the effects of the spacing of repetitions on subsequent memory performance have implications for the manner in which encoded events are conceptualised as being represented in long-term memory.

Four main classes of theory have been proposed to account for the effects of repetition on memory. According to strength theories (e.g. Bernbach, 1967; Wickelgren and Norman,1966) repetition increases the strength of a single trace monotonically, with the rate of loss of trace strength being the same for the two presentations. However, strength theory would predict the opposite of the Melton lag effect - that retention should decrease with increasing spacing between two presentations of the same item. Furthermore, according to strength theory the individual presentations of an item are not identifiable and, consequently, reasonably accurate frequency judgements such as those obtained by Hintzman and Block (1970) should not be possible.

Consolidation theory (e.g. Landauer, 1967) asserts that the second presentation of an item resets the consolidation process as if the first presentation had never occurred. There is more total consolidation for distributed than for massed repetitions, since the first of two spaced presentations is more effective in terms of consolidation than the first of two massed presentations. Evidence against consolidation theory has come from a study by Bjork and Allen (1970) who showed that a difficult task interpolated between the two presentations of a repeated item led to slightly better retention than an easy interpolated task. A similar finding was obtained by Tzeng (1973). If a consolidation account of repetition were correct the difficult task should disrupt the consolidation process more and lead to poorer retention.

Evidence that the second presentation of a repeated item is the locus of the spacing effect is consistent with the other two classes of theories: inattention theory and encoding variability. Hintzman, Block and Summers (1973) have shown that memory for the second presentation of an item increases with increases in the spacing between the two presentations, while memory for the first presentation is unaffected. Hintzman et al have suggested that poorer retention at short lags is due to involuntary insufficient processing of the item on its second occurrence. The inattention hypothesis (e.g. Underwood, 1970 ; Waugh, 1970) states that the subject chooses to pay less attention to the second presentation of an item when it closely follows the first presentation than when the spacing between the repetitions is longer. In support of the inattention hypothesis, Shaughnessey, Zimmerman and Underwood (1972) found that subjects took less time inspecting repeated items at zero lag than they did inspecting items repeated at longer lags. While other studies have suggested that subjects pay less attention to massed than to spaced repetitions (e.g. Johnston and Uhl, 1976; Zimmerman, 1975) Elmes, Greener and Wilkinson (1972) found that recall of the item immediately following the repeated item decreased as a function of lag, i.e. there was no evidence of more processing occurring for words immediately following items repeated at short lags. Further evidence against inattention theory comes from studies which have equated the attention paid to second occurrences of items at different spacings, but failed to eliminate the spacing effect. (D'Agostino and DeRemer, 1973; Elmes, Sanders and Dovel, 1973).

The final type of theory proposed to account for the beneficial effects of repetitions and the spacing effect also attributes the locus of the effect to the second presentation of the repeated item. According to the differential encoding hypothesis, or encoding variability hypothesis (Madigan, 1969) the greater the spacing between the two presentations of an item the more likely will the encoded context on the two presentations differ- Bower's(1972) random contextual drift. Since retrieval depends upon reconstruction of the contextual cues present at input, with an increasing spacing between repetitions the total number of potential retrieval routes increases. The effect of differential encoding at longer lags is to result in the encoding of a word in two subjective units or in a larger subjective unit with several access routes. Evidence in support of the differential encoding hypothesis has come from studies in which differential encoding of items has been induced by presenting different study comtexts on the two presentations. Such manipulations should result in differential encoding at both short and long lags and as a consequence should eliminate the Melton lag effect. Madigan (1969) found that the lag effect was attenuated when the subjects were forced to use two different encodings of study nouns. Using sentence materials,Thios (1972) found that repetition at longer lags was beneficial when the same or a very similar context was repeated, while with different contexts suggesting different semantic processing of the repeated event the lag effect was eliminated. Gartman and Johnston (1972) found that the spacing effect was eliminated when different meanings of homonyms were encoded on the two presentations. Finally, Winograd and Raines (1975) found that the lag effect was attenuated with forced differential encoding of homonyms when retention was tested by recognition.

As Hintzman (1974) has argued, the spacing effect cannot be due to differential semantic encoding, since recognition of the first occurrence of the repeated item is necessary for the lag effect to occur. It would appear, rather, that similarity versus difference in context is the critical list characteristic influencing retention. Bower (1972) has suggested that when an item is presented for study a subset of stimulus elements are encoded with changes in context affecting changes in the encoding process. There is a gradual change in the study context as other items and events occur during a lapse of time, with the context change growing progressively over time. With a lag the change of context may change which stimulus elements are encoded. The more active elements in the trace, the more available retrieval routes.

While Hintzman and Block (1970) have suggested that each repeated event leaves its own trace - the multiple trace hypothesis - these multiplexed traces are assumed to co-exist. Paivio's (1974) work with verbal and pictorial materials suggests that, within a modality, massed presentations lead to the formation of multiple retrieval routes to a single trace, while with longer lags increasingly independent traces are formed. Although Gartman and Johnston (1972) have argued that recall is a function of the number of higher-order units in which an item is included and that changing the semantic interpretation of a homonym is likely to increase the number of codes for an item rather than to increase the number of retrieval routes for a single trace, Slamecka and Barlow (1979) have presented evidence which conflicts with this interpretation. Slamecka and Barlow found that repeating a homonym with a noun biasing a different meaning from the first presentation produced a repetition effect and led to comparable cued recall to when the same meaning was biased on the two presentations. The two cues for each homonym were found to be acting independently only when they were related to two different meanings of the homonym. They concluded that the repetition effect was mediated by the surface (nonsemantic) features of the homonym since in their Different Meaning condition recall of the homonym was enhanced even though it was re-experienced in semantically unrelated contexts (a lag of 24 items occurred between the two presentations of each homonym). As a consequence, Slamecka and Barlow have argued that the two cues in the Different Meaning condition acted independently because although they led to the same target trace they activated two semantically unrelated retrieval paths. In their same meaning condition the retrieval routes of the two cues were assumed to converge, due to their semantic relatedness, upon a final common path to the target.

To sum up, studies of repetition effects and the spacing effect have led to contradictory statements about the manner in which different meanings of homonyms are represented in long-term episodic memory. It is generally agreed now that the effect of spacing presentations of an item is to provide a more varied contextual encoding of the item on its two occurrences, thereby providing a wide range of available encoded features for retrieval. What is not so clear is how the different occurrence of an item and different meanings of a repeated homonym are represented in memory. While some researchers (e.g. Slamecka and Barlow, 1979) would argue that the two meanings of the homonym are represented within a single trace, others such as Gartman and Johnston (1972) endorse the idea that each encoded meaning of the homonym has a separate representation in long-term memory.

The empirical studies comprising the present research are presented in the following four chapters. In chapter three, the word pool is described and normative data concerning the pre-experimental associative strengths of the homonyms and their encoding stimuli presented. In the subsequent two chapters the way in which the results of three qualitatively different forms of encoding of homonyms are represented in episodic memory is investigated. Within these two chapters the framework for episodic memory representation which was proposed in the previous chapter is progressively developed to accommodate the various experimental findings. The experiments in chapter six are more directly concerned with the question of single versus multiple representations of homonyms in episodic memory. In this chapter several repetition studies are described which are aimed at determining whether or not different meanings of homonyms are stored independently of one another and, if so, whether such independence occurs within a single memory trace or across different memory traces. In the final chapter the proposed framework for episodic memory representation is compared to and contrasted with established models of long-term memory and generalised to provide a plausible explanation of various episodic memory phenomena, including those which have been discussed in the present chapter.

CHAPTER 3

THE WORD POOL

1. <u>General Characteristics</u>

In the majority of the studies to be reported, homonyms were encoded in three qualitatively different ways. In the Same Meaning (SM) condition, two encoding stimuli which were semantically related to the same meaning of the homonym were presented with the homonym at input (e.g. bat BALL net). In the Different Meaning (DM) condition the two encoding stimuli were semantically related each to a different meaning of the homonym (e.g. bat BALL dance). Finally, in the unrelated (UNR) condition one encoding stimulus was semantically related to the homonym and the other unrelated (e.g. bat BALL horse). For each homonym, one semantically related encoding stimulus appeared in each of the three conditions (the "common" encoding stimulus), with the qualitative nature of the second encoding stimulus varying across conditions.

A total of 42 homonyms comprised the word pool. For each homonym, four encoding stimuli were selected, three of which were semantically related to the homonym and one of which was unrelated. Of the three related encoding stimuli, two were semantically related to one meaning of the homonym (with one fulfilling the function of common encoding stimulus) and one was related to a different meaning. A second unrelated encoding stimulus was selected for each of 26 homonyms employed in the first experiment. The word pool of homonyms and encoding stimuli are presented in Appendix I.

The encoding stimuli were one-. two- and three-syllable nouns. The homonyms were of one and two syllables. The two meanings of each homonym which were selected for use in the studies served, in the majority of cases, the same grammatical function, i.e. a noun function.

Two smaller word pools were constructed for use in later studies. The first consisted of ten homographs (words with the same orthography but different phonology (e.g. BOW)). Two encoding stimuli were selected for each homograph, each of which was semantically related to a different form of the homograph. The majority of encoding stimuli were one- and two- syllable nouns, while the remainder (three) were adjectives. The homographs were also of one and two syllables. Again, in the majority of cases the two forms encoded in the studies served a noun function.

The second smaller word pool consisted of ten homophone pairs (words with the same phonology but different orthography (e.g. pair, pear)). One semantically related encoding stimulus was selected for each member of the ten homophone pairs. The homophones were one-syllable and the encoding stimuli one- and two-syllable nouns.

2. <u>Word Frequencies</u>.

The frequency of occurrence of each homonym, homograph, homophone and encoding stimulus in the Thorndike and Lorge (1944) norms was determined. The resulting frequencies are shown next to each word in Appendices I, II and III. With few exceptions, all of the words employed in the experiments were of medium-to-high Thorndike-Lorge frequency (> ten occurrences per million words). The sets of homonyms, homographs, homophones and encoding stimuli were all of comparable frequency of occurrence in the Thorndike-Lorge norms.

3. <u>Word Association Study.</u>

While some normative data for word associations to homonyms have been reported in the literature (e.g. Cramer, 1970; Kausler and Kollasch, 1970), the studies were carried out on populations of American college students and, moreover, did not include all of the homonyms utilised in the present research. As such, it was decided that a test of free association to each of the homonyms, homographs and homophones employed in the present studies be carried out, in order to obtain a set of word association norms which would be applicable to the research to be reported. The most important reason for collecting such normative data was to establish that observed differences in recall between various encoding conditions, and, in particular, between the Same Meaning and Different Meaning conditions, could not be due to differences between the conditions in the pre-experimental associative strengths of the homonyms, homographs and homophones and their encoding stimuli.

<u>Subjects</u>

115 male and female introductory psychology students at the University of Stirling acted as subjects. The subjects were tested in five psychology practical classes.

<u>Materials</u>

The stimulus pool consisted of 42 homonyms, ten homographs and ten homophone pairs. Two separate lists of 36 words were constructed each of which contained 21 homonyms, five homographs and one member of each of the ten homophone pairs. Instances of the three calsses of words were mixed randomly within each list. 58 subjects received one list and 57 subjects received the other.

<u>Procedure</u>

The subjects were required to produce three free association responses to each stimulus word. They were instructed to respond as quickly and spontaneously as possible.

Results and Discussion.

The percentages of subjects responding with their first associate ("primary response") to either of the two different meanings of the homonyms employed in the research were determined. In addition, the percentages of subjects providing an associate, in any of their three responses, to the two different meanings of each homonym were determined, ("any response"). The percentages of "primary" and "any" responses to the two meanings of each homonym are presented in Appendix IV . For the present purposes, responses to meanings other than those used in the experiments to be reported were disregarded.

For 28 (2/3) of the homonyms the dominant meaning is encoded in the Same Meaning condition in the following studies while the subordinate meaning serves as the second meaning in the Different Meaning conditions. For the remaining homonyms this relationship is reversed. In all cases meanings were found to be dominant with regard to both "primary" and "any" responding.

Of greater importance for the present purposes, however, is the degree of association between the homonyms, homographs and homophones and their encoding stimuli. For each homonym the percentage of subjects producing each of the four encoding stimuli in any of their three responses was determined. The resulting percentages are presented in Appendix I. The mean percentages of production for the four categories of encoding stimuli are as follows: the common encoding stimuli had a mean production frequency of 17.18%; the second encoding stimuli in the Same Meaning condition had a mean production frequency of 13.74%; the second encoding stimuli in the Different Meaning condition had a mean production frequency of 15.85%; finally, the unrelated encoding stimuli had a mean production frequency of 0%. With regard to pre-experimental associative strength, there was no difference between the three classes of related encoding stimuli in the frequency with which they were provided as free association responses to the homonyms. The frequency of production of the encoding stimuli to the homographs was 14.57%, a figure comparable to that obtained for the homonyms (see Appendix II). The mean production frequency for the encoding stimuli paired with the homophones was 37.90% (see Appendix III). This higher production frequency is probably attributable to the nonambiguity of the members of the homophone pairs. The possible implications for results obtained will be discussed in Chapter 6 in which the experiments utilising homophones are reported.

Since different subsets of items from the pool were employed in different experiments, the average associative strengths between pairs of words in each condition, as indexed by the mean production frequency of the encoding stimuli, are presented separately for each experiment in Appendix V.

In most of the experiments to be reported which incorporated cued recall, recall of the homonyms was cued by one or by both encoding stimuli. In both of the studies using the homographs and homophones, recall was cued by the encoding stimuli. While the retention tests in these studies rely upon a forward association between the encoding stimulus or stimuli and the to-be-remembered word, the present word association test tapped the backward association from the to-be-remembered word to the cue. The present findings do, however, provide information of a general nature concerning the pre-experimental strengths of associations between the homonyms, homographs and homophones and their encoding stimuli. It would seem safe to assume that, given the similarity across encoding conditions in the mean production frequencies of the encoding stimuli, little or no overall difference in the strengths of forward associations should exist across encoding conditions, even though differences between the strengths of forward and backward associations may exist for individual word pairs.

CHAPTER 4

RETENTION OF HOMONYMS

In the three experiments to be reported in the present chapter, either one or two meanings of homonyms were encoded at input and retention of the homonyms tested under a variety of retrieval conditions. A representational framework, within which the findings of the three experiments are interpreted, is proposed at the end of the chapter. The aim of the subsequent two chapters is to test hypotheses derived from the framework and to determine the manner in which different meanings of homonyms are represented in long-term episodic memory.

Experiment 1.

The first experiment was of an exploratory nature - to determine the differential effectiveness of qualitatively different intralist and extralist cues for recall of homonyms encoded in each of three qualitatively different ways. Accordingly, no specific hypotheses were formulated prior to embarking upon the experiment. The resultant pattern of retention probabilities should give some indication of the qualitative nature of the memory traces resulting from the three different types of encoding.

Subjects.

A total of 72 subjects, of both sexes, participated in the present study. The subjects were students from a variety of further education courses who volunteered to take part in the experiment. 48 subjects took part in the main experiment and 24 in the baseline study.

Design.

1. Experimental Variables.

An incidental learning paradigm which induced the subjects to encode either one or two meanings of homonyms was employed in the present study. Each homonym was presented in the context of two encoding stimuli (biasing nouns), one on either side of the homonym. Three qualitatively different homonym - encoding stimuli combinations were employed:

(1) In the Different Meaning (DM) encoding condition the encoding stimuli were semantically related each to one of two different meanings of the homonym.

(2) In the Same Meaning (SM) encoding condition both the encoding stimuli were semantically related to the same meaning of the homonym.

(3) In the Unrelated (UNR) encoding condition one encoding stimulus was semantically related to the homonym and the other unrelated.

The subjects' orienting task was to indicate on each trial whether or not they could perceive a semantic relationship between the homonym and each of the two encoding stimuli. In this way, the subjects were induced to encode two different meanings of the homonym in the DM condition, while in the other two conditions only one meaning should be processed. The manipulation of encoding conditions was a within-subjects variable.

The nature of the retention test was, on the other hand, a between-subjects variable. Three cued recall conditions and a free recall test were employed in the experiment. In the cued recall tests two cues were presented simultaneously for the recall of each homonym, with the qualitative nature of the cues differing across cueing conditions:

(1) In the Different Meaning (DM) cueing condition the two cues were semantically related to two different meanings of the homonym.

(2) In the Same Meaning (SM) cueing condition the two cues were semantically related to the same meaning of the homonym.

(3) In the Unrelated (UNR) cueing condition one cue was semantically related and the other unrelated to the homonym.

The encoding stimuli in the three encoding conditions served as the retrieval cues in the corresponding cueing conditions. In free recall the subjects were required to retrieve the homonyms unaided. This yielded the following design:

		Encoding Condition (Within Subjects)		
		DM Encoding	SM Encoding	UNR Encoding
Retrieval Condition (Between Subjects)		bag CASE court	bag CASE trunk	bag CASE chair
	DM cueing	bag court	bag court	bag court
	SM cueing	bag trunk	bag trunk	bag trunk
	UNR cueing	bag chair	bag chair	bag chair
	Free Recall	-	-	-

Figure 4.1. General Experimental Design.

2. Balances and Controls.

The subjects received 36 main encoding trials, preceded by three practice trials representing each of the three forms of encoding. All of the subjects received the same practice trials, subsequent retention of which was not tested. Three main presentation lists were constructed. Each list had two versions - A and B - which were identical in content but differed to the extent that encoding stimuli presented to the left of the homonyms in version A were presented to the right of the homonym in version B, and vice versa. The same 36 homonyms were presented in the same order in each list. The qualitative nature of the encoding of each homonym differed across lists. Within each list 12 homonyms were presented in each of the three encoding conditions. The 12 homonyms presented in the DM encoding condition in lists 1A and 1B were encoded in the SM condition in lists 2A and 2B, and in the UNR condition in lists 3A and 3B, and so on. The ordering of encoding conditions was randomised within each list.

For each homonym, one encoding stimulus occurred in each of the three encoding conditions - the "common" encoding stimulus (e.g. 'bag' in figure 1.). In each encoding condition the common encoding stimulus was presented to the left of the homonym on one half of the trials and to the right of the homonym on the remaining trials.

Each of the six presentation lists was administered to eight subjects. From each list two subjects received subsequent free recall instructions and two subjects each received one of the cued recall tests. Thus, a total of 12 subjects were tested in each of the four retrieval conditions.

Since the retrieval cues for each homonym were the appropriate encoding stimuli and since one encoding stimulus accompanied the homonym in each of the three encoding conditions, at recall at least one retrieval cue for each homonym had been previously presented as an encoding stimulus (i.e. was an intralist cue). For 12 of the homonyms from each list, both retrieval cues had previously been encoded with the homonym at input(e.g.DM encoding followed by DM cueing).

The homonyms were cued in the same random order in each of the three cued recall conditions. The order of cueing was different from the original presentation order. For half of the homonyms in each encoding condition the intralist cue or cues were presented on the same side (with respect to the homonym) as during input. The cues for the remaining homonyms were presented on the opposite side from during encoding. In each cueing condition there were two cueing lists - A and B - which differed only to the extent that cues presented on the left-hand side in version A were presented on the right-hand side in version B, and vice versa. One subject from each presentation list received version A and another received version B.

Baseline Study.

A baseline study which involved only two encoding conditions was included in the present experiment. As in the main part of the study, in the Unrelated (UNR) condition one encoding stimulus was semantically related to the homonym, and the other unrelated. In the 2UNR condition, both encoding stimuli were unrelated to the homonym. Again, the manipulation of encoding conditions was a within-subjects variable. The objective of the baseline study was to provide some indication of the memorial consequence of total unrelatedness of the target and context words. Given such a baseline the beneficial effects of increasing item relatedness in the word triplets can be observed.

One group of 12 subjects were tested for free recall of the homonyms, while another 12 subjects were tested by cued recall. In the latter test, recall of only those homonyms which had been encoded in the context of two unrelated biasing nouns was cued since cued recall of homonyms in the UNR condition was tested in the main part of the experiment. Two retrieval cues were simultaneously presented for the recall of each homonym. In addition to the three cueing conditions employed in the main part of the experiment, a further cueing condition was introduced in which both of the unrelated encoding stimuli were provided as intralist retrieval cues at test (2UNR cueing condition). The manipulation of cueing conditions in the baseline study was a within-subjects variable.

The subjects received 36 experimental trials preceded by three practice trials. On one of the practice trials one encoding stimulus was semantically related to the homonym, while on the other two both were unrelated. Subsequent retention of the homonyms in the practice trials was not tested. The same homonyms which were employed in the main study were used in the control study. A single presentation list was constructed. Instances of the two encoding conditions were randomly mixed within the list. On 24 of the trials both encoding stimuli were unrelated to the homonym.

Recall of six homonyms was cued in each of the four cueing conditions. In the DM, SM and UNR cueing conditions the same cues were employed as inthe main study. In the DM and SM cueing conditions, therefore, both cues were extralist associates of the homonym whose recall they were cueing. In the UNR cueing condition, one unrelated encoding stimulus (intralist cue) and an extralist associate were provided as cues. Finally, both recall cues had been previously presented as unrelated encoding stimuli in the 2UNR cueing condition. Recall of the homonyms was cued in an order different from the original presentation order. The ordering of cueing conditions was randomised within the sequence. The intralist cue or cues in the UNR and 2UNR cueing conditions were presented on the same side at input and test for one half of the homonyms and on opposite sides for the remaining homonyms.

Materials and Apparatus.

The homonyms and encoding stimuli employed in the study were selected from the word pool. Each homonym was presented in black uppercase letters, 2cm high, on a white flash card. The encoding stimuli, one of which was presented on either side of the homonym, were printed in 7mm black uppercase letters.

The subjects were provided with a numbered response sheet on which to record the two encoding responses ('Yes' or 'No') for each trial. Responses to the left-and right-hand encoding stimuli were separated by a dividing line down the centre of the response sheet. The presentation rate was paced by an electronic timer. A 3-digit number was printed on the reverse of the response sheet. The subjects were required to count backwards in 3's from this number prior to the retention test, to reduce recency effects.

Each pair of cues in the cued recall test were printed on a white card in 3mm block uppercase letters. The two cues were separated by a red line on which the subjects wrote their recall response. In the free recall conditions the subjects simply listed their recall responses on the back of the encoding response sheet.

Procedure

1. Main Experimental Group.

The subjects were tested in groups of 1-4. Each word triplet was presented for five seconds, with a one-second intertrial interval. On each trial the subjects were required to compare the left- and right-hand encoding stimuli, in turn, with the homonym and decide whether or not the two words (homonym and encoding stimulus) were semantically related. Each pair of encoding decisions were recorded on the response sheet.

Immediately following presentation of the final word triplet, the subjects were instructed to count backwards in 3's from a 3-digit number for a period of 1½ minutes. An unanticipated retention test was then administered. The subjects in the free recall condition were instructed to list the middle words from the word triplets (i.e. the homonyms) which they could remember on the back of the response sheet. The subjects in the cued recall conditions were presented with a stack of 36 cue cards, which were face down. They were instructed to turn the cards over, one at a time, and write the appropriate homonym from the input list on the line between the two cues. The subjects were informed that at least one member of each pair of cues had been previously presented as an encoding stimulus during the encoding phase of the experiment. The subjects were instructed not to dwell too long on each pair of cues, but if they finished before the end of the five minute recall period were allowed to reconsider pairs of cues which had not elicited an immediate recall response.

Only at debriefing were the subjects informed that each of the target words was a homonym. No subject reported being aware of the ambiguity of the target words in the SM and UNR encoding conditions during the encoding phase of the experiment.

2. Baseline Study.

The baseline study procedure was, in most respects, identical to that in the main study. The subjects in the control study were forewarned that most of the encoding stimuli and homonyms were unrelated, so that they would not be inclined to look for less than immediately obvious relationships between the encoding dtimuli and target words. Following the distractor task, the subjects in the cued recall group were provided with a stack of 24 cue cards. The subjects were informed that in most cases one or both cues would not have been presented with the target word during encoding, but that each of these extralist cues was semantically related to the middle member of a previously presented word triplet.

Analysis.

In order to avoid problems of interpretation, in this and in all subsequent experiments retention probabilities were based only on those encoding trials on which the subject's encoding decisions correspond to those of the experimenter. For example, if the subject perceived an 'unrelated' encoding stimulus as being related to the homonym, difficulties would arise in deciding whether it was perceived as bearing a relationship to the same or to a different meaning of the homonym from the other encoding stimulus. Moreover, if the subject failed to perceive one of the encoding stimuli and the homonym in the DM encoding condition as being semantically related, then presumably only one meaning of the homonym was encoded. For these reasons, retention probabilities were determined only for items from 'correctly' encoded trials.

It is assumed in all of the studies that if the subject perceives both encoding stimuli as being related to the homonym in the DM condition, he is, in fact, encoding two distinct meanings of the homonym. It seems highly unlikely that only one meaning is being encoded since in this condition there are no obvious semantic relationships between one encoding stimulus and the meaning of the homonym activated by the other. Similarly, in the SM encoding condition both encoding stimuli on any trial are assumed to activate the same meaning of the homonym.

In each experiment individual retention probabilities were obtained by dividing the subject's raw recall or recognition score in each condition by the total number of items from correctly encoded word triplets which could be recognised or recalled. In the present study, mean recall probabilities were based on the individual recall probabilities of 12 subjects in each retrieval condition.

In the present experiment, since the data were normally distributed and the variance in the treatment populations was equal, a 3 x 4 within-(encoding condition) and between-(retrieval condition) subjects analysis of variance was performed on the recall data of the main experimental groups. The above assumptions could not be made for other data obtained in this and in subsequent experiments, mainly due to positive or negative skewness. To achieve consistency within and across experiments in the power of the tests used, nonparametric tests were performed on the rest of the data to be reported for this and the following experiments. A parametric analysis was performed on the main data from the present experiment since the main focus of interest in this study was on the interaction of encoding and retrieval conditions, a relationship which would not be demonstrated by the use of nonparametric tests.

Results.

Baseline Study Data

The mean probabilities of cued recall in the baseline study are presented in Table 4.1.

	Cueing Condition			
	DM	SM	UNR	2UNR
P(Recall)	.13	.17	.17	.07

Table 4.1. P(Recall) of items encoded in the context of two unrelated encoding stimuli as a function of cueing condition.

Cued recall performance was uniformly low. The majority of subjects failed to recall any homonyms in one or more cueing conditions and two subjects failed to recall any target items at all. A Friedman's two-way analysis of variance by ranks was performed on the cued recall data of the 10 subjects who produced such data. This analysis failed to demonstrate any reliable differences in recall between the various cueing conditions (3 d.f., $x^2 = 2.76$, $P < .50$). Floor effects prevent any conclusions from being drawn from the data, but they do form a baseline against which the advantages of encoding an item in the context of one or two semantically related biasing nouns can be compared.

The mean probability of free recall of homonyms encoded in the context of two unrelated encoding stimuli was, $P = .105$. The mean free recall probability of homonyms encoded in the context of one related and one unrelated encoding stimulus was $P = .171$, which is comparable with the figure obtained in the main part of the study ($P = .169$). A Wilcoxon matched-pairs signed-ranks test was performed to determine whether homonyms encoded in the context of one semantically related and one unrelated biasing noun were recalled significantly better than homonyms whose encoding stimuli were both unrelated.

This analysis failed to show a reliable difference in free recall between the two conditions (N = 11, T = 17, N.S.). Again, however, the data constitute a baseline against which the performance of subjects in the other encoding conditions can be compared.

Cued Recall and Free Recall: Main Experimental Groups.

The mean probabilities of recall for each combination of encoding and retrieval conditions are presented in Table 4.2.

		Encoding Condition			
		DM	SM	UNR	Means
Retrieval Condition	DM	.804	.511	.442	.586
	SM	.570	.787	.535	.631
	UNR	.475	.527	.553	.518
Free Recall		.382	.337	.169	.296
Means		.558	.540	.425	

Table 4.2: P(Recall) as a Function of Encoding and Retrieval Condition.

Since the data were on an interval scale and it could be assumed both that the distributions of scores in the treatment populations were normal and that the variance in the treatment populations was equal, a within- and between-subjects analysis of variance with three levels of the within-subjects variable (encoding condition) and four levels of the between-subjects variable (retrieval condition) was carried out to test for differences between the means. Significant main effects of both encoding condition ($F(2,88)=12.09$, $P<.001$) and retrieval condition ($F(3,44)=10.08$, $P<.001$) were obtained, as was a reliable interaction between encoding and retrieval conditions ($F(6,88)=9.39$, $P<.001$).

The most striking aspect of the above results is the powerful interaction between encoding and retrieval conditions.

Cued recall performance was considerably higher in the DM and SM conditions when both encoding stimuli were provided as cues at test and marginally so following encoding in the UNR condition. The highest level of recall in this situation occurred in the DM encoding/cueing condition, with recall in the SM encoding/cueing condition only slightly lower. In both cases, however, the levels of performance were considerably higher than in the comparable UNR condition.

Comparing performance across encoding conditions, it can be seen that while in the DM cueing condition recall was highest following DM encoding, recall following SM encoding was approximately 20% higher than that obtained as a result of encoding in the UNR condition. In the SM cueing condition recall performance was slightly better following DM as opposed to UNR encoding. In the UNR cueing condition, while highest recall resulted from UNR encoding, the level of recall following SM encoding was approximately 10% higher than that obtained from DM encoding.

A similar comparison across cueing conditions reveals an interesting pattern in the results. Within the DM encoding condition recall was considerably higher in the SM cueing condition than in the UNR cueing condition (.570 vs .475). In a similar vein, in the UNR encoding condition the SM cueing condition resulted in a higher level of recall (.511 vs .442) than the DM cueing condition. The superiority of the SM cueing was of a similar magnitude following encoding in the DM and UNR conditions. On the other hand, there was little apparent difference in the effectiveness of the DM and UNR cueing conditions following encoding in the SM condition (.511 vs .527). Taken together, these findings suggest that an extralist associate of an encoded meaning of the homonym may provide access to the homonym over and above that provided by a semantically related intralist cue, whereas an extralist associate of a nonencoded meaning of the homonym is as ineffective in providing access to the trace of the homonym as a totally unrelated extralist cue.

Finally, the pattern of results obtained in free recall mirrors that obtained in cued recall when both encoding stimuli were provided as cues at test, although in free recall the general level of performance was considerably lower. In each of the three encoding conditions, the lowest performance was obtained when recall was tested in the absence of any specific cues.

<u>Position of Encoding Stimuli at Encoding and Test</u>.

A further set of analyses were performed on the cued recall data to determine whether recall was higher when the encoding stimuli were presented on the same side (with respect to the homonym) at input and test. For each combination of encoding and cueing conditions, separate recall probabilities were determined for homonyms whose cues were presented on the same side at encoding and test and those whose encoding stimuli were presented on cpposite sides. The resulting mean recall probabilities are presented in Table 4.3.

Encoding Condition:	DM			SM			UNR		
Cueing Condition:	DM	SM	UNR	DM	SM	UNR	DM	SM	UNR
Same Side	.808	.640	.504	.503	.747	.605	.471	.461	.488
Opposite Sides	.812	.490	.442	.519	.819	.546	.380	.560	.628

Table 4.3: P(Recall) As a Function of the Relative Presentation Position of the Encoding Stimuli at Encoding and Test.

A series of nine Wilcoxon matched-pairs signed-ranks tests were performed on the data, each of which failed to show a reliable difference in recall. There was no evidence, therefore, of a beneficial effect on recall of re-presenting the encoding stimulus or stimuli on the same side at test.

Intrusions: Cued Recall.

Intrusions occurred in cued recall when only one encoding stimulus was provided as a retrieval cue. In some such cases the subjects mistakenly responded with the second encoding stimulus rather than the homonym at recall. Table 4.4 shows the number of subjects producing recall intrusions in each combination of encoding and cueing conditions.

		Encoding Condition		
		DM	SM	UNR
Cueing Condition	DM	-	3	0
	SM	1	-	2
	UNR	0	7	-

Table 4.4. Number of Subjects Producing Recall Intrusions in Each Combination of Encoding and Cueing Conditions.

Due to the generally low frequency of intrusions, the data were not subjected to statistical analysis. It can be seen from Table 4.4 however, that there was a marked tendency for intrusions to occur more frequently when the homonym was encoded in the context of two biasing nouns, both of which were semantically related to the same meaning of the homonym.

Intrusions: Free Recall.

In free recall, intrusions occurred when the subject produced an encoding stimulus as a recall response. Nine of the 12 free recall subjects produced at least one intrusion amongst their free recall responses. Individual probabilities of intrusions were obtained by dividing the number of intrusions from correctly encoded trials by the total number of correct and incorrect recall responses from correctly encoded trials produced by the subject in each condition. The mean intrusion rates, which are presented in Table 4.5, are based on the individual intrusion rates of nine subjects. The mean intrusion rates represent the relative probabilities across encoding conditions that a response generated by these subjects will be an encoding stimulus rather than a target word (i.e. a homonym).

	Encoding Condition		
	DM	SM	UNR
Intrusion Rate	.089(3)	.208(5)	.270(5)

Table 4.5. Free Recall Intrusion Rate as a Function of encoding condition. The Figures in parentheses indicate the number of subjects producing intrusions in each condition.

A Friedman's two-way analysis of variance by ranks was performed on the intrusion data. It failed to demonstrate any significant differences between the encoding conditions in the incidence of intrusions (2 d.f., x^2 = .50, $P<.971$). It can, nevertheless, be seen from Table 4.5 that both the number of subjects producing intrusions and the mean intrusion rate were somewhat lower in the DM encoding condition.

Discussion.

The present study has shown that when the initial encoding context was completely reinstated at test (i.e. when both encoding stimuli were provided as retrieval cues) and when no specific cues were provided at test, the highest levels of recall were obtained when two distinct meanings of the homonym were encoded at input, and the lowest when the homonym was encoded in the context of one semantically related and one unrelated noun. While such an outcome could be interpreted as resulting from the formation of more unique or distinctive (and thus more highly accessible) traces when two different meanings of a homonym are encoded, further findings in the experiment indicate that the interaction of the encoding and retrieval environment also exerts a strong influence on the levels of performance obtained. In particular, extralist cues were found to be effective only if semantically associated to an encoded meaning of the homonym that they were cueing. Extralist cues related to nonencoded senses of the target words provided no greater access to the trace of the homonym than semantically unrelated extralist cues.

Evidence that a more <u>efficient</u> retrieval process occurs following the encoding of two meanings comes from the intrusion data. While not proving statistically reliable, there was a tendency for the subjects to be more likely, following encoding in the SM and UNR conditions, to produce encoding stimuli in their free recall repertoires. Similarly, in cued recall the subjects were most likely, following encoding in the SM condition, to produce the second encoding stimulus as a recall response. It would appear than when two different meanings of the homonyms were encoded, the subjects were better able at output to differentiate between the homonyms and encoding stimuli. It seems likely that the differential intrusion rates occur as a result of the manner in which the homonyms and encoding stimuli are represented in long-term episodic memory following each of the three types of encoding. One such representational framework will be outlined in the general discussion section at the end of the present chapter.

The baseline study was incorporated in the present experiment to determine the differential effectiveness of encoding the homonyms in the context of semantically related and unrelated biasing nouns. To this end, the study demonstrated, quite conclusively, the beneficial effects of semantic congruity on both free and cued recall, with the highest levels of performance being obtained when both encoding stimuli were semantically related to the homonyms with which they were encoded. Such a finding is comparable with Shulman's (1974) and Craik and Tulving's (1975) notion of encoding congruity. An explanation of the congruity effect will be proposed in a later chapter once additional pertinent data have been reported.

Experiment 2.

The major aims of this second experiment were two-fold. Firstly, another measure of retention was introduced in order to extend the range of retrieval contexts in which the differential effectiveness of the three types of encoding on retention of the homonyms could be examined. In the present study retention of the homonyms was tested by three-alternative forced-choice recognition and,again,by free recall. A confidence rating scale was included in the recognition test to determine whether any differences existed across encoding conditions in the subjects' confidence in their recognition responses.

The second aim of the experiment was to produce more workable intrusion data, since relatively few intrusions were obtained in the previous study. To this end, the free recall instructions were modified slightly in an attempt to elicit more recall intrusions. The recognition test involved selecting the homonyms from the re-presented original word triplets. Any failures to select the correct alternative constitute recognition errors. As previously noted, the value of such recall intrusion and recognition error data lies in the fact that they are further indicative of the efficiency of the underlying retrieval process, and differential efficiency in the retrieval process may be a consequence of the manner in which the word triplets are represented in episodic memory following the three qualitatively different forms of encoding.

Subjects.

The 36 who took part in the experiment were male and female Introductory Psychology students at the University of Stirling who received course credit for participation.

Design.

The incidental learning paradigm employed in Experiment 1 was used to induce the subjects to encode either one or two meanings of homonyms. Again each homonym was presented in the context of two encoding stimuli, one presented on either side of the homonym. The same three encoding conditions were employed and, again, the subjects' orienting task was to decide whether or not the homonyms and encoding stimuli were semantically related. The manipulation of encoding conditions was a within-subjects variable.

Retention of the homonyms was tested by free recall or by three-alternative forced-choice recognition. In the latter test each homonym was re-presented with its encoding stimuli and the subjects were required to:-

(1) Underline the word which had originally been presented in the middle of the word triplet, and

(2) Rate their confidence, on a three-point scale, that the word they had underlined was, in fact, the target word.

The present form of recognition test was employed in preference to a standard 3-AFC recognition test, in which the target item is presented in the context of extralist lures, for one major reason. Presumably when the subjects are required to free recall the homonym they must access the representations of the word triplets in episodic memory and then produce the homonym as an output response i.e. an output decision is required once the representation of the triplet has been accessed. In the present recognition test a similar state of affairs exists since the subject must again access the triplets via the copy cues and then decide which of the three items was originally presented in the middle. Had a standard 3-AFC test been used, a different recognition decision would have been required, namely differentiating the homonym from other items which were not present on the study list. The present recognition test, then, taps similar access and decision processes as those involved in recall and thereby renders the results from the two types of retention tests more directly comparable. What the recall and recognition tests tap is not item memory alone, but also memory for item position in the word triplets. In a later experiment free recall of item information alone is tested and the results compared to those obtained in the present and previous studies in which an output decision based on position information is required.

The subjects received three practice trials followed by 42 main experimental trials. The practice trials represented each of the three forms of encoding. All subjects received the same three practice trials, subsequent retention of which was not tested.

Three main presentation lists were compiled. The 42 homonyms were presented in the same order in the three lists, with the qualitative nature of the encoding stimuli for each homonym differing across lists. In each list 14 homonyms were encoded in each of the three encoding conditions. On one half of the trials in the UNR condition the unrelated encoding stimulus was presented to the left of the homonym, and on the remaining trials was presented to the right. Instances of the three encoding conditions were mixed within the lists.

Three groups of 12 subjects each received one of the presentation lists. Six subjects from each list received subsequent free recall instructions and six were administered the forced-choice recognition test. In the recognition test the members of each word triplet were listed together vertically. The positioning of the homonym within the unit (top,bottom or middle) was randomised within each condition. Since different encoding stimuli were employed across presentation lists, three versions of the recognition test were prepared, with one corresponding to each presentation list. The homonyms were presented in the same order across tests. The test order differed from the presentation order at input. The three-point scale of confidence ratings for recognition responses was as follows:-

1. Not very confident
2. Fairly confident
3. Very confident.

<u>Materials and Apparatus</u>

The encoding stimuli and homonyms employed in the study were drawn from the word pool. The word triplets were presented via an overhead projector. The homonyms and encoding stimuli were presented in black uppercase letters against a white background, with the homonyms approximately twice as large as the encoding stimuli. One encoding stimulus was presented on either side of the target word.

The subjects were provided with a response booklet. The first page comprised of a numbered response sheet. Responses ('yes' or 'no') to the left-and right-hand encoding stimuli were separated by a line down the centre of the sheet. The presentation rate was paced by a timer which produced an audible tone at 4-second intervals. A three-digit number was printed at the top of the second page of the response booklet. The subjects were required to count backwards in threes from this number prior to the retention test, recording the answers to their calculations as they progressed.

The free recall subjects were provided with a blank sheet of paper on which to list their recall responses. Subjects receiving the three-alternative forced-choice recognition test were issued with a test sheet containg the 42 word triplets. The word triplets were numbered, and the subjects worked from left ro right and from top to bottom down the page. The confidence rating scale was displayed throughout the retention interval via an overhead projector.

Procedure.

The encoding procedure in the present experiment was, in most respects, identical to that in the previous study. The subjects were tested in groups of 1-6. Each word triplet was presented for a duration of four seconds during which time the subjects recorded their encoding responses in the response booklet. A four-second intertrial interval followed. Following presentation of the final word triplet, the subjects counted backwards in threes from a three-digit number for 1½ minutes, immediately after which an unanticipated retention test was administered. Subjects in the free recall group listed the target words which they could remember on a blank recall sheet. The recall instructions were modified slightly from the previous experiment, to encourage the subjects to adopt a less stringent output criterion. The subjects were instructed to list words which they thought may have been presented in the middle of the word triplets, even though they were not completely certain that the word they had recalled was a true target word. Subjects receiving the recognition test proceeded through the numbered word triplets, underlining the word from each triplet that they thought had been presented in the middle of the triplet during the encoding phase, and rating their confidence in their choices. The recognition test was self-paced, however no subject required more than five minutes, the time limit imposed upon subjects in the free recall group, to complete it.

Results.

Free Recall.

The mean probabilities of free recall in each encoding condition, based on the individual recall probabilities of 18 subjects, are presented in Table 4.6.

	Encoding Condition		
	DM	SM	UNR
P(Recall)	.249	.130	.083

Table 4.6. P(Free Recall) as a Function of Encoding Condition.

As can be seen, the same general pattern is apparent in the results as in Experiment 1, with the highest level of free recall of the homonyms obtained in the DM condition and the lowest in the UNR condition. In the present study, however, the difference in recall between the DM and SM conditions is noticeably larger, and that between the SM and UNR encoding conditions considerably smaller. A Friedman's 2-way analysis of variance by ranks was carried out on the present free recall data. It demonstrated a significant difference in recall bewteen the three encoding conditions (2 d.f., $x^2 = 16.33$, $P<.001$). Three follow-up Wilcoxon matched-pairs signed-ranks tests performed on pairs of conditions showed that while the SM and UNR conditions did not differ significantly in their levels of recall (N=17,T=40.N.S.), recall in the DM encoding condition was reliably higher than that in either of the other two conditions(in both cases, $P<.01$).

Free Recall Intrusions.

Intrusions occurred in free recall when the subject produced an encoding stimulus as a recall response. The intrusion rates were based only on responses from correctly encoded trials. 15 subjects generated intrusions in at least one encoding condition. The mean intrusion rates presented in Table 4.7 are based on the individual probabilities of intrusions of these 15 subjects and as such, represent relative intrusion rates across conditions rather than absolute intrusion rates for the entire group of free recall subjects.

The intrusion rate represents the probability that a recall response generated by the subject was an encoding stimulus rather than a homonym.

	Encoding Condition		
	DM	SM	UNR
Intrusion rate	.187(7)	.335(10)	.417(8)

Table 4.7: The Mean Free Recall Intrusion rate as a Function of Encoding Condition. The Figures in parenthesis indicate the Number of Subjects Producing Intrusions in each Condition.

Only one subject produced intrusions in all three conditions, and six subjects generated intrusions in only one condition. A Friedman's two-way analysis of variance by ranks was performed which failed to demonstrate a reliable difference between the three encoding conditions in the rate of intrusions.

Recognition.

The mean probabilities of correct recognition, which were based on the individual recognition probabilities of 18 subjects, are shown in Table 4.8 along with the recognition error rate in each encoding condition.

	Encoding Condition		
	DM	SM	UNR
P(Recognition)	.818	.683	.635
P(Error)	.182	.317	.365

Table 4.8: Mean Probability of Correct Recognition and Mean Recognition Error Rate as a Function of Encoding Condition.

The mean probabilities of free recall and recognition are represented in Figure 4.2. Despite the considerably higher levels of performance obtained with the forced-choice recognition test, the two sets of data are strikingly similar. As with free recall, the highest level of performance was obtained in the DM encoding condition and the lowest in the UNR condition. The differences between the DM and SM conditions in the levels of performance were very similar for recall and recognition (.119 vs. .135) and the differences between the SM and UNR conditions were, to all intents and purposes, identical (.047 vs. .048).

Since in the recognition test the subjects were required to underline one word in every triplet, the recognition error rate in each encoding condition was obtained by subtracting the recognition probability from I.0. The probabilities of correct recognition and the recognition error rates are, therefore, reciprocal to one another, a fact which should be borne in mind although concern will be mainly focused on the correct recognition probabilities.

A comparison of recognition error and relative recall intrusion rates can be seen in Figure 4.3. Again, a similar pattern of results was obtained with the two retention tests. Had absolute, rather than relative intrusion rates been used, the pattern would be identical but the overall level somewhat

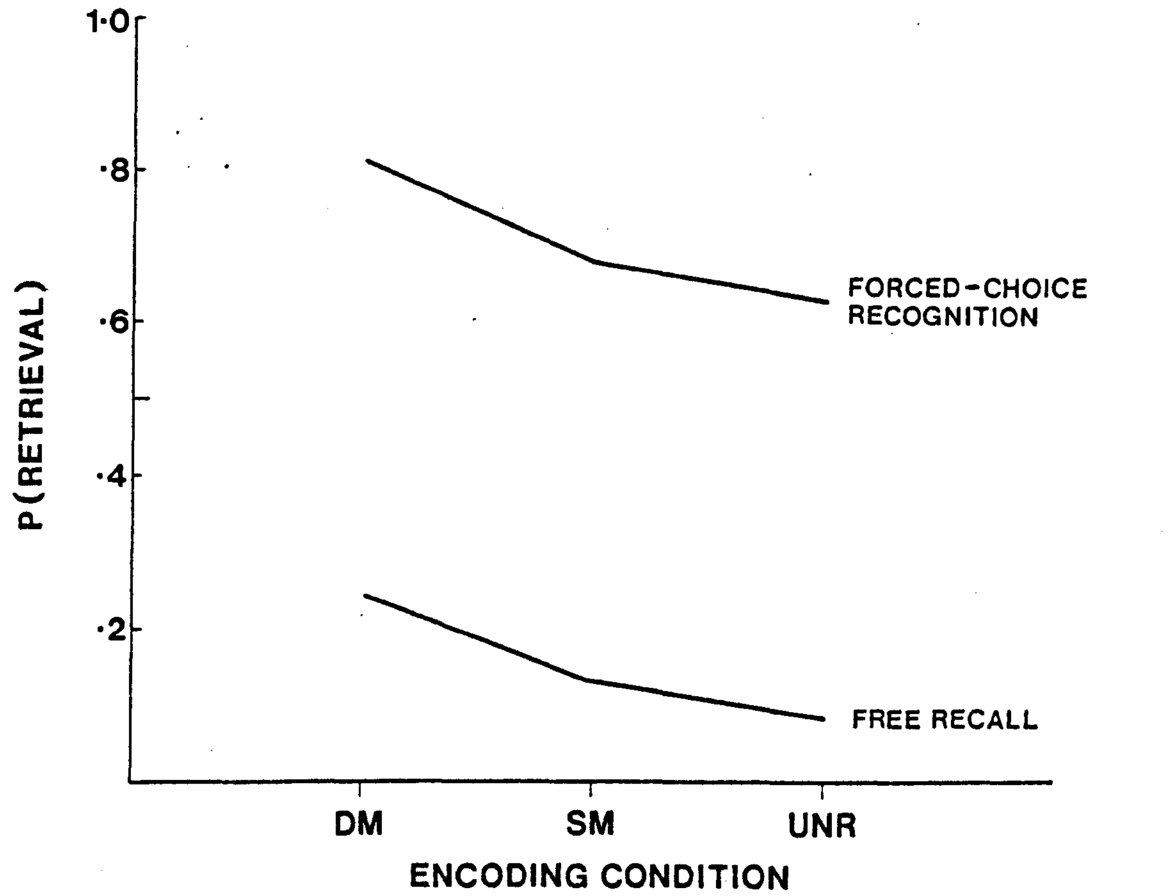

FIGURE 4·2 Mean probabilities of free recall and recognition as a function of encoding condition

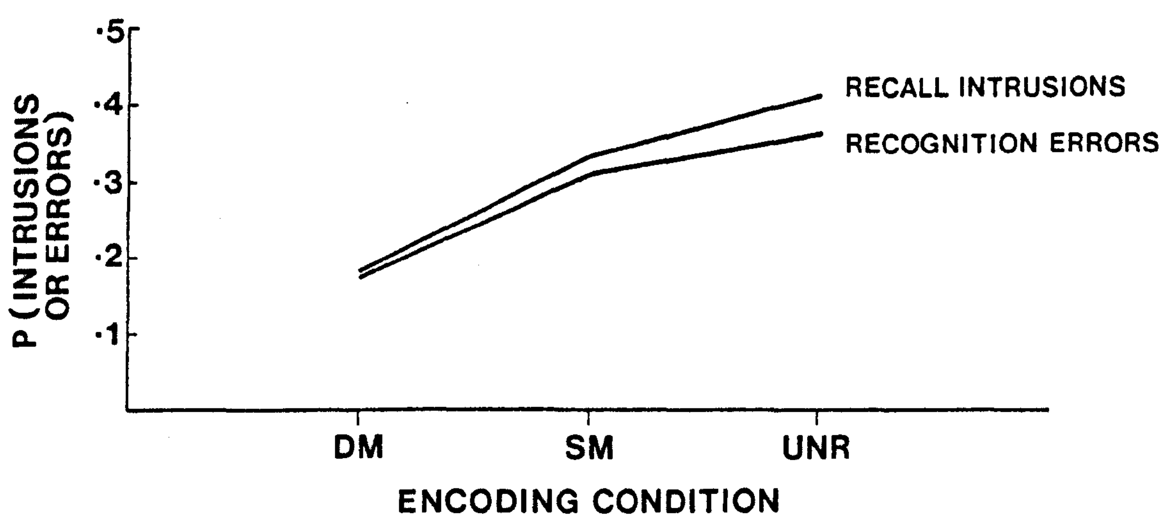

FIGURE 4·3 Mean probabilities of free recall intrusions and recognition errors as a function of encoding condition lower. In both free recall and forced-choice recognition the highest performance levels and lowest intrusion or error-rates were obtained in the DM encoding condition while the poorest performance and highest intrusion or error rates were found following encoding in the UNR condition. Although higher error rates necessarily follow from lower performance levels (and vice versa) in the forced-choice recognition test, this is not necessarily the case in free recall therefore the results obtained with the latter retention test lend support to those obtained with the former.

A Friedman's two-way analysis of variance by ranks was carried out on the recognition data which demonstrated a significant difference between the three encoding conditions in the levels of recognition and, consequently, in the error rates (2 d.f., $x^2 = 13.03$, $P<.01$). Three follow-up Wilcoxon matched-pairs signed-ranks tests showed that while recognition performance in the SM and UNR conditions did not differ significantly ($N = 18$, $T=64.5$, N.S.), the level of correct recognition in the DM condition was reliably higher than that in the other two conditions (in both cases, $P<.01$).

A further analysis was performed on the recognition error data in the UNR condition to discover whether or not the semantically related encoding stimulus was incorrectly recognised more frequently than the unrelated encoding stimulus. Separate error probabilities for the related and unrelated encoding stimuli were determined for each subject. The resulting mean error probabilities were .79 for related encoding stimuli and .21 for unrelated encoding stimuli. Ten subjects incorrectly recognised only semantically related encoding stimuli. A Wilcoxon matched-pairs signed-ranks test was performed which showed that the related encoding stimuli were incorrectly recognised with a significantly higher probability than the unrelated encoding stimuli ($N=18$, $T=14$, $P<.01$).

Confidence Ratings.

Separate mean confidence ratings were obtained for correct and incorrect recognition responses in each of the three encoding conditions. The mean confidence ratings for correctly recognised items were based on the data from 18 subjects. Since four subjects had 100% correct recognition in the DM encoding condition, these subjects' data were excluded from the computation of mean confidence ratings for incorrect recognition responses and from subsequent analyses. The failure of subjects to produce recognition errors in the DM condition was apparently a list effect, since all four occurrences were from subjects receiving the same presentation list. It should be noted, however, that these subjects produced a normal rate and pattern of recognition errors in the other two conditions. Their level and pattern of confidence ratings were also comparable with those of other subjects in the study.

The mean confidence ratings for correct and incorrect recognition responses in each ofthe three encoding conditions are presented in Table 4.9.

	Encoding Condition		
	DM	SM	UNR
Correct Recognition	2.83	2.45	2.45
Incorrect Recognition	2.27	1.89	1.89

Table 4.9: Mean Confidence Ratings for Correct and Incorrect Recognition Responses as a Function of Encoding Condition.

A Friedman's two-way analysis of variance by ranks demonstrated a significant difference between the three encoding conditions in the mean confidence ratings for correctly recognised items (2 d.f., x^2 = 11.36, $P<.01$). A similar analysis performed on the recognition error data failed to demonstrate a reliable difference between the three encoding conditions in the mean confidence ratings for incorrect recognition responses (2 d.f., x^2 = 3.86, $P<.20$). Three follow-up Wilcoxon matched-pairs signed-ranks tests were carried out on the confidence rating data for the correct recognition responses. These analyses showed that while there was no difference in the mean confidence ratings between the SM and UNR conditions ($N=18, T=71$, N.S.), the subjects were more confident of their reponses in the DM encoding condition than in either of the other two conditions (in both cases, $P<.01$).

To determine whether the mean confidence ratings for correct responses in each condition were reliably higher than those obtained for incorrect responses, three further Wilcoxon matched-pairs signed-ranks tests were performed on the data from the 14 subjects who produced intrusions in all three encoding conditions. The anlyses showed that the subjects were more confident of correct than incorrect recognition responses in all three encoding conditions (DM, $P<.025$; SM, $P<.01$; UNR, $P<.01$; one-tailed tests).

Finally, for each subject a difference score ($\bar{d}$) was obtained in each condition between the mean confidence ratings for correct and incorrect recognition responses. The difference score was obtained by subtracting the mean confidence rating for incorrectly recognised items from that for correct recognition responses. The mean difference scores for the 14 subjects concerned, which represent the subjects' ability to discriminate between correct and incorrect responses, are presented in Table 4.10.

	Encoding Condition		
	DM	SM	UNR
$\bar{d}$	.508	.419	.471

Table 4.10: Mean Difference Between Confidence Ratings for Correct and Incorrect Recognition Responses as a Function of Encoding Condition.

A Friedman's two-way analysis of variance by ranks failed to demonstrate any significant differences between the encoding conditions in the ability to discriminate between correct and incorrect recognition responses (2 d.f., $x^2 = .14$, $P<.95$).

Discussion.

The second experiment has confirmed the superiority in free recall resulting from encoding two meanings of homonyms as opposed to encoding one meaning. It also demonstrated, again, the relative ineffectiveness for subsequent free recall of the homonym of encoding it in the context of one semantically related and one unrelated biasing noun. More importantly, the second experiment has extended to the range of the effect to the recognition situation as can be seen from the striking parallel between the free recall and forced-choice recognition data.

The patterns of free recall intrusions and recognition errors were also remarkably similar and correspond to the pattern of free recall intrusions found in the first experiment. In both experiments the DM encoding condition was found to produce the highest levels of recall and lowest intrusion rates while encoding in the UNR condition resulted in the lowest performance levels and highest rates of intrusions. The observation that a substantial number of recognition errors occurred in the DM encoding condition would tend to discredit any notion that in this condition the subjects were simply able to "work out" which member of the word triplet had occurred in the middle during the encoding phase. It would appear, rather, that in this condition the word triplets are represented in memory in such a way that the homonym can be more easily distinguished than in the other two conditions.

Another interesting finding in the present experiment was the observation that in the UNR condition the unrelated encoding stimulus was very rarely incorrectly chosen as a recognition response. It would appear that in this condition the homonym and semantically related encoding stimulus are stored as a unit while the unrelated encoding stimulus is represented somewhat independently. Further supportive evidence for this notion will be provided in later studies where it will be shown that the related encoding stimuli are better recalled than the unrelated encoding stimuli, but only in an associative cueing situation.

Finally, the study demonstrated that not only was recognition best in the DM encoding condition, but the subjects also exhibited greater confidence in correct recognition responses in this condition. Such higher confidence in responses would tend to add support to the suggestion that, as far as retention of the homonym is concerned, encoding two different meanings of the homonym resulted in the formation of a more highly accessible and discriminable representation, with respect to the retrieval conditions employed in this experiment.

Experiment 3.

The previous experiment has provided quite conclusive evidence that under conditions of free recall and three-alternative forced-choice recognition, superior memory for homonyms results from encoding two meanings as opposed to one meaning of the homonyms at input. While the same general trend was found in the first experiment when both encoding stimuli were provided as retrieval cues at test, the observed difference in recall between the DM and SM encoding conditions was very slight indeed. Given the apparent robustness of the superiority of DM encoding for subsequent free recall and recognition of the homonym, it would seem likely that providing both encoding stimuli as retrieval cues would provide a similar pattern of results, since the three types of retention test may be viewed as providing varying degrees of reinstatement of the initial encoding context (e.g. Watkins, 1979). Along such a continuum the provision of both encoding stimuli as retrieval cues would represent an intermediate degree of context reinstatement, with free recall and three-alternative forced-choice recognition representing the lower and upper ends of the continuum respectively. To test this hypothesis and clarify the effects on recall of cueing the homonym with both encoding stimuli, the pertinent part of the first experiment was isolated and repeated using a within subjects design.

Subjects.

18 male and female subjects participated in the present study. The subjects were Introductory Psychology students at the University of Stirling, who received course credit for

taking part in the experiment.

Design.

The incidental learning paradigm used in the previous two experiments was employed in the present study. The same three encoding conditions were employed, with each homonym encoded in the context of two biasing nouns. Again, on each trial the subjects compared the encoding stimuli, in turn, with the homonym and indicated for each comparison whether or not they could perceive a semantic relationship between each pair of words. The manipulation of encoding conditions was a within-subjects variable. In the present study recall of each homonym was cued by both encoding stimuli.

The subjects received 36 trials, with 12 homonyms encoded in each of the three conditions. Three main input lists, with two versions each, were constructed. The two versions of each list differed in that encoding stimuli presented to the left ofthe homonyms in one version were presented to the right in the other version. The homonyms were presented in the same serial order, but in a different encoding condition, across the three sets of lists. The ordering of encoding conditions within the lists was randomised. On one half of the trials in the UNR condition in each list the unrelated encoding stimulus was presented to the left of the homonym, and on the remaining six trials to the right.

Six cueing lists were constructed, corresponding to the six input lists. Each homonym was cued simultaneously by both its encoding stimuli. The two members of each pair of cues were separated by a line on which the subjects wrote their recall response. Since the first experiment showed no indication of a differential effect of presenting the intralist cues on the same or on different sides at input and test, in the present study each pair of cues was presented on the same side, with respect to the homonym, as at encoding. The homonyms were cued in a different random order from their original presentation order at the input phase. Three subjects each received one of the six presentation lists and the corresponding cueing list.

Materials and Apparatus.

The homonyms and encoding stimuli used in the experiment were drawn from the word pool. The word triplets were presented via a Kodak Carousel projector in white uppercase letters against a black background. The slides were prepared using Letraset, with the homonyms in 18 pt and the encoding stimuli in 12 pt Helvetica Light. The presentation rate was paced by an electronic timer which produced an audible tone at 5-second intervals.

The subjects were provided with a numbered response sheet which was divided into two columns. Yes/No encoding responses to the left-hand encoding stimuli were recorded in the left-hand column and those to the right-hand encoding stimuli in the right-hand column. A three-digit number was printed on the back of the response sheet. In the distractor task employed, the subjects counted backwards in threes from this number for a predetermined period of time; writing down their answers as they progressed.

The recall cues were typed in uppercase. A line separated the two cues for each homonym. The subjects wrote their recall responses on this line. The cues were presented on two pages, with the recall of 18 homonyms cued on each page.

Procedure.

The subjects were tested in groups of three. Each word triplet was presented for a duration of four-seconds, with a one-second intertrial interval. During this period the subjects compared the two encoding stimuli, in turn, with the homonym, decided whether or not the two words in each comparison were semantically related, and recorded the two encoding decisions on the response sheet.

Following presentation of the final word triplet, the subjects performed the counting backwards distractor task for 1½ minutes. The unanticipated retention test was then administered. The subjects were told that each pair of cues had been previously presented together in the context of a third word, and were instructed to complete the word triplets by recalling the middle words. Five minutes were allowed for recall, however the majority of subjects completed the test well within this imposed time limited.

Results.

The mean cued recall probabilities for each of the three encoding conditions, based on the individual data from 18 subjects, are presented in Table 4.11.

	Encoding Condition		
	DM	SM	UNR
P(Recall)	.839	.733	.539

Table 4.11: P(Cued recall) as a Function of Encoding Condition.

The present data are directly comparable with those obtained in Experiment 1 when both encoding stimuli were provided as cues for recall of the homonyms. The same pattern of results was obtained in the two studies with the best recall performance in the DM encoding condition and the worst in the UNR condition, although in the present experiment a much larger difference in recall was obtained between the DM and SM conditions. A Friedman's two-way analysis of variance by ranks, performed on the present data, indicated a reliable difference in recall between the three encoding conditions (2 d.f.,x^2 = 21.86, P<.001). Three follow-up Wilcoxon matched-pairs signed-ranks tests showed that the three encoding conditions all differed significantly from one another in their levels of cued recall (in all cases, P<.01).

Discussion.

The third experiment further extends the range of retrieval contexts in which the beneficial effects on retention of encoding two meanings as opposed to one meaning of homonyms can be found. Even when both intralist cues are semantically related to the homonym whose recall they are cueing, recall is found to be higher when two different meanings of the homonym are encoded and cued. The finding of lowest recall in the UNR condition is less surprising, especially if it is assumed that only the homonym and semantically related encoding stimulus are stored together in episodic memory as an integrated unit. Accordingly, the presentation of both encoding stimuli as cues at test provides only one effective access route to the target word.

An additional interesting finding is that the levels of recall obtained in the present study were, at least in the DM and SM conditions, as high as the levels of recognition found in the previous experiment. It is possible that providing the homonym as a copy cue in the recognition test does little to increase the probability of accessing the encoded representation of the word triplets, over and above the access provided by the encoding stimuli. A viable alternative hypothesis is that the high levels of cued recall found could be attributable to the absence of an output decision ('which word appeared in the middle?') when the representation is accessed via two as opposed to three intralist cues.

General Discussion.

In the present section it is proposed that the rather consistent differences in retention obtained following the three qualitatively different types of encoding and, in addition, the differential recall intrustion and recognition error rates found, are attributable to differences in the manner in which the word triplets are represented in long-term episodic memory following encoding in the DM, SM and UNR conditions. First, the representational consequences of each of the three types of encoding, basedon the representational framework proposed in the first chapter, will be discussed. The results of the first three experiments will then be discussed with reference to the postulated representational structures.

Beginning with the UNR encoding condition, in line with the second assumption it is proposed that the homonym and semantically related encoding stimulus are stored together as a unit while the unrelated encoding stimulus is represented, to all intents and purposes, separately although some tenuous, probably contextual, link may exist between this encoding stimulus and the homonym. The above formulation is schematized in Figure 4.4. Evidence for such a representation comes from Experiment 2, in which it was found that the unrelated encoding stimulus was very rarely chosen as a recognition response (10 of the 18 subjects incorrectly recognised only semantically related encoding stimuli). This would appear to indicate that, generally speaking, a response decision was required only between the homonym and related encoding stimulus.

The manner of representation shown in Figure 4.5 is proposed for the SM encoding condition. It is suggested that the comparison of the first encoding stimulus and the homonym leads to the discovery of a subset of common semantic features which form the unitising link for a joint representation in episodic memory. When the second encoding stimulus is compared with the homonym, this comparison also results in a subset of shared semantic features being established. Consequently, the second encoding stimulus is also represented in conjunction with the homonym. However, since the encoding stimuli are semantically related to the same meaning of the homonym, a subset of semantic features common to the two encoding stimuli will be encoded, as will a smaller subset common to all three words. This sharing of semantic features by the

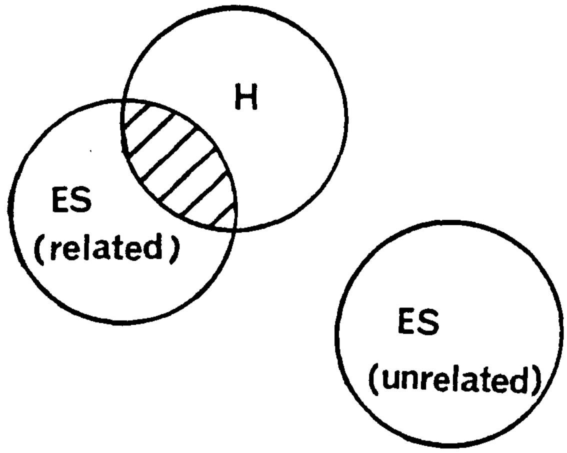

FIGURE 4.4 Proposed representational structure: UNR encoding condition

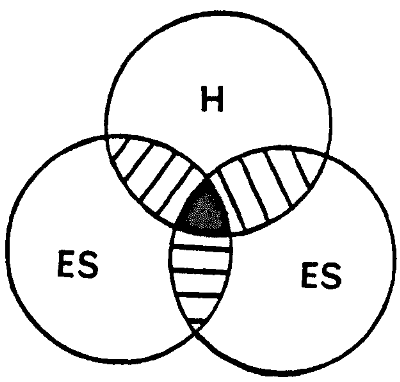

FIGURE 4.5 Proposed representational structure: SM encoding condition

encoding stimuli accounts for the finding in Experiment 1 that the second encoding stimulus was frequently produced as a cued recall intrusion in the SM encoding condition.

In both of the above encoding conditions only one meaning of the homonym is encoded at the input phase and, accordingly, a single resultant memory representation of the homonym is postulated. In the DM encoding condition, however, two entirely different meanings of the homonym are encoded. As such, the question arises as to whether the two different meanings should be conceptualised as being represented within the same single trace, or whether two separate representations of the homonym should be proposed. The two alternative forms of representation are shown in Figure 4.6. Figure 4.6a represents the situation in which both encoded meanings of the homonym are represented within a single episodic trace, based on the orthographic and phonological characteristics of the "word". As in the SM encoding condition, since both encoding stimuli are semantically related to the homonym, the three words will be represented in episodic memory as a unit. In this case the two encoding stimuli are semantically related to two entirely different meanings of the homonym and consequently each activates a completely different set of semantic features. The result is that while the representation of both encoding stimuli are semantically linked to that of the homonym, there is no overlap of shared semantic features between the representations of the two encoding stimuli.

The alternative form of representation is shown in Figure 4.6b. Here, each encoded meaning of the homonym is assumed to have a separate episodic memory representation.

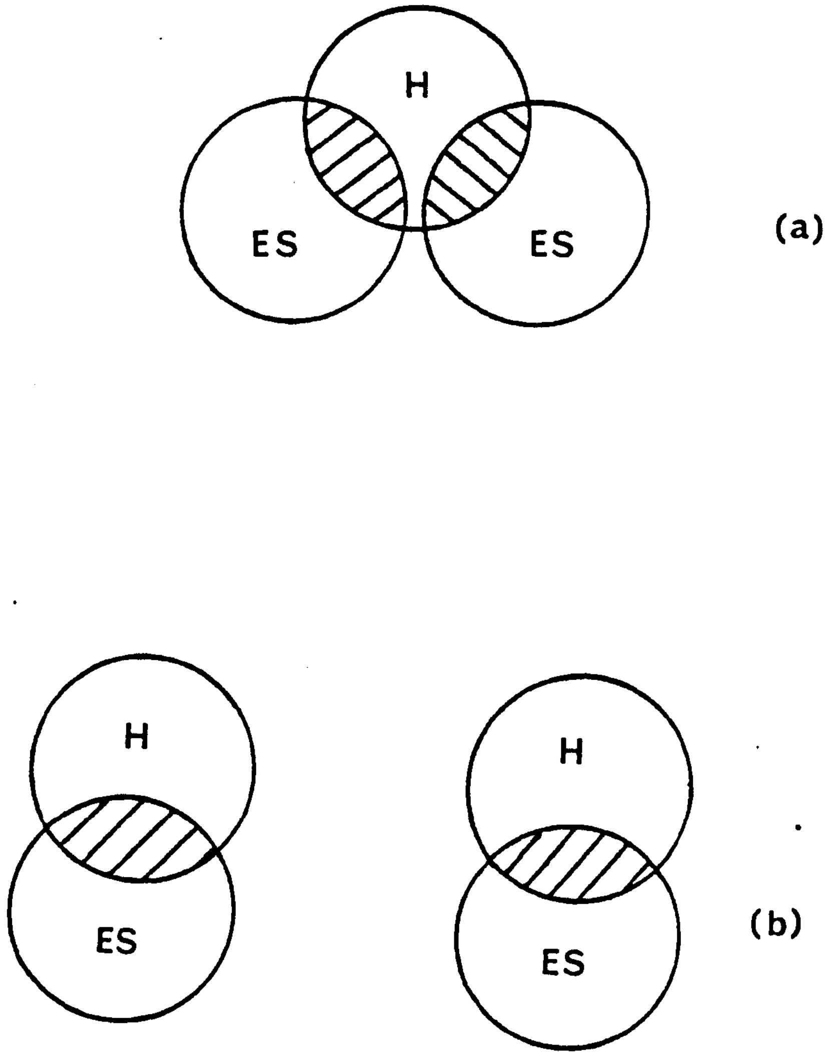

FIGURE 4.6 Proposed representational structures:DM encoding condition

KEY H - HOMONYM ES - ENCODING STIMULUS

Unique semantic features

Semantic features shared by two items

Semantic features shared by three items

While the two representations of the homonym will contain a common set of orthographic and phonological features, two completely different sets of semantic features will be activated at input and stored in the two traces. Since each encoding stimulus shares a subset of semantic features with the particular meaning of the homonym which it is biasing, each encoding stimulus will be stored with the meaning of the homonym to which it is semantically related.

The results obtained in the first three experiments fail to differentiate between the above alternative forms of representation since they are compatible with both types of representation. Later experiments to be reported were aimed at determining whether or not different meanings of homonyms are stored independently of one another i.e. represented by independent sets of semantic features and, if so, whether such independent storage occurs within a single memory representation or across traces. The remainder of the present section will be devoted to demonstrating how the postulated differences in episodic memory representation resulting from the three qualitatively different types of encoding can account for the differences in retention levels, confidence ratings, recognition errors and recall intrusions found between the three encoding conditions.

In the first experiment it was observed that extralist cues which were semantically related to an encoded meaning of the homonym were more effective than extralist cues related to a nonencoded sense of the homonym (e.g. UNR encoding followed by SM vs DM cueing). When the former cues are presented at retrieval, semantic features which are also present in the episodic trace of the word triplet may be encoded. Retrieval information provided by the second type of extralist cue is unlikely to match the encoded semantic features which comprise the episodic representation of the triplet. As a consequence, the latter type of cue will be ineffective in aiding recall; indeed, as ineffective as a totally unrelated extralist cue as was shown in Experiment 1.

The main finding of interest in the first three studies was that under certain conditions of cued recall, free recall and recognition, the homonym was retrieved with the highest probability when two of its meanings had been encoded at input (DM encoding condition). The lowest probabilities of retrieval occurred when the homonym was encoded in the context of one related and one unrelated encoding stimulus (UNR encoding condition). Furthermore, in these studies the highest levels of retention were associated with the lowest rates of recognition errors and recall intrusions, and vice versa.

When both encoding stimuli were provided as cues for recall of the homonym, the highest level of recall was found in the DM encoding condition, while recall in the SM condition was somewhat lower. In the two conditions both encoding stimuli share common semantic features with the homonym. Once their representation is accessed, both encoding stimuli can act as retrieval routes for recall of the homonym. In the present framework, however, there is some degree of overlap in the retrieval information provided by the two cues in the SM condition. No such redundancy of retrieval information exists in the DM encoding condition. Consequently, a greater overall amount of retrieval information is available to aid recall of the homonym. As a result, the homonym is recalled with a higher probability in the DM encoding condition than in the SM condition. The lowest level of recall was found in the UNR condition since in this condition only one encoding stimulus shares semantic features with the homonym; accordingly, only one effective retrieval route exists for its recall.

The same ordering of performance was obtained with the three-alternative forced-choice recognition test. Moreover, greater confidence in correct recognition responses was reported following encoding in the DM condition. Within the present framework, the observed pattern of results can be explained with reference to the number of shared semantic features comprising the episodic representations of the word triplets and the manner in which the encoded semantic features of words within the triplets are assumed to overlap. There should be little difference between the DM and SM encoding conditions in the accessibility of the representations formed, due to their containing roughly equivalent numbers of shared semantic features overall. In the DM encoding condition, the homonym will be more easily accessed than the encoding stimuli since its representation contains approximately twice as many salient shared semantic features as the representations of each encoding stimulus. As a result of its representation containing considerably more salient features, the homonym will be correctly identified with a high probability and with comparatively high confidence. In the SM encoding condition there is less difference between the representations of the homonym and encoding stimuli in the number of salient semantic features which they contain. While the homonym will be somewhat more easily accessed than either encoding stimulus, the smaller difference in the number of salient encoded features contained in their respective traces will result in recognition responses being made with less confidence and the encoding stimuli being incorrectly recognised with a higher probability than in the

DM encoding condition. The episodic trace of the homonym is least accessible in the UNR condition since it contains only one subset of shared semantic features. Moreover, the representations of the homonym and the semantically related encoding stimulus will contain a similar number of such salient features, resulting in a high probability of incorrect recognition responses. While in all three encoding conditions the representation of the homonym will contain more unique semantic features than that of either encoding stimulus, the importance at retrieval of these unique features is considered small compared to that of the more salient focal shared features. Incorrect recognition of the unrelated encoding stimulus in the UNR encoding condition is unlikely to occur since it is represented separately from the other members of the word triplets.

The above explanation can also be applied to the findings obtained in free recall of differential recall levels and intrusion rates across encoding conditions. The only difference between the free recall and recognition situations is that in the former, only contextual information is provided for retrieval of the episodic representations, while in recognition the retrieval information takes the form of copy cues. The striking parallel between both the correct free recall and recognition results, and the recall intrusion and recognition error results in Experiment 2 would appear to support the idea that the same basic retrieval process was involved in both retrieval contexts. In both retrieval situations the probability of accessing the encoded representation will depend upon the number of salient semantic features present in the to-be-remembered trace, and the probability of making a correct output decision once the trace has been accessed will be dependent upon the relative numbers of encoded focal features present in each part of the unitised representation.

In the above explanation the same reasoning applies whether in the DM condition a single representation of the homonym or two separate representations corresponding to the two different meanings encoded are postulated. In the former case the two meanings of the homonym are assumed to be separately represented within the trace anyway. While each trace of the homonym in the latter formulation will have a lower probability of being accessed than the single trace of the homonym,in the former the existence of two separate traces will increase the probability of at least one being accessed.

In the following chapter predictions derived from the present representational framework will be tested with the aim of determining its validity and providing a more complete picture of the consequences for various measures of retention of the representations formed as a result of the three qualitatively different types of encoding.

CHAPTER 5

RETENTION OF ENCODING STIMULI

Given the representational framework outlined in the final section of Chapter 4, various predictions can be made as to the effect of providing one or more members of the word triplets as cues for recall of the remaining members or member. In the three experiments to be reported in the present chapter, retention of the encoding stimuli was tested in various retrieval contexts. The results obtained were found to be consistent with the representational structures proposed in the previous chapter and provide a more extensive picture of the patterns of cue effectiveness.

One possibility which must be ruled out is that the superior retention of the homonyms observed following encoding two meanings of the homonyms may result from quantitative differences in encoding rather than the existence of qualitatively different memory traces. Since in the DM encoding condition, comparison of the homonym with the second encoding stimulus necessitates the activation of a completely different subset of semantic features associated with a second, different,meaning of the homonym, the homonym may be more extensively processed in this condition than in the SM condition in which the same meaning of the homonym is achieved for both comparisons. This possibility will also be investigated in the following three studies.

Experiment 4.

The major aims of the first experiment to be reported were two-fold. First, to determine whether differential recall of the homonym across encoding conditions occurs in a free recall situation in which no output decision is required and, second, to test the hypothesis that superior retention in the DM condition is a result of simply more extensive processing of the homonym in that condition.

It is possible that in the previous studies employing tests of free recall, the representation of the homonym was equally accessible in the DM and SM encoding conditions, with lower recall in the latter condition occurring as a result of a more difficult output decision in that condition. That is, it appears to be more difficult to differentiate between the homonyms and encoding stimuli in the SM encoding condition than in the DM condition, and this difference in discriminability may account for the observed differences in free recall. In the present framework the representation of the homonym should be more highly accessible following encoding in the DM condition since in this condition the representation of the homonym should contain the largest number of salient shared semantic features. If such differential accessibility of the homonym exists, then the homonym should still be recalled with a higher probability in the DM condition when the necessity to differentiate between the representations of the homonym and encoding stimuli prior to producing a recall response is eliminated.

Evidence for more extensive processing of the homonym in the DM encoding condition can be obtained by comparing recall of the left-and right-hand encoding stimuli in the DM and SM conditions. In the DM encoding condition, it is probable that the comparison of the second, right-hand encoding stimulus with the homonym necessitates the same degree of semantic processing of both words as does the comparison of the homonym with the first, left-hand encoding stimulus. This being the case, there should be no difference in recall of the left-and right-hand encoding stimuli. If in the SM encoding condition, however, preservation of the meaning biased on the two comparisons leads to less extensive processing of the homonym and right-hand encoding stimulus on the second comparison, than recall of the left-hand encoding stimuli should be somewhat higher than that of the right-hand encoding stimuli. This possibility is tested in the present experiment.

Subjects.

The 18 subjects who took part in the present study were male and female Introductory Psychology students at the University of Stirling who participated in partial fulfilment of a course requirement.

Design.

The incidental learning paradigm used in the previous experiments was also employed in the present study. The same three encoding conditions were used, with the homonyms encoded in the context of two biasing nouns in each condition. Again on each trial the subjects compared each encoding stimulus, in turn, with the homonym and decided whther or not they could perceive a semantic relationship between the two words. A within-subjects design was employed. Retention was tested by free recall of all list words.

The subjects received a total of 36 trials, with 12 in each of the three encoding condition. Three presentation lists, with two versions each were constructed in the same manner as in the previous experiments. Each homonym was encoded in a different condition across the three pairs of lists. The first and last three trials in each list served as primacy and recency buffers respectively. The three encoding conditions were represented in both buffers. Recall of items only from the remaining 30 trials was scored.

Materials and Apparatus.

The homonyms and encoding stimuli used in the experiment were drawn from the word pool. The word triplets were presented via a Kodak Carousel projector in white uppercase letters against a black background. The slides were prepared using Letraset with the homonyms in 18 pt and the encoding stimuli in 12 pt Helvetica Light.

The subjects were provided with a numbered response sheet which was divided into two columns corresponding to the two comparisons required on each trial. Encoding decisions ("Yes" or "no") to the left-hand encoding stimuli were recorded in the left-hand column and those to the right-hand encoding stimuli in the right-hand column. The presentation rate was paced by an electronic timer which produced an audible tone at 5-second intervals. A blank sheet of paper was provided for free recall.

Procedure.

The subjects were tested in groups of three. Each word triplet was presented for a duration of four seconds, with a one-second intertrial interval. During each four-second interval the subjects made the relevant comparisons and recorded their decisions on the response sheet. Following presentation of the final word triplet the subjects were issued with a blank sheet of paper and an unanticipated free recall test was administered. The subjects were instructed to list all of the previously presented words which they could remember. Five minutes was allowed for recall.

Results.

The overall free recall probabilities in each of the three encoding conditions (which include recall of homonyms and encoding stimuli) are presented in Table 5.1.

	Encoding Condition		
	DM	SM	UNR
P(Recall)	.245	.239	.162

Table 5.1: Overall P(Free Recall) as a Function of Encoding Condition.

A Friedman's two-way analysis of variance by ranks failed to demonstrate a reliable difference between the three encoding conditions in the overall recall levels (2 d.f., $x^2 = 4.19$, $P<.20$).

The free recall data in each condition were broken down and separate recall probabilities were obtained for the homonyms and each of the two encoding stimuli i.e. for each of the three positions in the word triplets. The resulting mean free recall probabilities are shown in Table 5.2.

		Encoding Condition			
		DM	SM	UNR	Means
Position of item in word triplet	Left	.204	.196	.147	.182
	Middle	.320	.257	.186	.254
	Right	.211	.265	.154	.210
	Means	.245	.239	.162	

Table 5.2: Mean Probabilities of Free Recall of the Homonyms and Left- and Right-Hand Encoding Stimuli as a Function of Encoding Condition.

A separate analysis was performed on the data for each encoding condition to determine whether there were any differences in the levels of recall of the homonyms and left- and right-hand encoding stimuli. In the DM encoding condition, a Friedman's two-way analysis of variance by ranks indicated a reliable difference in the recall of the three items in the word triplets (2 d.f., x^2 = 9.03, P<.02). Three follow-up Wilcoxon matched-pairs signed-ranks tests showed that the homonyms were significantly better recalled than either the left- or right-hand encoding stimuli (in both cases, P<.01), the recall levels of which were not reliably different (N=11, T=24, N.S.).

Two Friedman's two-way analyses of variance by ranks performed on the comparable recall data for the SM and UNR conditions failed to demonstrate any reliable differences in the recall of the homonyms and left- and right-hand encoding stimuli in these conditions (SM condition; 2 d.f., x^2 = 3.69, P<.20: UNR condition; 2 d.f., x^2 = 3.53, P<.20).

Separate analyses were also performed on the data for each of the three positions in the word triplets to determine whether there were any differences across encoding conditions in the recall of the homonyms or either the left- or right-hand encoding stimuli. Each of the three Friedman's two-way analyses of variance by ranks which were carried out failed to demonstrate any reliable differences between the three encoding conditions in the levels of recall of either the left- or right-hand encoding stimuli (left-hand encoding stimuli; 2 d.f., x^2 = 0.86, P<.70); right-hand encoding stimuli; 2 d.f., x^2 = 4.33, P<.20) or the homonyms, although for the latter, the difference in recall between the encoding conditions just failed to reach conventional levels of significance (2 d.f., x^2 = 5.86, P<.10).

In the UNR encoding condition, separate free recall probabilities were determined for the semantically related and unrelated encoding stimuli. The resulting mean free recall probabilities are presented separately in Table 5.3 for the left- and right-hand encoding stimuli.

Relation of Encoding Stimulus to Homonym		Position of Encoding Stimulus In Word Triplet: Left	Right	Means
	Related	.094	.114	.105
	Unrelated	.197	.203	.196
	Means	.147	.154	

Table 5.3: P(Free Recall) of Related and Unrelated Encoding Stimuli in the UNR Condition as a Function of Position in the Word Triplets.

Two separate Wilcoxon matched-pairs signed-ranks tests were performed on the data for the related and unrelated encoding stimuli. Both failed to show a reliable difference between the recall of the left- and right-hand encoding stimuli (Related encoding stimuli, N=11, T=29.5, N.S.: Unrelated encoding stimuli, N=14, T=48, N.S.). A Wilcoxon matched-pairs signed-ranks test showed that of the right-hand encoding stimuli,unrelated encoding stimuli were significantly better recalled than related encoding stimuli (P<.02), while a similar analysis found that the difference in recall between related and unrelated encoding stimuli just failed to reach significance when these words occupied the left-hand position in the triplets (N=15, T=27, N.S.). Overall, however, there was a reliable superiority in the recall of the unrelated over semantically related encoding stimuli;(P<.01).

Discussion.

While not proving statistically reliable, the relative levels of recall of the homonym across encoding conditions were as expected from the framework outlined in Chapter 4. The trend was for the highest recall in the DM encoding condition and the lowest in the UNR encoding condition, indicating that the representation of the homonym was most accessible in the former condition while the least accessible representation of the homonym resulted from encoding in the latter condition. That this should be so is a consequence of the different numbers of salient semantic features contained in the traces of the homonym in the three different encoding conditions. These focal semantic features are considered to be more durable than their counterparts which are unique to individual items in the representation. Since retrieval is conceptualised as the matching of retrieval information with information contained in the episodic trace, the shared semantic features, being more durable, will be more highly accessible at retrieval.

No evidence was found in the experiment to suggest that recall of the homonym in the DM encoding condition results simply from more extensive analysis of the homonym in that condition at encoding. There was no reliable difference in the recall of the left- and right-hand encoding stimuli in the SM condition. If the second comparison in the SM condition required less extensive semantic processing than the first comparison,then a resulting superiority in recall of the left-hand (first) encoding stimulus should have been obtained. If anything, the results were in the opposite direction, with recall of the right-hand encoding stimulus being slightly better than that of the left-hand encoding stimulus.

An interesting finding resulting from the study was that the homonyms were significantly better recalled than either the left- or right-hand encoding stimuli in the DM condition while no differential recall of the homonyms and encoding stimuli was found in the other two conditions. Such an outcome is consistent with the present representational framework. In the DM condition the trace of the homonym contains twice as many salient shared semantic features than that of either encoding stimulus and consequently is more highly accessible at retrieval. In the SM and UNR encoding conditions the difference between the representations of the homonym and encoding stimuli in the number of shared features which they contain is considerably smaller and accordingly the difference between them in accessibility is smaller.

The final finding of interest in the present study was the superiority in recall of unrelated over semantically related encoding stimuli in the UNR condition. As will be shown in the following two studies, the opposite effect is found in cued recall where the related encoding stimuli are consistently better recalled. It would appear that the unrelated encoding stimulus and the homonym are extensively processed in the orienting task, in an attempt to find a subset of semantic features common to the two words. Since the search for shared semantic features is unsuccessful, the two words are represented separately in episodic memory. In the present free recall situation, successful retrieval is not necessarily dependent upon the accessing of other members of the word triplet. The unrelated encoding stimulus has been more extensively processed than its semantically related counterpart and its representation contains a large number of unique semantic features. It is consequently accessed with a relatively high probability. As will be shown in the following two studies, when recall is dependent upon the utilisation of shared semantic features as retrieval routes, recall of the unrelated encoding stimulus is consistently poor. This demonstrates the influence of the retrieval context on the relative levels of retention observed.

Experiment 5.

In the present study one encoding stimulus and the homonym were presented as cues for recall of the second encoding stimulus. It is expected that the highest level of recall in this situation should be found in the SM encoding condition since only in this condition do both cues share semantic features with the target word and thereby act as effective retrieval routes for its recall. In the DM condition only one of the cues (the homonym) can provide direct access to the to-be-remembered word. As such, recall in this condition is expected to be lower than in the SM condition. The poorest recall performance is expected in the UNR encoding condition when recall of the unrelated encoding stimulus is cued, since in this condition only a tenuous contextual link is assumed to exist between the homonym and the target word.

Subjects.

The 36 subjects who took part in the experiment were male and female Introductory Psychology students at the University of Stirling who participated in partial fulfilment of a course requirement.

Design.

The incidental encoding procedure which was used in the previous four experiments was employed in the present study. The same three qualitatively different types of encoding of homonyms were induced at input.

The subjects were presented with a total of 42 word triplets, including three primacy and three recency buffer trials. As in

Experiment 4, each of the three forms of encoding were represented in both buffers, although subsequent retention of buffer items was not tested. A within-subjects design was employed. Within the 36 critical trials of the lists, 12 homonyms were encoded in each of the three conditions. Three main input lists, with two versions each, were constructed. The two versions of each list differed only to the extent that encoding stimuli presented to the left of the homonym in one version were presented to the right of the homonym in the other version, and vice versa. The serial ordering of the homonyms was constant across lists, while the ordering of encoding conditions was randomised within the lists. In the UNR condition the unrelated encoding stimulus was presented to the left of the homonym on one half of the trials and to the right of the homonym on the remaining trials.

Retention in the present experiment was tested by cued recall. On each cueing trial one encoding stimulus and the homonym acted as cues for recall of the second encoding stimulus. On one half of the trials in both the Dm and SM encoding conditions recall of the left-hand encoding stimulus was cued, while recall of the right-hand encoding stimulus was cued on the remaining six trials in both conditioms. A between-subjects design was employed in the UNR condition. One group of subjects from each input list were cued for recall of the unrelated encoding stimuli, while a different group of subjects were cued for recall of the semantically related encoding stimuli. In both cases the left- and right-hand encoding stimuli were cued equally often. The order of cueing of the targets was randomised and was different from the original presentation order of the word triplets.

Six subjects each received one of the six input lists, with two subjects from each input list receiving one of the two versions of the cued recall test for that list.

Materials and Apparatus.

The homonyms and encoding stimuli used in the study were drawn from the word pool. The word triplets were presented via a Kodak carousal projector in white uppercase letters against a black background. The slides were prepared using letraset, with the homonyms in 18 pt and the encoding stimuli in 12 pt Helvetica Light. The presentation rate was paced using an electronic timer which produced an audible tone at 5-second intervals.

The subjects were provided with a numbered response sheet which was sectioned into two columns corresponding to the two encoding decisions required on each trial.

Each pair of recall cues were presented on a separate card. The two cues were typed in black uppercase letters. The cues from each word triplet were presented in the same relative positions as during the encoding phase, with a line in the appropriate location (to the left or to the right of the homonym) on which the subjects wrote their recall response.

Procedure.

The subjects were tested in groups of up to six. Each word triplet was presented for a duration of four-seconds, with a one-second intertrial interval. The encoding procedure was identical to that in the previous experiments.

Immediately following presentation of the final encoding trial, the subjects were issued with a stack of 36 cue cards. The subjects were informed that each pair of cues had been presented together in the encoding phase, in the context of a third word. The subjects were instructed to complete the word-triplets with the appropriate list words, writing their recall responses on the line provided. Recall was unpaced, although the subjects were discouraged from spending too long on each pair of cues. No subject required more than five minutes for recall.

Results.

The overall mean probabilities of cued recall in each of the three encoding conditions are presented in Table 5.4 for the two groups of subjects, one of which was cued for recall of the semantically related encoding stimuli in the UNR condition and the other for recall of the unrelated encoding stimuli.

		Encoding Condition			
		DM	SM	UNR	Means
Encoding Stimuli Cued in UNR Condition	Related	.585	.732	.471	.596
	Unrelated	.566	.657	.199	.474
	Means	.576	.694	.335	

Table 5.4: P(Cued Recall) as a Function of Encoding Condition.

A Friedman's two-way analysis of variance by ranks performed on the recall data of the subjects in the 'related' group indicated a reliable difference in recall between the three encoding conditions (2 d.f., x^2 = 9.00, $P<.02$). Three follow-up Wilcoxon matched-pairs signed-ranks tests demonstrated that all three encoding conditions differed significantly from one another in their levels of recall (in all cases, $P<.01$). The best recall performance was obtained in the SM encoding condition. Recall was intermediate in the DM condition, and the lowest level of recall was found in the UNR condition.

Similarly, a Friedman's two-way analysis of variance by ranks was performed on the overall cued recall data of the subjects in the "unrelated" group. Again, a reliable difference in recall between the three encoding condition was indicated (2 d.f., x^2 = 27.53, P<.001). Three follow-up Wilcoxon matched-pairs signed-ranks tests confirmed that the three encoding conditions differed significantly from one another in terms of recall (DM vs. SM, P<.05; DM vs. UNR, SM vs. UNR, P<.01). As with the othergroup of subjects, the highest level of cued recall was obtained in the SM encoding condition and the lowest in the UNR condition.

In each encoding condition, separate recall probabilities were determined for the left- and right-hand encoding stimuli. In the UNR condition the above recall probabilities were determined separately for related and unrelated encoding stimuli. The resulting mean cued recall probabilities are shown in Table 5.5.

		Encoding Condition			
		DM	SM	UNR(related)	UNR(Unrelated)
Position of Encoding Stimulus in Triplet	Left	.570	.668	.426	.214
	Right	.591	.724	.573	.197

Table 5.5: Mean Cued Recall Probabilities for Left- and Right-Hand Encoding Stimuli as a Function of Encoding Condition.

Two Wilcoxon matched-pairs signed-ranks tests, performed on the data of all 36 subjects, failed to demonstrate significant differences in the recall of left- and right-hand encoding stimuli in the DM and SM encoding conditions (DM, N=25,T=135.5, N.S.; SM, N=30,Z=1.38, P=.0869).

In the UNR condition, the recall data for the related and unrelated encoding stimuli were separately analysed. In both cases, a Wilcoxon matched-pairs signed-ranks test failed to indicate a difference in the recall of left- and right-hand encoding stimuli (Related encoding stimuli; $N = 12, T = 21$, N.S.: Unrelated encoding stimuli, $N = 11$, $T = 25$, N.S.). In none of the encoding conditions, then, was there any evidence that encoding stimuli occupying one position (left or right) at input were better recalled than encoding stimuli occupying the alternative position.

A Mann-Whitney U-test performed on the cued recall data for the left-hand encoding stimuli showed that the related encoding stimuli were significantly better recalled the Unrelated encoding stimuli ($N = 18$, $U = 92$, $P<.05$). A similar analysis performed on the recall data for the right-hand encoding stimuli also demonstrated a superiority in recall of the related over the unrelated encoding stimuli ($N = 18$, $U = 69$, $P<.01$). Regardless of the position which the encoding stimuli occupied in the word triplets, retention of the semantically related encoding stimuli was superior to that of the unrelated encoding stimuli.

Discussion.

As predicted, the highest levels of recall were obtained in the SM encoding condition for both groups of subjects. In this condition the two cues share to some extent overlapping subsets of semantic features with the target encoding stimulus, thereby providing two effective access routes for retrieval of the to-be-remembered word. Lower levels of recall were obtained in the DM encoding condition. In this condition only the homonym shares common semantic features with the target word:

the cueing encoding stimulus may aid retrieval of the unit stored in memory, but does not itself function as a direct retrieval route for recall of the other encoding stimulus which is being cued. In the UNR condition, recall of the unrelated encoding stimulus is exceedingly low since only very tenuous links exist between the representation of the cues in memory and the to-be-remembered word, these links most likely being contextual in nature. Recall of the semantically related encoding stimuli was found to be higher than that of the unrelated encoding stimuli, but was still lower than the recall performance obtained in the DM encoding condition. When recall of the related encoding stimulus is cued in the UNR condition, an effective retrieval route exists from the homonym to the target word, as in the DM condition. That recall was not as high as that in the DM encoding condition indicates that in the DM condition the episodic representation of the homonym was initially more accessible through the cues. In the DM condition the trace can be accessed through both cues while in the UNR condition the homonym is solely responsible for accessing the representation of itself and the related encoding stimulus since the unrelated encoding stimulus is,for most purposes, separately represented in episodic memory. Such differences in the ability of the cues to initially access the episodic representation containing the to-be-remembered encoding stimulus would seem to be responsible for the observed differences in recall between the DM condition and the UNR condition when the homonym and unrelated encoding stimulus were provided as cues for recall of the related encoding stimulus.

As in the previous experiment there was no evidence that the right-hand encoding stimuli received less extensive processing than the left-hand encoding stimuli in the SM condition. Again, if anything, there was a slight (though not reliable) superiority in the recall of right-hand over left-hand encoding stimuli in this condition.

Finally, the superior recall of semantically related over unrelated encoding stimuli in the UNR condition can be contrasted with the finding in Experiment 4 of superior recall of the unrelated encoding stimuli when retention was tested by free recall. Lower recall of the unrelated encoding stimuli is expected under the present conditions of cued recall since the representation of the to-be-remembered word is not contained in the episodic memory trace which is accessed by the cues. That the unrelated encoding stimulus is recalled at all in such circumstances would seem to be due to the retrieval and utilisation of common contextual information shared by the two representations. The related encoding stimuli have a higher probability of recall than the unrelated encoding stimuli under cueing conditions in which successful retrieval of the to-be-remembered word is dependent upon the matching of semantic information provided by the cue with that contained in the episodic representation of the target word.

Experiment 6.

In the final experiment to be reported in this chapter the homonym was provided as a cue for the recall of both encoding stimuli. What will be the exact effect across encoding conditions on the overall recall levels in this cueing situation is unclear. The representation of the homonym should be more easily accessed in the DM encoding condition than in the other two conditions, since in this condition the trace of the homonym is assumed to contain a larger number of highly accessible shared semantic features than does the representation of the homonym in either of the other two encoding conditions. On the other hand, in the SM encoding condition once the trace of the homonym has been accessed, recall of one encoding stimulus, by virtue of their sharing a subset of semantic features, may facilitate recall of the other encoding stimulus. In other words, when the representation of one encoding stimulus has been retrieved in the SM encoding condition, two effective retrieval routes then exist for recall of the second encoding stimulus. Such a facilitatory effect may counter the advantage of higher accessibility of the trace of the homonym in the DM condition, leading to comparable recall performance in the two conditions. Alternatively the advantage of higher initial accessibility in the DM encoding condition may be under- or over-compensated for, resulting respectively in lower or higher recall in the SM condition.

The lowest levels of recall are expected in the UNR encoding condition since the representation of the homonym should be least accessible in this condition. Furthermore, the act of recalling one encoding stimulus should not greatly enhance the likelihood of the other one being recalled, since no direct semantic link exists between the two. This is also the case in the DM condition. Consequently, one other prediction that can be derived is that the probability of recalling both encoding stimuli given that one has been recalled should be highest following encoding in the SM condition.

<u>Subjects.</u>

The 18 subjects who took part in the experiment were Introductory Psychology students of both sexes at the University of Stirling, who participated in partial fulfilment of a course requirement.

Design.

The design of the encoding phase of the study was identical to that of Experiment 5, so will not be repeated here.

Three subjects each received one of the six presentation lists. Retention in the present experiment was tested by cued recall. At retrieval, the homonyms were provided as cues for the recall of both of their encoding stimuli. The homonyms were presented in a different random order from that at input. The order of cueing was the same for all 18 subjects.

Materials and Apparatus.

The same word triplets and mode of presentation were employed for the input phase of the study as in Experiment 5.

At test, the subjects were provided with a list of cues. The cues were printed in uppercase letters. The subjects wrote their two recall responses in a space to the right of each homonym.

Procedure.

The subjects were tested in groups of three. Each of the 42 word triplets was presented for a duration of four-seconds, with a one-second interval between trials. The encoding procedure was identical to that of the previous experiments.

Immediately following the final encoding trial the subjects were issued with a list of cues, and informed that each had originally appeared in the middle of a word triplet. The subjects were instructed to write next to each cue the two encoding stimuli with which it had been presented during the encoding phase. Recall was unpaced, but the subjects were discouraged from spending too long on any particular cue. No subject required more than five minutes to complete the recall test. As in the previous experiments, learning was incidental, with the subjects receiving no prior warning that retention would be subsequently tested.

Results.

The overall mean recall probabilities in each of the three encoding conditions are presented in Table 5.6 with separate recall probabilities shown for the related and unrelated encoding stimuli in the UNR condition.

	Encoding Condition			
	DM	SM	UNR-Related	UNR-Unrelated
P(Recall)	.581	.590	.427	.188

Table 5.6: Overall Mean Probabilities of Cued Recall as a Function of Encoding Condition.

A Friedman's two-way analysis of variance by ranks, performed on the overall cued recall data, indicated reliable differences between the conditions in the levels of recall (3 d.f. $x^2 = 29.18$, $P<.001$). Six follow-up Wilcoxon matched-pairs signed-ranks tests were carried out to test for differences in recall between each pair of conditions. It was found that while there was no reliable difference in recall performance between the DM and SM conditions (N=17,T=65,N.S.), recall in both of these conditions was significantly higher than that of both the related and unrelated encoding stimuli in the UNR condition (in all case, $P<.01$). Furthermore, within the UNR condition, recall of the semantically related encoding stimuli was reliably higher than recall of the unrelated encoding stimuli ($P<.01$). In summary, the encoding stimuli were equally well recalled in the DM and SM, while recall performance was intermediate for related encoding stimuli in the UNR condition and lowest for unrelated encoding stimuli in that condition.

Separate recall probabilities were determined for the left-hand and right-hand encoding stimuli in each condition. The mean probabilities of cued recall are presented in Table 5.7.

		Encoding Condition			
		DM	SM	UNR-Related	UNR-Unrelated
Position of Encoding Stimulus in word triplet	Left	.540	.544	.465	.180
	Right	.622	.631	.385	.193

Table 5.7: Mean Probabilities of Cued Recall of Left-and Right-Hand Encoding Stimuli as a Function of Encoding Condition.

Four Wilcoxon matched-pairs signed-ranks tests were carried out to determine whether there were any differences between the recall of left- and right-hand encoding stimuli in any ofthe three conditions. Two separate analyses were performed for the semantically related and unrelated encoding stimuli in the UNR condition. All four analyses failed to show any differences in the recall of left-hand and right-hand encoding stimuli: (DM; N=13, T=21.5,N.S.: SM; N=17, T=41.5,N.S.: UNR(Related); N=16, T=50,N.S.: UNR(Unrelated); N=14,T=52.5, N.S.).

A further two Wilcoxon matched-pairs signed-ranks tests indicated a reliable superiority in recall of related over unrelated encoding stimuli for encoding stimuli presented both to the left and to the right of the homonym (left-hand encoding stimuli, P<.01; Right-hand encoding stimuli, P<.05).

For each subject the probabilities of recalling both encoding stimuli given that one had been recalled were determined for each of the three encoding conditions. The resulting mean conditional probabilities are shown in Table 5.8.

	Encoding Condition		
	DM	SM	UNR
P(Both/One)	.460	.511	.166

Table 5.8: Mean Probabilities of Recalling Both Encoding Stimuli given that one has been Recalled as a Function of Encoding Condition.

A Friedman's two-way analysis of variance by ranks demonstrated a reliable difference between the three encoding conditions in the conditional recall probabilities (2 d.f., x^2= 13.58. P<.01). Three follow-up Wilcoxon matched-pairs signed-ranks tests showed that the probability of recalling the second encoding stimulus given that the first had been recalled was significantly lower in the UNR condition than in the other two conditions (in both cases P<.01) the conditional recall probabilities of which did not differ (N=18, T=55,N.S.).

The probabilities of the retrieval cue being effective in the recall of at least one encoding stimulus were also determined for each of the three encoding conditions. The resulting mean recall probabilities are presented in Table 5.9.

	Encoding Condition		
	DM	SM	UNR
Probability of Recalling at least one encoding stimulus	.781	.752	.527

Table 5.9: Mean Probability of a Cue being Effective in the Recall of at least one Encoding Stimulus as a Function of Encoding Condition.

A reliable difference between the three conditions in the recall probabilities was indicated by a Friedman's two-way analysis of variance by ranks (2 d.f., $x^2 = 19.75$, $P<.001$). Three follow-up Wilcoxon matched-pairs signed-ranks tests showed that while the levels of recall obtained in the DM and SM encoding conditions did not differ significantly from one another, (N=17,T=46,N.S.) performance in both conditions was reliably better than in the UNR condition (in both cases $P<.01$).

Discussion.

The finding that recall of related encoding stimuli in the UNR condition was reliably lower than recall in the DM encoding condition provides some evidence in support of the suggestion that the memorial representation of the homonym is more accessible to its copy cue in the latter condition. The observation that within the UNR condition the related encoding stimuli were better recalled than the unrelated encoding stimuli can be accounted for by the presence in episodic memory of a subset of semantic features common to the former encoding stimuli and the homonyms, and the absence of such a semantic retrieval route between the homonyms and the unrelated encoding stimuli.

Although from the framework outlined in the previous chapter the representation of the homonym would be expected to be more accessible to its copy cue in the DM condition than in the SM condition,similar levels of recall were obtained in the two conditions. It was suggested in the introduction to the present experiment that in the SM condition, recall of one encoding stimulus provides a second, additional retrieval route for recall of the other encoding stimulus by virtue of their sharing a subset of encoded semantic features. This may compensate for the initially lower accessibility of the unit represented in episodic memory. While the difference between the DM and SM conditions in the probability of recalling both encoding stimuli given that one has been recalled was not statistically reliable,the observed trend was in the predicted direction, providing at least some evidence, however slight,that retrieving one encoding stimulus is morelikely to facilitate retrieval of the other encoding stimulus in the SM condition than in the DM condition. Evidence will be provided in later studies that only in the DM condition do the two encoding stimuli access the homonym independently. In the present study, then, the high conditional probability of recalling the second encoding stimulus would appear to be an artifact arising from the independent retrieval of the two encoding stimuli. The prediction that the above conditional probability would be lowest in the UNR condition was fully borne out by the results. In this condition, recall of one encoding stimulus does not facilitate retrieval of the other. While this is also the case in the DM condition, there is nevertheless in the DM condition an initially higher probability that the second encoding stimulus will be recalled to the homonym anyway, since in this condition both encoding stimuli are represented together with the homonym in episodic memory, linked to the homonym by sets of shared semantic features.

That the trace of the homonym is least accessible to the copy cue in the UNR condition was evidenced by the finding that the probability of recalling at least one encoding stimulus was lowest in this condition. There was no reliable difference between the DM and SM encoding conditions in the probability of recalling at least one encosing stimulus, but a very slight superiority in favour of higher recall in the DM encoding condition was found.

Finally, there was no evidence in the present experiment that the left-hand encoding stimuli were better recalled than the right-hand encoding stimuli in the SM condition. Thus there is no support for the notion that the homonym is less extensively processed during the second comparison than during the first comparison in this condition and, consequently, no support for the suggestion that the homonym benefits from qualitatively more processing in the DM encoding condition.

General Discussion.

The findings from the previous three experiments are consistent with the representational framework outlined in Chapter 4.

While, for simplicity, the hypotheses were proposed and the results discussed in terms of a single representation of the homonym in the DM condition, it should be noted that these findings can be easily accounted for if it is assumed that separate representations of the homonym are established for each meaning encoded. In both cases the two meanings are assumed to be represented independently of one another: in one case within a single trace and in the other across traces. The previous six studies, while providing a pattern of cue effectiveness across encoding conditions which is consistent with the postulated representations resulting from the three types of encoding, fail to differentiate between the two possible forms of representation which have been proposed for the DM condition. Furthermore, there has been no direct evidence that the different meanings of homonyms are represented totally independently of one another, either within or across traces.

In the following chapter, experiments will be reported which test the suggestion that the two meanings of the homonym are represented independently of one another following encoding in the DM condition. The second aim of the following experiments is to determine whether a single or multiple representation of the homonym exist in long-term episodic memory when more than one meaning of the homonyms are encoded.

CHAPTER 6

THE REPETITION STUDIES

One question stemming from research on the effects of repetition upon subsequent memory performance concerns how the different occurrences of a word which is repeated within a list are represented in long-term memory. Does each presentation of a repeated item result in the formation of a separate memory trace or are successive presentations simply represented within the trace established by the first occurrence of the item? In the following studies to be reported, homonyms were presented twice within a list, either on consecutive trials or with a short lag between the two occurrences of each repeated item. Tests of free recall and cued recall were employed to determine whether the two occurrences of each homonym were represented independently in episodic memory and, if so, whether such independence of representation occurred within a single trace or across traces. It is expected that only when two different meanings of the homonyms are encoded on the two occurrences will the resultant memorial representations be stored independently of one another. Encoding the same meaning of the homonym twice should result in some semantic features which define the appropriate meaning of the homonym being encoded on both occurrences of the item. Whether the two meanings of the homonym are represented within a single trace or in different traces is more difficult to predict since the results obtained to date are compatible with both forms of representation. The aim of the final two experiments to be reported was to differentiate between these two alternative forms of representation.

Experiment 7.

Paivio (1974, 1975) has employed a technique introduced by Waugh (1963) to determine whether or not two separate presentations of an item lead to the formation of two independent memory traces. If such independent memory traces are formed, then additive effects upon free recall performance should be obtained. That is, the probability of recalling the twice-presented event should be equivalent to the combined probability of recalling two single, independent events: $P(A+B)=P(A)+P(B)-P(A)P(B)$. If the traces are stored nonindependently then the resulting combined effects on free recall should be less than additive. Using this technique, Paivio (1974) has shown that encoding a word verbally on two successive or closely spaced trials results in less than additive effects on recall performance, with the traces of the item becoming increasingly independent as more items intervene between the two occurrences of the repeated word in the list.

Following the above logic, if different meanings of homonyms are represented independently of one another in memory, then two successive presentations, each inducing the encoding of a different meaning of the homonym, should produce additive effects on memory performance as derived from performance resulting from a single presentation of the homonym.

Subjects.

The 30 subjects who took park in the experiment were male and female Introductory Psychology students at the University of Stirling, who received course credit for participation.

Design.

In the present study each homonym was presented in the context of a single biasing noun. The homonyms were presented on a single trial or on two consecutive trials, with the qualitative nature of the encoding stimulus on the second trial differing across repetition conditions.

1. In the Different Meaning (DM) repetition condition the

encoding stimulus on the second presentation was semantically related to a different meaning of the homonym from that on the first presentation.

2. In the Same Meaning (SM) repetition condition, the second encoding stimulus was semantically related to the same meaning of the homonym as the encoding stimulus on the first presentation.

3. In the Identical Repetition (IR) condition the same semantically related encoding stimulus was paired with the homonym on both trials.

The manipulation of repetition conditions was a between-subjects variable.

Intentional learning instructions were employed, but an orienting task was also used to ensure that the homonyms were encoded with respect to the biasing nouns. The subjects were required to indicate on each trial whether or not they could perceive a semantic relationship between the homonym and encoding stimulus. Free recall of both once- and twice-presented homonyms was tested.

Three main presentation lists, with two versions each, were constructed. 30 homonyms were presented in each list, 15 in the single presentation (SP) condition and 15 in one of the repetition conditions, resulting in a total of 45 trials. In the repetition conditions there was a zero lag between the two occurrences of each homonym. A different repetition condition was incorporated in each of the three sets of lists. The two versions of each list differed in that items in the repetition condition in one version were encoded in the SP condition in the other, and vice versa. The homonyms were presented in the same serial order across lists, with the ordering of encoding conditions randomised within the lists. Five subjects each received one of the six presentation lists.

Materials and Apparatus.

The homonyms and encoding stimuli used in the experiment were selected from the word pool. The word pairs were presented via an overhead projector in black uppercase letters against a white background. The homonym was presented to the right of the encoding stimulus and was underlined in red. The presentation rate was paced by an electronic timer which produced an audible tone at three-second intervals.

The subjects were provided with a response booklet on the first page of which they recorded their encoding decisions ('Yes' or 'No') in the orienting task. A three-digit number was printed at the top of the second page. Prior to the recall test the subjects were required to count backwards in three's from this number, writing down the answers as they progressed. At the end of the testing session the subjects were provided with a blank sheet of paper on which to list their recall responses.

Procedures.

The subjects were tested in groups of up to five. Each word pair was presented for a duration of three-seconds, with a three-second intertrial interval. On each trial the subjects were required to indicate on their response sheets whether or not they could perceive a semantic relationship between the two words. The subjects were also informed that retention of the underlined member of each pair would be tested at the end of the session. Following presentation of the final word pair, the subjects counted backwards in three's from a three-digit number for one minute. The subjects were then issued with the recall sheets and instructed to list all of the underlined words which they could remember. Five minutes was allowed for free recall of the homonyms.

Results.

The mean probabilities of recall of once- and twice-presented homonyms for each of the three groups of subjects are presented in Table 6.1.

	Repetition Group		
	DM	SM	IR
Twice-Presented	.374	.409	.467
Once-Presented(SP)	.179	.188	.303

Table 6.1: Mean Recall Probabilities for Once-and Twice-Presented Homonyms as a Function of Repetition Group.

Three Wilcoxon matched-pairs signed-ranks tests were performed which demonstrated, in each repetition condition, that recall of homonyms following two successive presentations of the homonyms was reliably higher than that following a single presentation (in each case, $P<.01$; one-tailed test). A Kruskal-Wallis one-way analysis of variance failed to indicate a significant difference between the three repetition conditions in the level of recall of twice-presented homonyms (2 d.f., $x^2=2.67$, $P<.30$). Likewise, a Kruskal-Wallis one-way analysis of variance, performed on the data for once-presented homonyms, failed to demonstrate a reliable difference between the three groups of subjects in the recall of once-presented homonyms (2 d.f., $x^2 = 4.56$, $P<.20$).

For each subject the expected probability of recall of twice-presented homonyms, had each occurrence resulted in the formation of an independent memory representation, was obtained using the formula for determining the combined probability of two independent events: P(A+B)=P(A)+P(B)-P(A)P(B). P(A) and P(B) represent the probability of recall of once-presented homonyms. The resulting mean observed and expected recall probabilities in each ofthe three repetition conditions are presented in Table 6.2.

	Repetition Condition		
	DM	SM	IR
Observed	.374	.409	.467
Expected	.308	.336	.474

Table 6.2: Observed and Expected Recall Probabilities for Twice-Presented Homonyms in the Three Repetition Conditions.

Three Wilcoxon matched-pairs signed-ranks tests were performed which failed, in all three repetition conditions, to indicate a significant difference between the observed and expected levels of recall (DM condition, N=10,T=19,N.S.; SM condition, N=9, T=8, N.S.; IR condition, N=19, T=26, N.S.). That is, additive effects on free recall performance were obtained with all three types of successive repetition.

Discussion.

The most important finding of the experiment was that, given all three types of repetition, additive effects upon free recall performance were obtained. While this would seem to suggest the existence, in each of the three repetition conditions, of two independent representations of the homonyms, such a state of affairs is counterintuitive, particularly in the light of Paivio's (1974) finding that encoding an item verbally on two consecutive trials led to less than additive effects on free recall performance. It seems least plausible with regard to the Identical Repetition condition in which the homonym was presented in the same nominal encoding context on both trials.

The following explanation is proposed to account for the universally obtained additive effects on free recall. In line with the representational framework presented in Chapter 4, it is suggested that the first occurrence of the homonym and its encoding stimulus are represented in long-term episodic memory as a unit, since a subset of semantic features common to both words is activated during encoding. In the IR condition. re-presentation of both the homonym and encoding stimulus, particularly under intentional learning instructions, leads to re-processing of the shared semantic features, and consequently renders the shared unit more accessible. Horowitz and Manelis (1972) have provided evidence that semantically related word pairs (and especially idioms) tend to be encoded, stored, and retrieved as a unit. Strengthening of associations on successive trials would lead to a higher probability of retrieving the encoded unit and, thus, the target word. Additivity in recall occurs because the homonym may be more easily accessed both directly and indirectly, via retrieval of the encoding stimulus, in the latter case due to the strengthening of the link between the two words comprising the unit in episodic memory.

In the SM repetition condition the second presentation of the homonym leads to a second set of shared semantic features being encoded, thereby rendering the representation of the homonym more accessible. In addition, a small subset of shared features from the first presentation receive reprocessing on the second presentation of the homonym. This serves to strengthen the links between the individual words comprising the unitised representation, increasing the possibility that the representation of the homonym may be indirectly accessed through the retrieval of one or other encoding stimulus. It is suggested that the observed additive effects on free recall would not have been obtained without the additional intentional learning instructions employed in the present study, which induce the subjects to extensively process the homonym and encoding stimulus on both trials. In the following experiment it will be shown that in the absence of intentional learning instructions, the second presentation of the word pair in the IR condition induces little or no further semantic processing. That is, features relevant to both encodings do not appear to be recoded on the second occurrence of the homonym.

In the DM repetition condition, the second presentation of the homonym results in a completely different set of semantic features being encoded. It is argued that in this condition alone the obtained additive effect on free recall is due to the independent storage of successive encodings in episodic memory. The aim of the next study is to further investigate the possibility that different meanings of homonyms are represented independently of one another in episodic memory, using a more controlled dual-probing technique.

Experiment 8.

When measuring retention of the homonym by free recall it is difficult to establish whether evidence of independent storage is a consequence of true independence or occurs due to increased accessibility of the unit as a result of the strengthening of links between individual words comprising the unit. In the present experiment, each homonym was presented on two consecutive trials, and retention of the homonyms was tested by cued recall. Recall of each homonym was cued twice- once by each encoding stimulus. Using such a dual-probing technique it is possible to determine whether the two cues for each homonym are operating in an independent fashion when accessing the representation of the homonym. If the two cues are acting independently, then there should be no difference between the probabilities of unconditional recall of the homonym to the second cue and recall to the second cue conditional upon the homonym having been recalled to the first cue, i.e. $P(B)=P(B/A)$. If the conditional probability is reliably higher than the unconditional probability, then it can be assumed that there is some degree of overlap in the retrieval information provided by the two cues.

In order to obtain a clearer picture of the operation of the two cues in each repetition condition, 2x2 contingency tables were constructed which give the probabilities of recall to both cues, neither cue, the first cue only and the second cue only. Tulving and Watkins' (1975) reduction method was used to construct the matrices, since this technique takes into account and compensates for the possibility that the act of recalling the homonym to the first cue somehow changes the structure of the accessed episodic memory representation. The reduction method thus provides a picture of the effectiveness of the two cues in retrieving the same functional representation. The resultant pattern of cue effectiveness should provide some qualitative support for the findings from the tests of independence of action of the two cues in each repetition condition.

Subjects.

72 male and female subjects took part in the experiment. The subjects were Introductory Psychology students at the University of Stirling, who participated in partial fulfilment of a course requirement.

Design.

The present experiment involved four qualitatively different types of successive repetition of homonyms encoded in the context of one biasing noun on each trial. The qualitative nature of the encoding stimuli accompanying the homonym on its two presentations varied across repetition conditions. In addition to the three repetition conditions employed in the previous experiment, a fourth Unrelated (UNR) condition was introduced. In this condition the homonym was paired with a semantically related encoding stimulus on one trial and an unrelated encoding stimulus on the other trial. The manipulation of repetition conditions was a within-subjects variable. An incidental orienting task was employed, wherein the subjects studied each pair of words and indicated whether or not they could perceive a semantic relationship between the two words.

Ten homonyms were presented in each of the four repetition conditions, resulting in a total of 80 trials. Four input lists were constructed, with each homonym appearing in a different repetition condition across the four lists. The homonyms were presented in the same serial order across lists. There was a zero lag between the two presentations of each homonym.The ordering of repetition conditions was randomised within the input lists. In the UNR condition the unrelated encoding stimulus accompanied one-half of the homonyms on their first occurrence, while the remaining five homonyms were paired with the semantically related encoding stimulus on their first occurrence.

Retention was assessed by a double-cueing technique wherein each homonym was cued, in turn, by each of its biasing nouns. The first and second cues for the homonyms were presented on separate cueing sheets. Thus, the second cues were presented after all of the homonyms had been cued by the first cues. The homonyms were cued in a different random order from that at input and the order of presentation of the cues on the second retrieval opportunity was different from that on the first.

18 subjects each received one of the four input lists. Nine subjects from each list received one version of the cueing test in which the homonyms were cued on the first retrieval opportunity by the first encoding stimuli and on the second retrieval opportunity by the second encoding stimuli. A second group of nine subjects from each input list were cued on the first retrieval opportunity by the second encoding stimuli and on the second retrieval opportunity by the first encoding stimuli. The two orders of cueing were introduced in order that Tulving and Watkins' (1975) reduction method could be employed to construct contingency tables demonstrating the pattern of cue effectiveness in the different repetition conditions. For each group of subjects the related and unrelated encoding stimuli in the UNR condition served as first and second cues equally often.

Materials and Apparatus.

The homonyms and encoding stimuli used in the experiment were drawn from the word pool. The word pairs were presented via a Kodak Carousel projector, in white letters against a black background. The slides were prepared using 12 pt Helvetica Light Letraset, with the homonyms in uppercase and the encoding stimuli in lowercase. The encoding stimuli were presented to the left of the homonyms. The presentation rate was paced using an electronic timer which produced an audible tone at four-second intervals.

The subjects were provided with a numbered response sheet on which to record their encoding decision for each trial. The recall cues were typed on two pages corresponding to the first and second retrieval opportunities. The cues were numbered and listed in two columns on both pages. The cues were typed in lowercase, with a line to the right of each cue on which the subjects wrote their recall responses.

Procedure.

The subjects were tested in groups of up to nine. Each word-pair was presented for a duration of three seconds, with a one-second intertrial interval. The subjects made their encoding decision for each word-pair during its presentation period. Following the presentation of the final encoding trial, the subjects were issued with the cueing lists and recall instructions. Again, learning was incidental and no prior warning had been given that retention would subsequently be tested. The subjects were instructed to proceed numerically through the first cueing sheet, writing next to each cue the word which had been paired with it at input, then to proceed in a similar manner through the second cueing list. The subjects were instructed not to refer back to the first page of cues when engaged in the second retrieval opportunity. Although recall was unpaced, the subjects were discouraged from spending too long on any particular cue. No subjects required more than ten minutes for completion of the recall test.

Results.

The overall mean probabilities of recall in each of the four repetition conditions, which include both the first and second retrieved opportunities, are presented in Table 6.3. Separate mean probabilities were determined for recall to the related and unrelated cues in the UNR condition.

	Repetition Condition				
	DM	SM	IR	UNR (Related cue)	UNR (Unrelated cue)
P(Recall)	.648	.656	.659	.600	.187

Table 6.3: Mean Probability of Recall as a Function of Repetition Condition.

A Friedman's two-way analysis of variance by ranks, performed on the overall cued recall data, indicated a reliable difference in recall performance between the repetition conditions (4 d.f., x^2=142.96, P<.001). A series of ten Wilcoxon matched-pairs signed-ranks tests were carried out to test for differences in recall between individual pairs of conditions. It was found that while the DM, SM and IR conditions did not differ reliably from one another in terms of overall recall, recall in all three conditions was significantly higher than that to the related cues (DM, P<.02; SM, P<.005; IR, P<.002) and to the unrelated cues (in all cases, P<.001) in the UNR condition. Within the UNR condition, recall to the semantically related cues was significantly higher than that to the unrelated cues (P<.001).

Separate mean recall probabilities for the first and second retrieval opportunities are presented in Table 6.4. Again the probabilities of recall to the related and unrelated cues in the UNR condition are presented separately.

	Repetition Condition				
	DM	SM	IR	UNR (Related cue)	UNR (Unrelated cue)
1st retrieval opportunity	.659	.680	.666	.648	.200
2nd retrieval opportunity	.634	.629	.648	.554	.172

Table 6.4: Mean Probability of Recall on the First and Second Retrieval Opportunities as a Function of Repetition Condition.

A Friedman's two-way analysis of variance by ranks, performed on the data for the first retrieval opportunity, demonstrated a reliable difference in recall between the repetition conditions (4 d.f., x^2=119.6, P<.001). Ten follow-up Wilcoxon matched-pairs signed-ranks tests failed to indicate a reliable difference between the DM, SM and IR conditions, and recall to the related cues in the UNR condition. Recall to the unrelated cues in the UNR condition was significantly lower than that in the other four conditions (in all cases, P<.001).

A Friedman's two-way analysis of variance by ranks was also carried out on the recall data for the second retrieval opportunity. Again, the analysis demonstrated a reliable difference in recall between the repetition conditions (4 d.f., x^2=119.7, P<.001). As before, a series of ten Wilcoxon matched-pairs signed-ranks tests were carried out to test for differences in recall between individual pairs of conditions. No significant differences in recall were found between the DM, SM and IR conditions. Recall in all three conditions was significantly higher than that to both the related cues (DM,P<.01; SM,P<.05; IR, P<.005) and the unrelated cues (in all cases, P<.001) in the UNR condition. Within the UNR condition itself, recall to the semantically related cues was significantly higher than recall to the unrelated cues (P<.001).

Within each repetition condition a Wilcoxon matched-pairs signed-ranks test was performed to test for differences in recall between the first and second retrieval opportunities. No such reliable difference was found in the DM and IR conditions, or for recall to the unrelated cues in the UNR condition (DM condition P<.20; IR condition, P<.30; UNR condition, $P<.30$). In the SM repetition condition, and for recall to the semantically related cues in the UNR condition, recall on the first retrieval opportunity was significantly higher than that on the second retrieval opportunity (SM condition, $P<.005$; UNR condition, $P<.05$).

The probabilities of recalling the homonym to the second cue given that it had been recalled to the first cue were determined for each repetition condition. In each condition, a Wilcoxon matched-pairs signed-ranks test was performed to determine whether the conditional and unconditional probabilities of recalling the homonym to the second cue were significantly different. If the two retrieval opportunities were operating in an independent fashion then: P(Recall to second cue) = P(Recall to second cue/recall to first cue). The mean conditional and unconditional recall probabilities are presented in Table 6.5.

	Repetition Condition					
	DM	SM	IR	UNR(Total)	(1st cue UNR related)	(1st cue UNR Unrelated)
P(2nd/1st)	.668	.712	.894	.258	.175	.382
P(2nd)	.637	.629	.648	.361	.172	.550

Table 6.5: Mean Conditional and Unconditional Probabilities of Recall to the Second cues as a Function of Repetition Condition.

The Wilcoxon tests showed that only in the UNR condition when the homonym was cued first by the semantically related encoding stimulus and then by the unrelated encoding stimulus were the two retrieval cues operating in a completely independent fashion. There was some degree of overlap in the informational content of the two cues in the other conditions, although in the DM repetition condition the difference between the conditional and unconditional recall probabilities was only marginally significant (N=72, P<.05). In the remaining conditions there was a reliable difference in the conditional and unconditional probabilities of recalling the homonym to the second cue (in all cases, P<.0001).

Finally, since two different cueing orders had been employed in the study, Tulving and Watkins' (1975) reduction method was used to construct 2x2 recall contingency tables for each of the repetition conditions. Separate contingency tables were constructed in the UNR condition for those items cued first by the related encoding stimulus and then by the unrelated encoding stimulus and those cued first by the unrelated encoding stimulus. Although Tulving and Watkins describe the resulting contingency tables as representing the structure of the memory trace, for the present purposes the tables are assumed only to represent cue effectiveness in the different conditions and to serve as qualitative support for the previous analyses. The resulting 2x2 contingency tables, or cue matrices, are presented in Tables 6.6-6.10., where cue A represents the first encoding stimulus and cue B the second encoding stimulus.

Table 6.6: Cue Matrix; DM Condition

		Cue B +	Cue B -	Total
Cue A	+	.47(.43)	.22(.26)	.69
	-	.15(.19)	.16(.12)	.31
	Total	.62	.38	

Table 6.7: Cue Matrix; SM Condition

		Cue B +	Cue B -	Total
Cue A	+	.55(.46)	.13(.22)	.68
	-	.12(.21)	.20(.11)	.32
	Total	.67	.33	

Table 6.8: Cue Matrix; IR Condition

		Cue B +	Cue B -	Total
Cue A	+	.64(.45)	.03(.22)	.67
	-	.03(.22)	.30(.11)	.33
	Total	.67	.33	

Table 6.9: Cue Matrix; UNR Condition A=Related Cue

		Cue B +	Cue B -	Total
Cue A	+	.19(.15)	.51(.55)	.70
	-	.02(.26)	.28(.24)	.30
	Total	.21	.79	

Table 6.10: Cue Matrix; UNR Condition A-Unrelated Cue

		Cue B +	Cue B -	Total
Cue A	+	.16(.11)	.06(.11)	.22
	-	.36(.41)	.42(.37)	.78
	Total	.52	.48	

As can be seen from the above tables, in the DM repetition condition, 37% of the homonyms could be recalled to only one cue. In the SM condition, this figure decreased to 25%, and in the IR condition only 6% of the homonyms were recalled to only one of the two cues. The above figures illustrate the decreasing independence of operation of the two cues, from the DM condition, through the SM condition to the IR condition.

The figures in parentheses in Tables 6.6-6.10 represent the expected probabilities of recall to the cues if the cues were operating independently in accessing the representation of the homonym. These figures were obtained by multiplying the relevant total recall probabilities in each of the matrices. Decreasing independence of action of the two cues is indicated by increasing differences between the obtained and expected recall probabilities. It can be seen that while in the DM condition the obtained and expected values differed by .04, the differences between the obtained and expected recall probabilities were .09 and .19 in the SM and IR conditions respectively. Such an outcome lends further support to the proposal that the independence of action of the two cues decreased from the DM to SM to IR conditions.

Turning to the cue matrices for the UNR repetition condition, the most noticeable feature is the relative ineffectiveness, in both cases, of the unrelated encoding stimulus as a recall cue. When the unrelated encoding stimulus served as the first cue, there was a higher probability of being unable to recall the homonym to either cue (42% vs. 28%) and recall to the related cue was lower (52% vs. 70%) suggesting a general decrease in accessibility to the related encoding stimulus on the second retrieval opportunity. This observation was supported by a previous analysis which demonstrated that in the UNR condition, recall to the semantically related encoding stimuli was reliably lower on the second than on the first retrieval opportunity. Thus, the cue matrices lend further support to the results of the previous analyses.

Discussion.

The only condition in which the two cues were found conclusively to be operating independently was the UNR condition when recall of the homonym was cued first by the related encoding stimulus and then by the unrelated encoding stimulus. Here recall to the unrelated cue was not influenced by whether or not the homonym was recalled to the first, semantically related, cue. In the present framework, the unrelated encoding stimulus does not share common semantic features with the homonym or with the semantically related encoding stimulus and consequently there is no overlap in the semantic retrieval information provided by the two cues at recall. In the UNR condition, when the homonym was cued first by the unrelated encoding stimulus, recall to the second related encoding stimulus was lower if recall to the first cue was successful i.e. recalling the homonym to the unrelated encoding stimulus appears to have had an inhibitory effect upon its subsequent recall to the related encoding stimulus. Why this should be so is unclear. Again, the relative ineffectiveness of the unrelated stimulus as a recall cue is indicative of the homonym and unrelated encoding stimuli being separately represented in long-term episodic memory.

In the IR condition, recall to the second cue was significantly higher if the homonym was successfully recalled to the first cue. This is also reflected in the cue matrix, which showed that in the majority of cases the homonym was recalled on both retrieval attempts or on neither. This is consistent with the present framework in which the homonym and encoding stimulus on the second presentation are conceived as being represented together within the same unitary trace established by the first occurrence of the word pair. That recall in this condition was not consistently higher than that in the DM and SM repetition conditions suggests that in the IR condition the word-pairs received little or no additional semantic processing on their second presentation. Had the semantic features shared by the two words received re-processing on the second trial, then a stronger link between the homonym and encoding stimulus would have been established with the consequence of higher recall than in those conditions in which all, or the majority of, shared semantic features were only encoded once.

That overall recall in the DM condition was not higher than that in the SM condition seems surprising, especially since the two cues in the latter condition were not operating independently, suggesting an overlap and hence redundancy in the retrieval information provided by the two cues. However, in the SM repetition condition the first encoding stimulus is likely to access the representation of both the homonym and the other encoding stimulus. This is evidenced by the large number of intrusions of the alternative encoding stimulus in this condition: 47% of all recall errors were intrusions of the other encoding stimulus. It is argued that such retrieval of the second encoding stimulus reactivates some semantic features shared by it and the homonym, thereby making the homonym somewhat more accessible on the second retrieval attempt than would be the case if the representation of the second retrieval cue were not accessed during the first retrieval opportunity.

While the two cues for the recall of the homonym in the DM condition were not found conclusively to be operating independently, the difference in the mean conditional and unconditional probabilities of recall to the second cues was only 3%. Given that a large N increases the probability of obtaining spuriously significant results (e.g. Bakan, 1966; Nunnally, 1960), and that with such a large N the difference in the present condition was only significant at the 5% level, it is possible that the cues were indeed operating independently of one another in this condition. The following two experiments also test the independence of action of the two cues in the DM repetition condition, under conditions of both visual and auditory presentation.

Experiment 9.

In the previous study, had the two cues in the DM condition been found conclusively to be acting independently of one another, some ambiguity would still have existed since it would be unclear whether the cues were accessing two independent memory traces or were operating as independent retrieval routes to the same single episodic representation of the homonym. In an attempt to resolve this ambiguity, cued recall of once-presented homonyms was included in the present experiment. If the two cues are found to be operating independently, and recall to the first cue in the DM repetition condition is higher than recall of once-presented homonyms, then it would appear that a single trace is being accessed with the observed repetition effect being mediated through surface (i.e. orthographic and phonological) features of the homonym. If the cues are operating independently then different semantic features are being accessed by the two cues so that any obtained repetition effect must be due to reprocessing of the nonsemantic features of the homonym and the corresponding strengthening of these features in the trace of the homonym.

While two of the major aims of the present study were to test for the independence of action.of the cues and to determine the locus of such independence, should it be found, cued recall of twice-presented homonyms was also compared with that of twice-presented homographs and homophones, under conditions of both visual and auditory presentation. One question which can be asked is, are the different forms of homographs and homophones represented independently of one another and, if so, does such independence occur within a single trace or across memory traces? Slamecka and Barlow (1979) have provided some evidence for repetition effects with different meanings of homonyms which would suggest that different meanings of homonyms are represented within a single trace. It is not clear, however, how different forms of homographs and homophones would be presented. While with homonyms both orthography and phonology remain constant across meaning change, orthography alone is shared by the different forms of a homograph and only phonology is shared by the different forms of a homophone. It is not unlikely that preservation of both sound and visual form is necessary for a single trace of an item to be established when the encoded meaning of that item is changed on its second occurrence, so that different meanings of homonyms but not different forms of homographs and homophones would be represented within a single memory trace. On the otherhand, it is possible that homographs and homophones are represented differently depending upon whether presentation is in the visual or auditory modality since the former share common orthography but are different phonologically, while the latter share a common phonology but differ orthographically. If visual presentation encourages episodic representation based on the orthographic characteristics of the word and auditory presentation encourages representation based on its phonological characteristics, then some interaction between the manner in which the homographs and homophones are represented in episodic memory and the modality in which they are initially presented would be expected. That is, auditory presentation should result in the formation of a single representation for the two forms of the homophones, but separate representations for each form of the homographs, while visual presentation should lead to a single representation of the homographs being formed, but separate traces being formed for each form of the homophones. This being the case, since homonyms share common orthography and phonology, no such interaction between modality and the resulting form of episodic memory representation should be found.

Subjects

72 male and female subjects took part in the experiment. The subjects were Introductory Psychology students at the University of Stirling, who received course credit for participation.

Design

In the present study, cued recall of twice-presented homonyms, homographs and homophones was compared with that of once-presented homonyms. Homonyms were used in the single-presentation comparison condition since a sufficient number of homographs could not be ound to form both a double-presentation and a single-presentation condition. For consistency, then, homonyms were used in all cases as single-presentation items. The two presentations of each repeated item occurred on two consecutive trials, i.e. there was a zero lag between the two occurrences of each repeated item.

Two presentation lists were constructed. The first list contained ten twice-presented homonyms (DM condition), ten twice-presented homographs (HG condition) and 30 once-presented homonyms (SP condition), resulting in a total of 70 encoding trials. The target words were encoded in the context of one biasing noun on each trial. The two encoding stimuli presented with the repeated items were semantically related each to a distinctly different meaning of these items. A different form of the homographs was encoded on each of the two presentations of the homograph. 20 of the homonyms in the SP condition were encoded in the context of a semantically related biasing noun. The remaining ten homonyms were encoded in the context of a semantically unrelated noun. Subsequent retention of the latter SP homonyms was not tested. The ordering of encoding conditions was randomised within the list.

The second input list contained ten twice-presented homonyms (DM condition), ten twice-presented homophones (HP condition) and 30 once-presented homonyms (SP condition). It should be noted, however, that a different orthographic form of the homophones was presented on each of the two trials. The two presentations represent repetition of the phonological rather than orthographic features of the word. Similarly, the HG condition represents repetition of the visual, but not phonological characteristics of the word. For convenience, however, these items will simply be referred to as twice-presented homophones and homographs. In the HP condition, the two encoding stimuli were semantically related each to one of the two different forms of the homophone. The format of the second input list was identical to that of the first, with the exception that homographs were encoded in the first list and homophones in the second. The same homonyms appeared in the DM and SP conditions in the two lists, and occupied the same serial position in the lists.

36 subjects each received one of the two input lists. For 18 subjects in each list the modality of presentation was visual and for the other 18 an auditory mode of presentation was employed. In the incidental orienting task used in the study, the subjects were required to indicate on each trial whether or not they could perceive a semantic relationship between the encoding stimulus and target word.

Recall of the target words was cued by their respective encoding stimuli. Each subject received two cueing lists. The twice-presented items were cued twice - once on each list - while ten of the SP items were cued on the first list and ten on the second, resulting in a total of 30 cues in each list. The twice-presented items were cued in a different random order on the two lists, both orders being different from the original order of presentation at the encoding stage. For one-half of the items in the DM, HG and HP conditions, the first encoding stimulus was presented as the first cue, while for the remaining target words the second encoding stimulus served as the first cue. The order of cueing of the once- and twice-presented homonyms was the same for the subjects who received the homograph list and those who received the homophone list.

Nine subjects in each of the four input list/modality groups received the two cueing lists in one order, while another nine subjects in each group received the cueing lists in the reverse order.

Materials and Apparatus.

The homonyms, homographs, homophones and encoding stimuli used in the study were drawn from the word pools. The mean frequencies of production of the encoding stimuli (in the word norm study) were comparable for the once- and twice-presented homonyms and the homographs. The encoding stimuli paired with the homophones were, however, produced as free association responses to the homophones with a somewhat higher frequency. The implications of this difference in pre-experimental associative strength will be examined in the discussion section.

Both visual and auditory modes of presentation were employed in the experiment. For visual presentation the word pairs were presented via a Kodak Carousel projector in white letters against a black background. The slides were prepared using 12 pt Helvetica Light Letraset, with the homonyms, homographs and homophones in uppercase and the encoding stimuli in lowercase. The encoding stimuli were presented to the left of the target words. The presentation rate was paced using an electronic timer which produced an audible tone at four-second intervals.

For the auditory mode of presentation, the two lists of word-pairs were recorded, in a female voice, on a cassette tape. Each member of the word pairs was spoken at a one-second rate, with a two-second pause between pairs. The target word (homonym, homograph or homophone) followed the encoding stimulus in each pair. The lists were presented via a sony TCM-757 cassette recorder.

The subjects were provided with a numbered response sheet on which to record their yes/no encoding decision for each word pair. A three-digit number was printed on the reverse of the response sheet. The subjects were required to count backwards in threes from this number for a predetermined time before being issued with the recall test.

The cues were presented on two separate pages. On each page the 30 cues were typed in lowercase and numbered, with a line to the right of each cue on which the subjects wrote their recall responses.

Procedure.

The subjects were tested in groups of up to nine. With visual presentation, each word-pair was presented for three seconds, with a one-second intertrial interval. With auditory presentation, a one-second presentation rate was employed for each member of the word pairs, with a two-second interval between pairs. During each trial, in both modalities, the subjects decided whether or not the two words in the pair were semantically related and recorded their encoding decision on the response sheet.

Following presentation of the final word pair the subjects were instructed to count backwards in threes from a three-digit number for one minute. The subjects were then issued with the two cueing lists and recall instructions. The subjects were informed that each cue had originally been presented in the context of a second word, and were instructed to write next to each cue the appropriate list word to complete the pair. The subjects were instructed to proveed through the first then second cueing lists in numerical order, and instructed not to refer back to the first list of cues when working on the second list. Recall was unpaced, but the subjects were discouraged from spending too long on any particular cue. None of the subjects required more than ten minutes to complete the cued recall test. As in the majority of previous studies, learning in the present experiment was incidental. Prior to the recall test, no warning had been given that retention would be subsequently tested.

Results.

The main focus of concern in the present study is on the recall of words on the first cueing sheet - that is, on the recall of the words in the DM, HG and HP condition to the first cues and on the recall of the first ten SP words cued.

The resulting mean probabilities of cued recall for auditory and visual presentation are sgown in Figure 6.1. The mean recall probabilities are presented in Appendix VI. Since on a priori grounds it would appear likely that some interaction between input modality and class of repeated item may be manifest in the recall data, an overall within- and between-subjects analysis of variance was performed on the data for the four groups

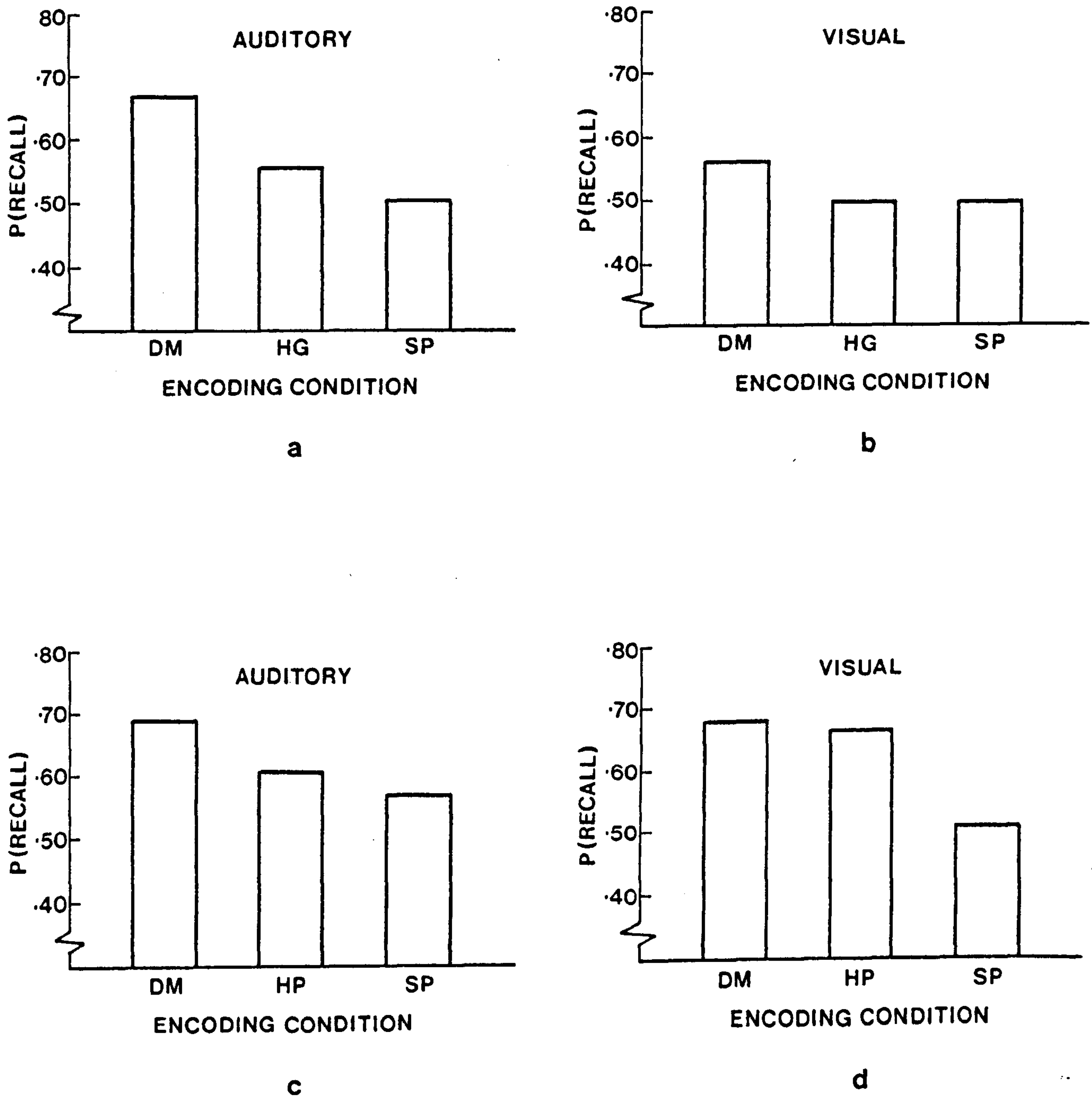

FIGURE 6·1 Mean probabilities of recall on the first retrieval opportunity as a function of encoding condition and presentation modality (Exp. 9) with encoding condition as the within-subject variable and input modality and repetition groups (HG vs. HP) as the between-subjects variables. While this analysis demonstrated a reliable main effect of encoding condition ($F(2,136)=11.92, P<.001$) there were no reliable main effects of input modality or repetition group and no reliable interaction between the different variables. The reliable differences in recall between the encoding conditions are mainly attributable to a superiority of the DM condition over the SP condition for each of the four groups of subjects, although recall was slightly higher in the HP condition than in the SP condition following visual presentation of the items.

An identical pattern of findings resulted from a similar analysis performed on the data for the second retrieval opportunity which are represented in Figure 6.2. The mean recall probabilities are presented in Appendix VI. Again no main effects of modality or repetition group were indicated nor were any interactions between the different variables. As before, the difference in recall between the encoding conditions proved to be reliable ($F(2,136)=9.62, P<.001$). Again, the difference between the encoding conditions is mainly a result of a difference in recall between the DM and SP conditions although there was, again, higher recall in the HP condition than in the SP condition when the items were presented visually.

As in the previous study, conditional and unconditional probabilities of recalling the repeated words to the second cues were determined to assess whether or not the two retrieval

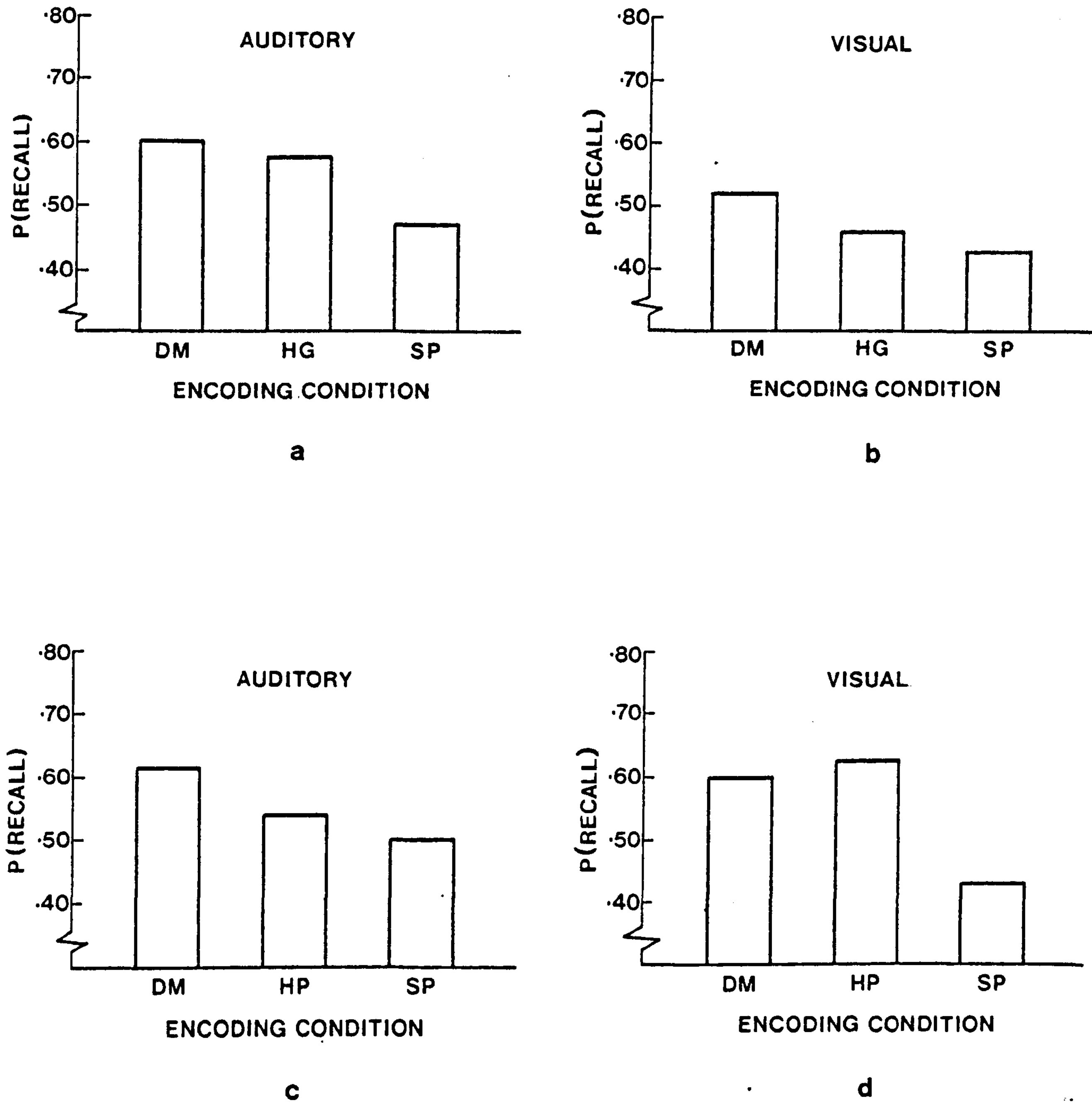

FIGURE 6·2 Mean probabilities of recall on the second retrieval opportunity as a function of encoding condition and presentation modality (Exp. 9) cues for each word were operating in an independent fashion. The resulting mean conditional and unconditional recall probabilities for each of the four groups of subjects are presented in Table 6.11.

	Auditory		Visual		Auditory		Visual	
	DM	HG*	DM	HG	DM	HP	DM	HP
P(2nd/1st)	.581	.710	.502	.543	.564	.574	.576	.604
P(2nd)	.601	.574	.523	.462	.612	.538	.602	.628

* P<.01

Table 6.11: Conditional and Unconditional Probabilities of Recall to the second cues in the DM, HG and HP Conditions as a Function of Presentation Modality.

A Wilcoxon matched-pairs signed-ranks test was performed on each of the eight sets of data to determine whether there were any reliable differences between the conditional and unconditional recall probabilities. Such a difference was found only for the recall of homographs following presentation in the visual modality (N=16,T=18,P<.01). In this particular condition the homographs were more likely to be recalled to the second cues if they had been successfully recalled to the first cues. In each of the other conditions no significant difference between the conditional and unconditional recall probabilities was found, indicating that in these conditions the two retrieval cues for each repeated item were operating independently of one another in accessing the target word.

Discussion.

The present experiment has demonstrated quite conclusively that for all four groups of subjects, under conditions of both visual and auditory presentation, the two cues for recall of the twice-presented homonyms were operating independently of one another. The two encoded meanings of the homonym were being independently accessed at retrieval. The two forms of the homophones were also retrieved independently of one another following presentation in both the visual and auditory modalities as were the two forms of the homographs following visual presentation. Under auditory presentation conditions, however, recalling the homographs to the first cues facilitated subsequent retrieval to the second cues.

What was also demonstrated was a reliable superiority in recall of twice- over once-presented homonyms. Recall of twice-presented homonyms to the first cues was higher than that of the once-presented homonyms for all four groups of subjects. Thus, it would appear that when two different meanings of a homonym are encoded, two independent access routes to a single representation are formed.

The data for the homographs and homophones was not so clear. For neither class of words was a reliable repetition effect obtained for recall to the first cues following either visual or auditory presentation. There was very little difference between recall of the homographs and once-presented items for either mode of presentation, suggesting that the two encoded forms of the homographs have separate representation in episodic memory. While there was little evidence of a repetition effect with the homophones following auditory presentation, a fairly large superiority in the recall of the homophones over the SP condition was obtained with visual presentation. Such a state of affairs is counterintuitive since it suggests the possibility that a single trace of the homophones is formed following visual presentation while two separate representations result from auditory presentation. Further support for this finding comes from the data for the second retrieval opportunity in which a reliable repetition effect was obtained following visual presentation of the homophones. Since the two recall cues for the homophones were operating independently of one another, recall of the homophones to the first cues should not affect the representation of the homophones which are accessed by the second cues. Consequently, repetition effects obtained in the second retrieval opportunity should also be attributable to repetition of the surface features of the repeated items within a single memory trace. The above rationale also applies to the repeated homonyms and homographs. The finding of higher recall of twice- over once-presented homonyms for all four groups of subjects on the second retrieval opportunity further strengthens the findings for the first retrieval opportunity.

With the homophones, however, it is possible that the observed superiority in recall of the repeated items over that of the once-presented items is a consequence of a difference in the pre-experimental associative strengths of the to-be-remembered items in the HP and SP conditions to their cues. In the word-association study, the encoding stimuli were produced in response to the homophones with a considerably higher frequency than were the relevant encoding stimuli produced in response to the homonyms. Such a difference in pre-experimental associative strength could be responsible for the observed repetition effect with the homophones rather than the repetition of the phonological features of the homophones which would result from the two different forms being represented together within a single episodic trace.

It is also possible, however, that the apparent crossover with modality, which also occurred to some extent with the homographs (where recall was slightly higher following auditory presentation than visual presentation) can be explained in terms of disambiguation of the different forms of the items. That is, when a homograph is presented auditorily or a homophone is presented visually there is explicit disambiguation of the different forms of the item. This may result in the correct form of the item (in the case of the homophones in particular) being more easily retrieved in the cued recall test. Implicit disambiguation may be less likely to occur when homographs are presented visually or homophones are presented auditorily. Such explicit disambiguation may account for the higher levels of recall obtained when the item is presented in a modality which emphasises the nonsemantic differences rather than similarities between the various forms of the item.

The implications of the present results will be discussed more fully once the results of the following experiment have been reported. The next study involves the same conditions employed in the present experiment, so taken together a more coherent and complete pattern of results may be obtained.

Experiment 10.

While in the previous study recall of the twice-presented homonyms was consistently higher than that of the once-presented homonyms, this superiority did not prove to be generally reliable when the data for the four groups were analysed individually. It is possible that the two different meanings of the homonyms which were encoded were being represented within a single trace with the superiority in recall being a consequence of repetition of the surface features of the homonyms. However, with a zero lag between the two presentations of each homonym, it is conceivable that only minimal structural analysis of the homonym was necessary on the second presentation, so that on the second presentation mainly semantic processing occurs. By increasing the spacing between the two presentations of repeated items, it should be more necessary to perform a fuller structural analysis of the repeated item on its second occurrence. If a true repetition effect exists and is mediated by the structural features of the homonym, then it should manifest itself more strongly when several other items intervene between the two occurrences of the repeated word. To test this suggestion, the previous experiment was repeated, with a five-trial lag occurring between the two presentations of each repeated item.

Subjects.

72 male and female subjects took part in the experiment. The subjects were Introductory Psychology students at the University of Stirling who participated in fulfilment of a course requirement.

Design.

The materials and procedure employed were identical to those in the previous experiment with the exception that in both input lists a five-trial (i.e. five word-pair) lag occurred between the two presentations of each repeated word.

Results.

The data were analysed in a similar fashion to those obtained in experiment 9. Two Wilcoxon matched-pairs signed-ranks tests were performed on the data from each of the four groups to determine whether or not there was any reliable difference between the conditional and unconditional probabilities of recalling the homonyms, homographs or homophones to the second recall cues. These data are shown in Table 6.12. All eight analyses failed to demonstrate a significant difference between the conditional and unconditional probabilities. Following both visual and auditory presentation, then, the different meanings of the homonyms and the different forms of the homographs and homophones were retrieved independently of one another.

	Auditory		Visual		Auditory		Visual	
	DM	HG	DM	HG	DM	HP	DM	HP
P(2nd/1st)	.508	.529	.610	.596	.632	.669	.482	.578
P(2nd)	.535	.575	.636	.555	.628	.590	.520	.599

Table 6.12. Conditional and Unconditional Probabilities of Recall to the Second Cues in the DM, HG and HP Conditions as a Function of Presentation Modality.

The levels of recall on the first retrieval opportunity for the three repetition conditions and the SP condition are represented in Figures 6.3 a-d. The mean recall probabilities are shown in Appendix VII .

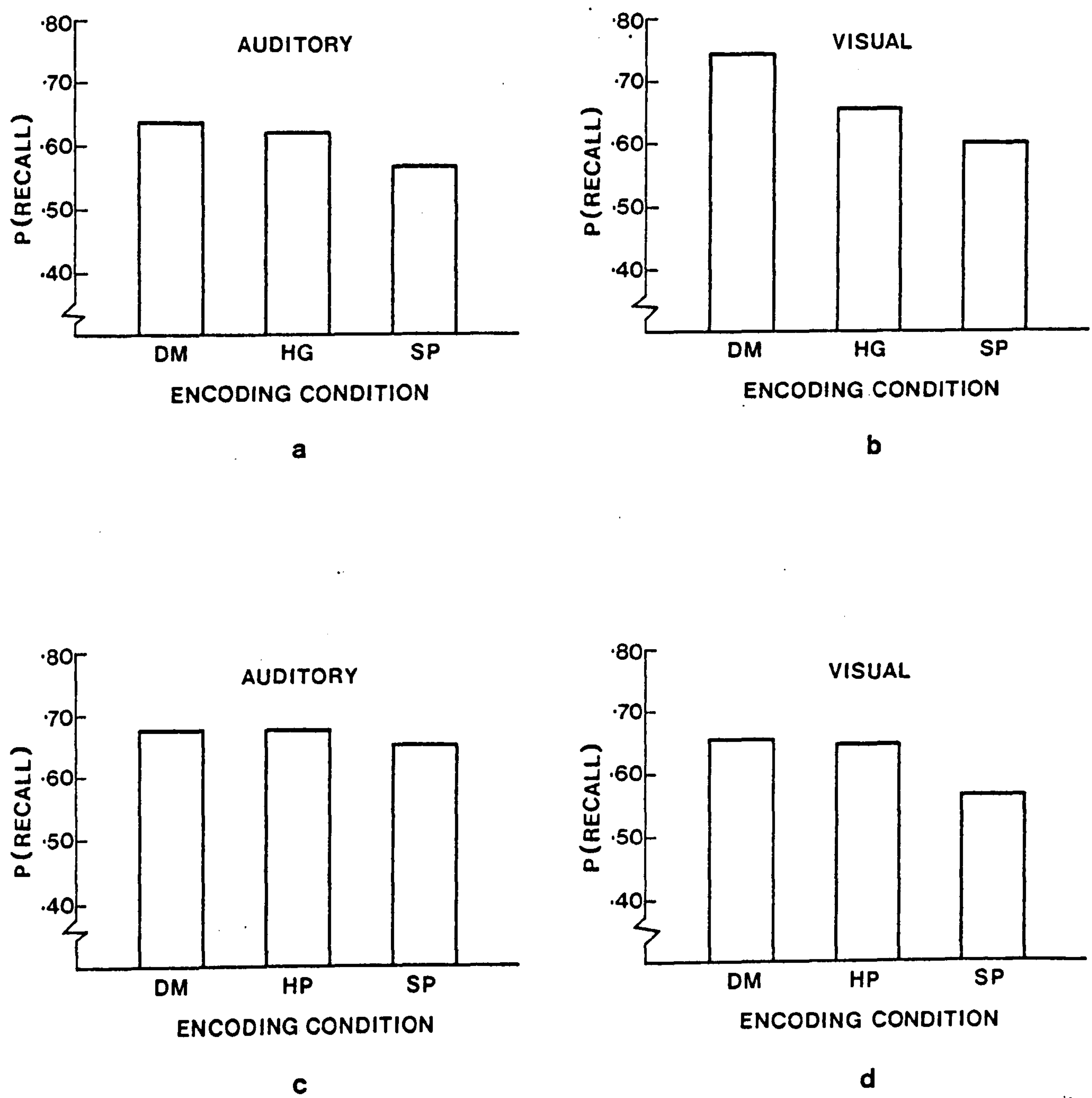

FIGURE 6·3 Mean probabilities of recall on the first retrieval opportunity as a function of encoding condition and presentation modality (Exp.10)

An identical analysis of variance was performed on the data to that in Experiment 9. Again, theonly reliable main effect was that of encoding condition ($F(2,136)=7.83, P<.001$ and no significant interactions between the variables were indicated by the analysis. While the difference between the encoding conditions is mainly attributable to a difference in recall between the DM and SP conditions, again there is some evidence of a repetition effect with the homophones following input in the visual modality. Thus the present results are consistent with those obtained in the previous experiment.

The recall data for the second retrieval opportunity are represented in Figures 6.4a-d and the mean recall probabilities are shown in Appendix VII. A significant main effect of encoding condition was demonstrated by a similar analysis of variance performed on the data for the second retrieval opportunity ($F(2,136)=7.48, P=.001$). While no other reliable main effects were indicated by this analysis, a significant interaction between the three variables was obtained ($F(2,136)=4.39, P<.02$). This interaction appears to be attributable to lower recall in the DM condition than in the HP condition following visual presentation of the items. Overall, however, a reliable repetition effect was obtained for the homonyms in the DM condition as was a repetition effect in the HP condition following both visual and auditory presentation of the items.

As in the previous experiment there was a small but consistent and reliable repetition effect in the DM condition. There was little evidence forthcoming from the present study or previous study to suggest the presence of such a repetition effect with the homographs. In both studies, however, reliable repetition effects were found in the HP condition. Two possible interpretations of these findings will be suggested. First, it is possible that the different forms of the homographs and homophones and the different meanings of the homonyms are represented within a single episodic memory trace, regardless of

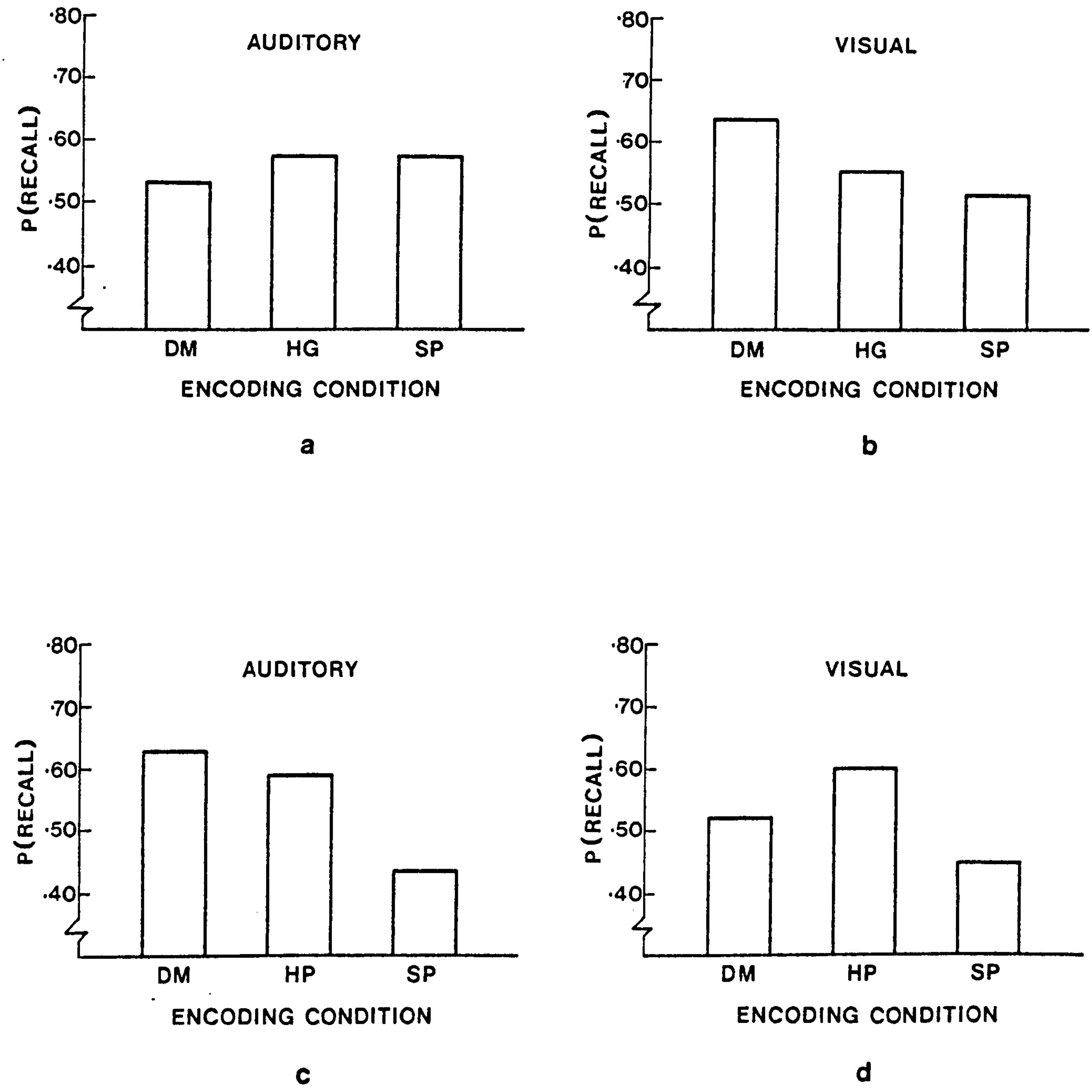

FIGURE 6·4 Mean probabilities of recall on the second retrieval opportunity as a function of encoding condition and presentation modality (Exp.10) input modality. Since no obvious interactions between input modality and class of stimulus were obtained it must be assumed that a similar form of representation results from the different modalities. The repetition effects obtained with the homonyms and homophones would then be viewed as a consequence of non-semantic features in the trace (in the former case orthographic and phonological and in the latter case phonological) being reprocessed on the second occurrence of the item, resulting in an increased accessibility of the item. In the case of the homographs, the repetition of orthographic features alone would be insufficient to produce any substantial increase in the later accessibility of the trace. Such an interpretation would be consistent with the general finding of highest recall in the DM condition, with the levels of recall in the HP condition tending to be closer to those in the DM condition than were those in the HG condition. In the DM condition the memory trace would benefit from the repetition of both orthographic and phonological features, while with the other two classes of items only one type of feature (orthographic <u>or</u> phonological) would be repeated. It is assumed that the repetition of phonological features is more beneficial for subsequent accessibility than the repetition of orthographic features. Such an assumption is consistent with findings from levels of processing studies (e.g. Craik, 1973).

The second possible interpretation is that only in the DM condition are the different encodings of the item represented within a single trace. When different forms of homographs or homophones are presented for study, each encoded form will be represented by a separate trace in episodic memory. The apparent repetition effects obtained in the HP condition would, in this view, be artifactual, and would not be indicative of an increased accessibility due to the repetition of phonological features. Rather, the observed repetition effect could be seen as reflecting differences in the average production frequencies of the encoding stimuli/cues in the HP and SP conditions. By virtue of the stronger pre-experimental associative relationship between the homophones and their encoding stimuli, the encoding of the encoding stimuli at test may be more similar to their encoding in the context of the homophones at input than are the input and retrieval encodings of the encoding stimuli in the SP condition. As a consequence, the encoding stimuli in the HP condition would be more likely to successfully access the encoded representation of the word pair in episodic memory. Since this possibility cannot be ruled out, it remains unclear just how homographs and homophones should be conceptualised as being represented in episodic memory. While the present evidence suggests that the non-semantic features associated with a verbal item form the basis for the representation of that item in episodic memory, it would seem most parsimonious to suggest that commonality of both orthographic and phonological features across meaning change is necessary for a single memory trace to be established. When preservation of either orthography or phonology alone occurs, the various forms of the item will be separately represented in episodic memory. It is recognised that such a conceptualisation is highly speculative, and for the remainder of the thesis discussion will focus upon the representation of homonyms alone, the evidence for which is substantially clearer.

Summary of the Repetition Studies.

What, then, have the studies reported in the present chapter said about the representation of homonyms in episodic memory? The first relevant finding is that when the same meaning of a homonym is encoded on two separate occasions, the two encodings of the homonym are retrieved in a non-independent fashion, suggesting some degree of overlap in the retrieval routes to the representation. The more similar the two encodings are, the greater their retrieval dependence will be, as was shown in Experiment 8. When the two encodings of the homonym are sufficiently different, as when two completely different meanings are encoded on its two occurrences, then the representations of the meanings will be retrieved in an independent fashion, suggesting that each of the retrieval cues is accessing a completely independent set of encoded semantic features. While it was unclear from Experiment 8 whether the two different meanings of the homonym which were encoded were represented together within a single trace, or were each represented by a separate trace, the subsequent two studies, which confirmed the independence of representation of the two different meanings, also produced evidence in favour of the former interpretation. When two different meanings of a homonym are encoded they are represented within a single memory trace with the different meanings being represented by independent, nonoverlapping sets of semantic features. As the similarity of the two encodings increases, so does the number of features that are common to both encodings of the homonym and the more likely it will be that certain features common to both encoding stimuli will be encoded. Evidence for such a representation comes from experiment 8 where it was found that 47% of all recall intrusions in the SM condition were intrusions of the other encoding stimulus.

In the final chapter, the framework for episodic memory representation that has been proposed will be discussed in relation to the findings from the experiments reported in the present chapter and an attempt will be made both to relate the framework to existing models of episodic memory and to apply it to the interpretation of several established episodic memory phenomena.

CHAPTER 7

DISCUSSION AND CONCLUSIONS

Following a discussion and summary of the previous empirical findings and proposed framework for episodic memory representation, the aims of this final chapter are two-fold. First, the proposed representational framework will be compared and contrasted with existing models of long-term episodic memory. Similarities to relevant models which have influenced the present conceptualisation of episodic memory representation will be drawn and the manner in which the present findings conflict with other conceptualisations of long-term episodic memory will be discussed. The second broad aim of the present chapter will be to explain a range of memory phenomena in terms of the present theoretical framework and to illustrate the general applicability of the representational structure proposed.

Summary of Empirical Findings and Discussion of the Proposed Representational Framework.

Prior to a more general discussion of the proposed framework for episodic memory representation, particularly in relation to the findings of the present research, the main empirical results will be summarized and discussed in a more specific manner.

The first six experiments were aimed at demonstrating the utility of the general framework proposed in the introductory chapter with reference to the representation of homonyms in episodic memory following three qualitatively different encodings of the homonyms. The results were consistent with the suggestion that semantically related items are stored together in memory, linked by a common set of encoded semantic features. Unrelated items, on the other hand, will be represented separately from one another. Shared semantic features, it was argued, assume greater salience than unique semantic features and are correspondingly more highly accessible at test.

In free recall, cued recall and recognition of the homonyms, the highest levels of performance were obtained in the DM condition and the lowest in the UNR condition, with intermediate levels of performance being found in the SM condition. These results were consistent with the notion that memory performance is dependent upon both the absolute number of salient features in the trace of the homonym and the relative numbers of salient features in the traces of the homonym and the two encoding stimuli. Such an argument was supported by the free recall intrusion data in which the lowest rates of intrusions occurred in the DM condition and the highest in the UNR condition. Moreover, recognition confidence rating were found to be highest in the DM encoding condition where two different meanings of the homonyms were encoded at input.

Support for the suggestion that cued recall is mediated through the shared semantic features came from Experiment 5. Highest recall of one encoding stimulus when the other encoding stimulus and the homonym were presented as cues occurred in the SM condition. Only in this condition were both cues assumed to share encoded semantic features with the to-be-remembered item.

Evidence for the idea that unrelated words are stored separately from one another in episodic memory was forthcoming from several studies. In the second Experiment it was found that subjects rarely incorrectly recognised the unrelated encoding stimulus in the UNR condition. In later experiments when recall of one or both encoding stimuli was cued, the unrelated encoding stimulus in the UNR condition was recalled with a lower probability than the semantically related encoding stimulus. Such findings are consistent with the idea that the related encoding stimulus and the homonym are represented together as a unit in episodic memory while the unrelated encoding stimulus is stored separately but associated with the unit through some weak contextual link.

While the results of the first six studies were consistent with the framework proposed in the first chapter and, in particular with the representational structures for the three encoding conditions which were derived from that framework, these studies failed to differentiate between the ideas of single versus multiple representations of homonyms in episidoc memory. The data was consistent with both types of representation. The subsequent studies, presented in Chapter 6, were aimed at determining the nature of homonym storage in a more precise manner by addressing the question of whether or not different meanings of homonyms are represented independently of one another and then, more significantly, whether each different encoded meaning of a homonym is represented within the same single episodic trace or in separate traces. To this end, the final set of studies demonstrated that when two different meanings of homonyms are encoded, the meanings are accessed independently of one another. Moreover, the final two experiments showed that when two different meanings of homonyms are encoded on two different occurrences of the homonym, a repetition effect occurs which must be mediated by the nonsemantic features of the homonym. This suggests that a single trace which was established on the first occurrence of the homonym was incremented on the second occurrence of the homonym rather than a different, separate trace being formed.

When the same meaning of a homonym was encoded on two different occurrences, but in slightly different semantic contexts on these occurrences, the two encoding stimuli were found to be acting non-independently in accessing the trace of the homonyms at recall, suggesting some overlap in the retrieval information provided by the two cues. When the homonym was repeated in nominally identical retrieval contexts and cued twice by the same encoding stimulus, the informational contents of the two cues were found to be virtually identical. Finally, further evidence for separate representation of unrelated items in episodic memory was forthcoming from Experiment 8 in which it was found that the unrelated encoding stimulus in the UNR condition was relatively inefficient in accessing the homonym with which it had been encoded at input.

In summary, then, the results of the first six studies have demonstrated the utility of the framework for episodic memory representation proposed in the introductory chapter, and the subsequent studies have both substantiated the framework and demonstrated that within the general framework different occurrence of a repeated item and different meanings of a repeated homonym are represented within the same single memory trace with the different meanings being represented by independent sets of encoded semantic features and different senses by more or less overlapping sets of such encoded semantic features.

Discussion of the Proposed Representational Framework.

Broadly speaking, the model of episodic memory which was outlined in Chapter one and developed in subsequent two chapters can be subdivided into three phases, those of encoding, storage and retrieval, which correspond to Melton's (1963) stages of trace formation, trace storage and trace utilisation, although empirically the present research was concerned foremost with the nature of episodic memory storage.

1. The Encoding Phase

An important distinction which is endorsed is that between episodic and semantic memory (Tulving, 1972). Within the present fraemwork, semantic memory is regarded as comprising a probably limitless network of words and ideas connected to associated semantic, imaginal, phonological and orthographic information. The manner in which the semantic memory system may be organised is not of direct concern here. It is sufficient for the present purposes to note that the above information is available in semantic memory and is accessed whenever a verbal item is presented for study. The realm of the present research is episodic memory in which temporally dated, personally experienced episodes and events are stored. Although Tulving's basic distinction between episodic and semantic memory is accepted, it is argued that the two memorial systems are more closely interrelated and interactive than Tulving has suggested. When a familiar verbal item is presented for study, either in the presence or absence of instructions to learn, its representation in semantic memory will be invariably accessed and a selection of semantic and nonsemantic features associated with its semantic memory representation will be activated. A sufficient number of features will be activated to perform the task at hand, in most cases these being semantic features since the majority of encounters with verbal stimuli require an understanding of the meaning of the item. From this viewpoint the functions of orienting tasks and study context are fundamentally similar. Orienting tasks direct the learner (intentional or otherwise) to focus on a more specifically defined subset of features in semantic memory thereby exerting some degree of control over the encoding activities of the learner. When the subject is simply instructed to learn the study material his encoding activities, i.e. the qualitative and quantitative nature of the information in semantic memory which he chooses to activate, are outwith the immediate control of the experimenter. The context surrounding an item-in-context operates in much the same way. Context provides a constraining cognitive environment, directing the subject to attend to a certain subset of features that are specified by the context. In this sense, the perceived meaning of a word will differ somewhat from one context to another since different contexts will guide the subject to select slightly different subsets of (in particular) semantic features.

The present approach represents a contextualist position. The encoding context has a powerful deterministic influence over which features in semantic memory are selected for activation and consequently transferred to episodic memory. In the experiments that were reported in the previous three chapters, both the prevailing encoding context and the semantic orienting task are assumed to have directly influenced the nature of the semantic memory features activated at encoding and which comprise the resultant episodic memory traces of the study items. The incidental learning instruction ("decide whether or not the two words are semantically related") direct the subject to attend to predominantly semantic features of the study words while the biasing noun both specifies which particular meaning of the ambiguous study item to attend to and further determines which features are activated for that meaning. It would appear that in the absence of a biasing context, the most frequent meaning of a homonym is accessed upon the item's presentation (e.g. Simpson, 1981; Winograd and Conn, 1971).

The outcome of the initial encoding operations is an activated subset of semantic and nonsemantic features associated with the study word and it is these activated features which comprise the episodic memory representation of the study item.

2. <u>Storage: The Nature of Episodic Memory Representation</u>.

The episodic memory representation of a to-be-remembered item will consist of relevant semantic and nonsemantic features which define that item. Levels of processing studies (e.g.

Craik, 1973; Craik and Tulving, 1975) have shown that semantic orienting tasks result in superior retention of the study material than do nonsemantic tasks. It is assumed that the semantic orienting tasks result in the encoding and storage of predominantly semantic features. A predominantly semantic episodic memory representation will be better retained than a significantly nonsemantic representation for two main reasons. First, semantic retrieval information is more likely to be encoded at test than is nonsemantic information, so that memory traces that contain a high proportion of semantic features will stand a higher chance of being successfully retrieved. Second, semantic features, being more specific than nonsemantic features which are common to many words, will define and identify the to-be-remembered word more precisely. Generally speaking, nonsemantic retrieval information, due to its possibly being shared by several items both present in and absent from the study list, will be less effective in the retrieval of any particular to-be-remembered word. In agreement with Watkins and Watkins (1975) it is suggested that the effectiveness of a retrieval cue will diminish as a direct function of the number of items that are potentially retrievable by that cue, or in other words the retrieval specificity of the cue.

In each of the experiments which were reported a semantic orienting task was performed upon the study words, thereby ensuring that the resulting episodic memory traces would be composed mainly of semantic features. While each studied word is represented in episodic memory as a collection of encoded features, items which share certain features in common may be represented together in a unitised fashion provided that the relevant common features have been encoded at input. It is proposed that the second occurrence of a repeated item will be represented within the same trace as the first, assuming that the original episodic representation of the item is accessed upon its subsequent occurrence. If the earlier occurrence of the item goes unrecognised upon its later presentation, then the two events will be separately represented in episodic memory (it should be noted, too, that little repetition effect will result since if the initial trace isinaccessible to its copycue on a later presentation it is unlikely to prove accessible when subsequent retention is tested).

Commonality of nonsemantic features forms the basis of representation for a verbal item that has more than one meaning - the different meanings are stored within the same single memory trace with each meaning being represented by a different, independent set of semantic features. As is the case with nonhomonyms, however, if upon encoding of a different meaning of the homonym the episodic memory trace of the first meaning is not accessed, then the two meanings will be represented within separate traces in episodic memory. Recognition of the previous occurrence of the homonym will involve recognition of the common nonsemantic features shared by the two meanings since encoding the second meaning will involve a totally different set of semantic features being activated from on the homonym's first occurrence. These different semantic features will prove ineffective in accessing the earlier occurrence of the homonym and accordingly if the nonsemantic features are not accessed the second encoded meaning of the homonym will be stored in a separate memory trace from the first. In the present studies, however, when two different meanings of the homonyms were encoded at input, the different meanings were biased either simultaneously, at a zero-trial lag or at a five-trial lag. In each of the experiments, then, the representation of the first meaning encoded should have been easily accessed when the second meaning was encoded: Slamecka and Barlow (1979) have provided evidence that non-semantic information pertaining to the first occurrence of a homonym can be retrieved even when a 24-item lag separates the two occurrences of the repeated item. That the second meanings of the homonyms in the present experiments were represented within the same episodic traces as the first meanings rather than in different traces was indicated in the final two experiments which showed that a consistent repetition effect was obtained when two different, and independently represented, meanings of a homonym were encoded on its two occurrences. This repetition effect must have been mediated by repetition of the nonsemantic features common to the two meanings of the homonym, when the second meaning of the homonym was encoded. For such a repetition of nonsemantic features to occur, the second presentation of the homonym must have accessed the first occurrence via the common nonsemantic features, resulting in the two meanings being stored independently of one another, but within a common trace based upon mutually shared nonsemantic features.

That the two different encoded meanings of the homonyms in the previous studies were represented independently of one another has been demonstrated quite conclusively in these studies. As has just been discussed, it also appears that the different meanings are represented within the same episodic representation with the two meanings being represented by two completely independent nonoverlapping subsets of encoded semantic features. When the same meaning of the homonym is biased by two different encoding stimuli it appears that a slightly different subset of semantic features associated with the homonym will be encoded in response to each of the two encoding stimuli although in such a situation many semantic features will be activated in response to both biasing nouns. When the homonym is encoded twice in relation to the same biasing noun, even more semantic features will be encoded on both occurrences (or potentially encoded) and fewer features unique to any individual encoding will be present in the resulting trace.

Within such a conceptualisation, a possible representational distinction between homonymy and polysemy can be proposed. It is suggested that true homonymy will be represented by totally independent subsets of semantic features corresponding to the different meanings encoded while polysemy would be associated with some overlap of semantic features common to the different senses encoded. The present model can encompass all degrees of meaning change by regarding homonymy, polysemy and nonhomonymy as points on a continuum where increasing differences in meaning within a single verbal item are represented by increasing independence of the semantic features associated with each meaning within a single episodic memory representation. The model also allows for flexibility in the processing activities of the learner. If the learner perceives and encodes some semantic commonality between the different meanings of a homonym, then the homonym will be represented in the same manner as a polysemous item, with some degree of overlap of semantic features which are perceived as being shared by the two different meanings encoded. In a similar fashion, the different senses of a polysemous item may be represented totally independently of one another if the subject fails to perceive any common semantic link between the different senses. It can be seen from this line of reasoning that homonymy and polysemy cannot be differentiated on objective a priori grounds but individual items will be so differentiated by the subject on the basis of prior experience, pre-experimental associations etc.

As has been previously noted, when a set of semantic features common to two (or more) words is perceived and encoded, the words will be represented together in episodic memory in a unitised fashion. If no semantic features are found to be shared by the items in question then the items will be represented individually in episodic memory possibly linked by encoded contextual information such as that relating to temporal contiguity and which may provide some degree of access from one representation to the other. When the encoding of relational information occurs the shared semantic features, being focal to the encoding, will acquire the greatest salience and consequently will prove more highly accessible at the retrieval stage. Cued recall of a word in a unitised representation by another word in the same representation is mediated through these shared semantic features. In the "Different Meaning" condition in the previous experiments, cued recall of the homonym could be mediated via either encoding stimulus since both shared common semantic features with the homonym. One encoding stimulus proved relatively ineffective as a cue for recall of the other encoding stimulus, however, since no direct encoded semantic link existed between them and, consequently, retrieval in this situation would appear to depend upon mediation via recall of the homonym which had links in episodic memory with both encoding stimuli. Such a situation did not occur in the "Same Meaning" condition, however, since in addition to sharing a subset of common semantic features with the homonym, the representations of the encoding stimuli were also linked by a further subset of semantic features shared by these two words.

A final general point to be made about the nature of episodic memory representation concerns the relative salience of features that have been encoded once and those which have been potentially recodable on a second occurrence. The evidence from the Identical Repetition condition in Experiment 8 suggests that when an item is presented in the same encoding context on two closely spaced trials (in this particular case there was a zero between the two trials) the experimental association between the items in the pair receives very little strengthening by the second occurrence. It would seem that with a short lag and contextual consistency the subject is guided to encode a highly similar or even virtually identical set of features to that on the previous trial, but fails to do so since these features have been recently activated and are still relatively salient in episodic memory. When the homonym is repeated in a slightly different encoding context, however, or when a different meaning is biased on the second occurrence, the different semantic features associated with the new context are activated and augment the existing episodic memory representation of the homonym. Consequently, the number of encoded semantic features in the trace of the homonym will be greater in the latter cases while the number of features shared by the encoding stimuli and the homonym will be roughly equivalent in the three conditions resulting in similar levels of recall of the homonym to the intralist cues. The relative number of shared semantic features comprising the episodic trace of an item appears to be critical in terms of that item's subsequent retrievability. The representation of a homonym encoded in the context of one semantically related and one unrelated encoding stimulus, and hence containing only one subset of shared semantic features,is less accessible than the representation of a homonym that has been encoded in the context of two semantically related encoding stimuli and which accordingly comprises of two such subsets of salient shared semantic features. Likewise, in the Different Meaning condition at least (Experiment 4), the homonym, whose representation presumably contained two sets of shared semantic features, was recalled with a reliably higher probability than either encoding stimulus the representations of which, it is argued, both contained only one set of salient common semantic features.

3. The Retrieval Phase.

The processes involved in the initial processing of an item and its subsequent retrieval are similar im many respects. It is argued that when retention is tested the retrieval cue is encoded in a manner similar to that at the input phase. The resultant collection of activated features (both semantic and nonsemantic, although predominantly the former) are matched against the collections of features comprising the episodic memory system. If a match between the retrieval information and the information contained in a particular trace is obtained (i.e. if the target memory is accessed) then the representation will be translated into its appropriate verbal form and an output response will be made. Presumably, some internal criterion is consulted when a match is obtained, to determine whether a sufficient number of features are shared by the trace and retrieval information to warrant execution of the output response. As at the initial encoding phase, the retrieval context will induce a bias towards certain features in the cue being encoded. Consequently, the more similar the encoding and retrieval contexts, the more likely it will be that similar features are activated at both phases and, accordingly, the more probable it will be that successful retrieval will occur.

In agreement with Tulving (1976) and Watkins (1979) it is argued here that all retrieval is mediated through cues and that the processes of free recall, cued recall and recognition are fundamentally similar. It is suggested that the three types of retention test lie on a continuum that represents the specificity of the retrieval information provided by the cues with, generally speaking, the most general retrieval information being provided in the free recall situation and the most specific in the case of recognition. In free recall a general contextual cue is provided that directs the subject to search for items that have been presented in a particular place and time. An intralist cue that has been encoded in relation to the to-be-remembered word at input will facilitate recall since it is likely to activate a small subset of features that had been encoded at input and are present in the episodic representation of the to-be-remembered item. A strong extralist associate by virtue of its being closely related to the target word will likewise activate a number of features contained in the episodic representation of the to-be-remembered word with a relatively high probability. The most specific and effective retrieval information will normally be provided by the recognition cue or copy cue. When a literal copy of the target word is presented as a cue, it is highly probably that at least some features encoded at the input phase and present in episodic memory will be encoded at the retrieval phase, causing the representation of the target item to be accessed with a high probability. Recognition is not infallible, however, since the possibility exists that different features pertaining to the target word will be encoded during the initial input and retrieval phases. The provision of different study contexts at input and test, for example, may result in very different features being encoded on the two presentations of the to-be-remembered word. It is clear, then, that while generally speaking the recognition cue should prove more effective than a recall cue, this is by no means always necessarily the case since under some circumstances the encoding of the recall cue may result in a higher proportion of trace features being activated at test. This point will be more fully discussed in a later section when the framework is applied to the phenomenon of recognition failure of recallable words.

While in the long-term the features comprising an episodic memory representation may become increasingly unavailable in a gradual fashion, it is contended that in the shorter term failure to retrieve the representation of an item is due to inaccessibility of that representation through a mismatch of retrieval information and trace information.

The present approach stresses both the necessary compatibility of encoding and retrieval operations and the importance of context in determining the contents and structure of episodic memory and the qualitative nature of the retrieval information that is available at test.

Similarities of the Proposed Framework to other Models of Episodic Memory.

The framework for episodic memory representation that has been proposed has similarities to several current models of episodic memory. It represents the combination of significant ideas from certain of these models, resulting in a fuller, more comprehensive and more detailed account of the nature of episodic memory storage.

Beginning with the encoding phase of the present framework, similarities can be found with models such as that of Bower (1967) who has argued that encoding consists of the selection by the subject of a component of the total stimulus. The present conceptualisation of the encoding process has the closest affinities with the levels of processing approach (Craik 1973; Craik and Lockhart, 1972; Craik and Tulving, 1975) and variations such as Nelson's (1979) sensory-semantic model. Like these views, encoding in the present framework is seen as involving the sampling of a subset of features out of the total constellation of features in semantic memory that specify and define a particular verbal item. Furthermore, the resultant episodic memory representation is viewed as a collection of these encoded features. Discrepancies exist between the present approach and the levels of processing approach with respect to the relative durability of various types of features and the exclusiveness of processing within a single domain that the latter framework expounds. It is argued here that nonsemantic features are not less durable per se, but rather are less effective for the subsequent retrieval of the encoded item since (a) standard retention tests bias the subject towards the encoding of predominantly semantic features in the cue for retrieval of the to-be-remembered item and (b) nonsemantic features alone will rarely succeed in exactly specifying a target memory since they are shared by many other items. It is meaning features that specifically differentiate an item from other nonsemantically similar items.

It has been generally accepted by levels of processing theorists that nonsemantic processing results in the formation of a nonsemantic memory trace while a semantic memory trace is formed as a result of processing in the semantic domain. Like Nelson and his colleagues, however, (e.g. Nelson, Wheeler, Borden, and Brooks, 1974) it is proposed here that while in a semantic orienting task the encoded semantic features are focal to the task, some nonfocal nonsemantic features are likely to be encoded too.

The concept of elaboration, proposed by Craik and Lockhart (1972) and studied by Craik and Tulving (1975) is held in the present view to represent the encoding of a larger and more varied range of features. The resultant trace is "richer" or more elaborate in the sense that it is composed of a greater diversity and number of encoded features. The benefits from elaborative processing will accrue at the retrieval stage when the encoded retrieval information stands a higher chance of accessing at least some of the previously encoded features.

More recently, the concept of distinctiveness has been introduced by the levels of processing theorists, and by other theorists, as an additional factor influencing the subsequent retrievability of an item (e.g. Eysenck, 1979; Jacoby and Craik, 1979; Jacoby, Craik and Begg, 1979; Stein, 1977). Distinctiveness of encoding is said to aid retrievability by differentiating an item from other study items. Consequently, any effective retrieval information will be specific to a distinctively encoded item and a discrimination problem will be avoided. In the present studies, DM encoding could be argued to be more distinctive than SM encoding, since in the former case each comparison of the encoding stimulus with the homonym results in a completely independent set of semantic features being encoded. At retrieval, little problem exists in determining which items were encoding stimuli and which was, in fact, presented in the middle of the word triplet, a problem which does occur in the SM condition where the two encodings of the homonym in response to the encoding stimuli are fairly similar.

Finally, the study by Klein and Saltz (1976) will be discussed with respect to the nature of encoding into episodic memory since the authors obtained findings comparable to those obtained in the present studies using a quite different orienting task. Klein and Saltz found that encoding a word on two semantic attribute dimensions led to higher recall of the word than did encoding on a single dimension. Furthermore, with incidental learning instructions, when the item was processed on two semantic dimensions recall was inversely related to the degree of correlation between the two dimensions. In Klein and Saltz's view, uncorrelated dimensions specify items encoding more precisely and distinctively in "cognitive space". The present findings parallel those of Klein and Saltz since it was shown that under free recall, cued recall and forced-choice recognition, the homonym was better remembered when two sets of salient shared semantic features were encoded than when one was encoded, and when two sets of shared features were encoded better memory performance was obtained when the two sets of semantic features were independent and unrelated to one another. In terms of the present framework, Klein and Saltz's "cognitive space" represents the episodic memory system, and the precise and distinctive encoding is paralleled by the encoding of two more or less independent sets of semantic features within a single memory trace. The more similar the encoding dimensions, or in the present case the features encoded in response to the two encoding stimuli, the fewer total salient features that comprise the episodic representation of the target item or (in the present studies) the homonym. The result is an increased accessibility of the target word since the more salient features comprising a trace, the more likely it becomes that at least some are accessible by the retrieval cue.

A further interesting finding from the Klein and Saltz study, and one that parallels the results obtained in Experiment 7 of the present series of studies, was that under intentional learning instructions the recall superiority that accrued from encoding a word on two uncorrelated semantic dimensions as opposed to two correlated dimensions disappeared. In Experiment 7 a combination of intentional learning instructions and a semantic orienting task were employed and the normal recall superiority resulting from encoding two different meanings of the homonym as opposed to one disappeared. It is suggested that when intentional learning instructions are issued prior to the presentation of the study items, the subject in the SM condition actively recodes certain features that have been encoded in response to the first encoding stimulus, thereby strengthening the link between the encoding stimuli and homonym as well as the episodic representation of the homonym itself. According to this view, in the Klein and Saltz study the provision of intentional learning instructions would encourage reprocessing of certain features relevant to both attribute dimensions when the encoding of the item on the second, related dimension occurs. The Klein and Saltz study indicates the general applicability of the present findings: just as different meanings of homonyms are represented in episodic memory by independent sets of semantic features within a single memory trace, so may independent sets of semantic features result from the encoding of a nonhomonym on two uncorrelated semantic attribute dimensions.

As has been discussed, while similarities can be drawn between the present approach and the levels of processing approach with respect to the nature of encoding processes, there are nonetheless some fundamental differences between the two in the way in which the encoding process and its resultant memorial consequences are conceptualised. The levels of processing theorists have comparatively little to say about the nature of episodic memory representation; while hypothesising as to the qualitative nature of episodic memory traces, there is little formalisation of the way in which these traces may be represented in relation to one another. Jones' (1976) fragmentation hypothesis represents a more detailed and formalised account of the nature of episodic storage. According to Jones, the functional memory trace is composed of a number of encoded components or features. If the cue represents a fragment of that total complex, then the entire complex will be accessed. That is, a fragment will provide access to the remainder of the memory trace of which it is a part. The main tenet of the fragmentation hypothesis is embodied in the representation framework that has been proposed to account for the results obtained in the homonym studies reported here. It is argued in the present approach that if an intralist retrieval cue succeeds in accessing its own representation in episodic memory, and that representation is linked by semantic features to the to-be-remembered word or words, then successful retrieval of these words will occur. An intralist cue will prove ineffective in the recall of a target word either if its episodic representation is not successfully accessed or if its episodic representation does not contain a set of encoded semantic features that are shared by the representation of the target word. When two distinctly different meanings of a homonym are encoded in response to two semantically related biasing nouns, which are themselves unrelated in meaning, one biasing noun should prove ineffective as a cue for recall of the other. Since the representations of both biasing nouns share a set of common semantic features with the representation of the homonym, if the representation of one encoding stimulus is accessed at test, then recall of the other biasing noun should be effected, mediated through the representation of the homonym.

The present framework for episodic memory representation also has commonalities with the representational system proposed by Horowitz and Manelis (1972). As in Horowitz and Manelis' conceptualisation of episodic memory, it is assumed that relational encoding consists of the encoding of features common to both items. These shared encoded features constitute a unifying link between the representations of the items in episodic memory, and since they are focal to the encoding of the event assume greater salience than nonfocal encoded features that are unique to either item. If the representation of one item is accessed, then the unit will be retrieved through the shared features. The present theoretical conceptualisation goes beyond that of Horowitz and Manelis who were concerned mainly with the long-term memory representation of various classes of adjective-noun pairs, by extending the principle to include the representation of noun-noun pairs, of successive encodings of the same word and of successive encodings of different meanings of homonyms.

While pairs of items that have been subjected to relational encoding are proposed to be represented together in a unitised fashion in episodic memory, items that do not share any encoded semantic features in common will be represented and retrieved independently of one another. Slamecka (1968) has proposed that items are stored independently of one another in long-term memory, with organisational effects such as clustering at recall being mediated through the use of an organised retrieval plan. Evidence against organised, dependent storage comes from Slamecka's part-list cueing effect in which it was demonstrated that providing several list items as cues did not facilitate recall of the remaining list items (also Roediger, 1973; 1974). Further evidence in favour of independent trace storage comes from a study by Rotondo (1979) who demonstrated that items from categorized lists of words were retrieved independently of one another, just as were the different encoded meanings of homonyms in the present studies. Such an outcome would suggest that under normal list-learning conditions, little relational encoding occurs between the list members, even though several of the items may belong to the same conceptual category. It was found in Experiment 7 of the present series of studies that following relational encoding, intralist cues that were related to the same meaning of the homonym operated nonindependently in accessing the representation of the homonym. It is suggested, then, that the relational encoding that was induced by the orienting instructions in the present studies resulted in semantically related items being represented in a unitised fashion, with each unit represented separately from others. In the absence of such explicit relational encoding instructions, it would appear that items are represented separately and independently of one another in episodic memory and as Slamecka (1968) has suggested, apparent organisational effects may result from the various items sharing features in common with generalised semantic or contextual retrieval information.

The present conceptualisation of episodic memory representation has similarities to Kintsch's (1974) model. While

Kintsch endorses the generation-recognition theory of recall, he has abandoned the problematic tagging notion of memory in favour of a feature encoding approach to episodic storage. As in the present approach, Kintsch visualises the episodic memory trace as being composed of a sample of features that function to define the stimulus in semantic memory. Kintsch also views relational encoding as resulting in the formation of two episodic memory representations that are linked by some set of common semantic features. While the present framework is in accordance with Kintsch's model of episodic memory to the extent that the outcomes of successive presentations of an event are assumed to be represented within the same memory trace, provided that the original trace can be accessed upon the item's subsequent occurrence, Kintsch makes no explicit reference to the manner in which successive encodings of homonyms, when the meaning encoded differs on each occurrence, should be conceptualised as being represented in episodic memory. Since Kintsch does explicitly state that each distinct meaning of a homonym should be regarded as a "word" and that each "word" has a separate lexical entry in semantic memory, it must be inferred that within Kintsch's conceptualisation of episodic memory, different meanings of homonyms are assumed to have separate memory representations. Furthermore, episodic memory representation, according to Kintsch's formulation, are based upon the encoded meaning features of a verbal item, thus different meanings of homonyms should be separately stored in episodic memory. There is no explicit reference in the present framework as to the nature of homonym representation in semantic memory, but it is not inconceivable that the lexical entries corresponding to different meanings of homonyms are linked by the common orthographic and phonological features that remain invariant across the different meanings. The present studies have shown that in episodic memory different encoded meanings of a homonym are represented within a single trace, just as are the encodings of different occurrences of a repeated nonhomonym, at least as long as the representation of the first meaning can be accessed when the second meaning is encoded. Within the present conceptualisation, then, the basis of representation in episodic memory would appear to be the orthographic and phonological, that is the non-semantic, features of the stimulus item, rather than the meaning of the item per se.

Finally, Tulving and Thomson's (1973) encoding specificity principle is explicit within the present theoretical framework. Successful retrieval will occur if, and only if, features contained in the episodic representation of the item are matched by encoded features present in the retrieval information. The present approach goes beyond that of Tulving (1976),however, by providing a structural framework for the way in which items are stored in episodic memory, and by providing an explanation of why certain encoded representations should be more accessible at test than others. Tulving (1979) has argued that memory test performance is determine exclusively by the interaction of encoding and retrieval processes but provides no explanation,in terms of the structure of episodic memory, of why one particular encoding /retrieval interaction should result in superior memory performance to another. The encoding specificity principle is endorsed in the present framework to the extent that a match between the encoded retrieval information and the encoded representation of the target item in episodic memory is deemed necessary for successful retrieval to occur. Retrieval will succeed only if a sufficient number of features contained in the episodic representation of the to-be-remembered item are present in the encoded retrieval information at test. By providing a description of the manner in which items may be represented in episodic memory in themselves and in relation to other word events, and hypothesising as to how different encoded features both within and across processing domains may differ in accessibility, the present framework goes beyond the encoding specificity principle and provides a more detailed and formalised account of the nature of episodic memory storage and retrieval.

Theories Challenged by the Present Findings.

In the present section the way in which findings from the studies reported here challenge two broad classes of theory- generation-recognition theory and strength theory- will be examined.

1. Generation-Recognition Theories of Recall

While several variations of generation-recognition theory exist (e.g. Anderson and Bower, 1972; Bahrick, 1970; Kintsch, 1970), the basic tenet of the theory in its original form was that recall involves the generation of response candidates upon which a recognition check is carried out to determine the presence or absence of an occurrence tag, whereas recognnition involves only the latter of these two stages. The assumption is that in recognition access to the long-term memory representation is automatic, and recognition will fail only if the relevant occurrence information is either inadequate or absent. To accommodate findings of context effects in recognition memory and recognition failure of recallable words which suggest that an access problem does exist in recognition, that is, access to the long-term memory representation of an item is not automatic, the original Anderson-Bower theory was modified by Anderson and Bower (1974) and Reder, Anderson and Bjork (1974). Instead of a single representation of a verbal item in long-term memory being postulated, it was not proposed that there were different representations in long-term memory for different meanings of homonyms and different senses of nonhomonyms. In the Anderson-Bower model, list learning, which falls within the realm of episodic memory, involves the marking of idea nodes with an occurrence tag. Only the encoded sense of a word will be tagged in this way at input. If a different sense of the target word is activated at test (through a change in the study context), then a different node corresponding to that particular sense will be examined for the presence of occurrence information and retrieval will fail because such information is not available for that different sense that was encoded at test.

There is no suggestion in the Anderson-Bower theory that access to the representation of one particular sense of a word or to one particular meaning of a homonym permits access to other long-term memory representations of that particular word. Consequently, the different representations of a word must be conceived of as functionally discrete units. The present studies have shown, on the contrary, that the different encoded meanings of a homonym are represented within a single functional unit in which the different meanings are represented by independent sets of encoded semantic features. The finding of a weak, but consistent, repetition effect indicates that even though a completely different meaning of the homonym is biased on its second occurrence, and correspondingly a different independent set of semantic features are encoded, access to the representation of the first meaning encoded can still occur. That Slamecka and Barlow (1979) obtained such a repetition effect with a 24-item lag between the two different encodings of the homonym suggests that under normal list-learning conditions, the original occurrence of an item should be accessible via nonsemantic features when recognition of that item is tested. Under Anderson and Bowers' (1974) conceptualisaion, if the representation of an encoded sense of a word is accessed and the appropriate occurrence information is present, then the word should be recognised. In terms of the present framework, the earlier representation of a word may be accessed but retrieval, being dependent upon the matching of trace and retrieval information, may not succeed since different semantic features are present in the episodic trace and in the encoded retrieval information.

The generation-recognition model of Anderson and Bower and Reder et al could be modified to accommodate the present finding that different meanings of a homonym are represented within the same single memory trace, which corresponds to Anderson and Bower's idea node, by postulating the operation of a stimulus-sampling mechanism when encoding occurs. In this view, the long-term memory representation of a homonym would be accessed when the item is presented for study and a set of features relevant to the particular encoding context sampled. This set of encoded features would comprise the episodic representation of the homonym. If a different meaning of the homonym was then encoded the long-term memory representation of the homonym would again be accessed and a further set of features relevant to the new meaning encoded, and added to the existing set of sampled features. Retrieval would involve the matching of encoded retrieval information with the sampled features encoded at input, and will fail if the retrieval information fails to match these previously encoded features. Such a modification renders generation-recognition theory virtually synonymous with the present theoretical conceptualisation of the nature of episodic memory representation. By acknowledging that a retrieval problem does exist in recognition and abandoning the simple tagging theory of episodic memory, generation-recognition theory loses the attractive features that rendered it a simple, yet plausible account of several memory phenomena.

2. Strength Theories of Memory

According to the exponents of the strength theory of memory, (e.g. Bernbach, 1967; Wickelgren and Norman, 1966) the presentation of an item results in the strength of the memory trace of that item being incremented in some way. With the passage of time the strength of the item in memory will gradually return to some original value. To determine whether a certain item was present in a list, the subject has simply to examine the strength of the item's memory trace. If the strength of the item is greater than some critical value or threshold, then the subject will decide that the item was indeed present on the previously presented list. Previous evidence against a simple strength theory of memory has come from various sources. Strength theory, for example, predicts the opposite of the Melton lag effect. According to strength theory an item should be better remembered if presented on two closely spaced trials than if presented on two widely spaced trials, since in the former case the strength of its representation from the first occurrence will be higher on its subsequent presentation so that the item's memory trace attains a greater overall strength when repeated at a short lag. The finding of context effects in recognition memory is also incompatible with strength theory which holds that an item will be correctly recognised if its strength exceeds a certain criterion. Certain findings in the present studies are also difficult to reconcile with the notion that observed memory performance will vary simply as a function of trace strength. For example, it was found that homonyms were consistently better recalled and recognised when encoding in the context of two semantically related biasing nouns than when one encoding stimulus was semantically related to the homonym and the other unrelated. In terms of strength theory, there should be no difference in retention of the homonym under these different conditions since the dual encoding in both cases should lead to equivalent incrementation of the strength of the memory representation of the homonym. Another finding that is difficult to reconcile with a simple strength theory of memory comes from Experiment 4 in which the homonym was found to be better recalled than either encoding stimulus in the DM condition while no difference in the recall of the homonym and encoding stimuli was foind in the SM condition. It is suggested here that while memory performance may depend to some degree upon the number and salience of features comprising a stored trace, memory performance is also critically dependent upon the qualitative nature of the retrieval information provided at test, and the ability of that retrieval information to access comparable information in the encoded representation of the to-be-remembered word in episodic memory.

Memory Phenomena Explained in Terms of the Present Framework.

In this final section the general applicability of the representational framework that has been proposed will be illustrated by demonstrating how the framework can provide a plausible account of a range of well-established episodic memory phenomena.

1. Context Effects in Recognition Memory.

As was discussed in Chapter two, context deletion, addition or substitution at test can have deleterious effects upon recognition performance compared to a situation in which the study context of an item remains constant from input to test. While the detrimental effects of changed context tend to be demonstrated most dramatically when homonyms constitute the to-be-remembered material (e.g. Light and Carter-Sobell, 1970; Hunt and Ellis, 1974) fairly large and consistent context effects have also been obtained with nonhomonyms (e.g. Thomson, 1972; Tulving and Thomson, 1971).

The finding of impaired recognition performance when different meanings of a homonym are biased at input and test (e.g. Light and Carter-Sobell, 1970) have been interpreted by certain authors as indicating that there exist in long-term memory different nodes for each different meaning of a homonym (e.g. Anderson and Bower, 1974; Reder, Anderson and Bjork, 1974). When a different meaning is biased at test, a different node will be accessed from that which was tagged (marked with an occurrence tag) during the input phase. Reder et al have also argued that findings of context effects with nonhomonyms suggests that even nonhomonyms may be multiply represented in long-term memory, such that a different node is accessed when the target word appears in a different context at test. The present framework can readily explain findings of context effects in the recognition of both homonyms and non-homonyms without recourse to the idea of multiple representations in episodic memory of either the former or the latter. As has been previously argued, when recognition is tested, the target item will be encoded at both the study and test phases. The selection of features to be activated is strongly determined, at both phases, by the prevailing verbal context. The more different the contexts at the study and test phases are, the more likely it will be that different features are encoded at the two phases. Since successful retrieval is argued to depend upon the overlap of information contained in the episodic trace of the target item and that provided by the retrieval cue, a change in context will reduce the chance of successful retrieval by reducing the probability of a successful match between the trace information and retrieval information being obtained. When no context is present at either study or test or the same context is provided at both stages, some "random contextual drift", to borrow Bowers (1972) term, may occur between input and test but the probability of similar features being encoded at the two phases will be substantially higher than if the verbal context accompanying the item during the study phase is different from that which is present at test. While it is likely that similar nonsemantic features will be encoded on both presentations of the to-be-remembered item, the subject may be reluctant to produce an output response on the basis of the matching of nonsemantic features alone, since these features are shared by many words and thus do not adequately differentiate various verbal stimuli.

It is suggested that there is no fundamental difference bwteen the recognition context effects obtained with homonyms and nonhomonyms. The difference lies in the disparity of encoding between input and test that is likely to occur when different senses of nonhomonyms and different meanings of homonyms are biased at study and retrieval. When the different meanings of a homonym are biased at study and test there will be virtually no overlap in the semantic features that are encoded at the two phases, whereas with nonhomonyms or when the same meaning of a homonym is biased, at least some of the semantic features encoded at input are likely to be encoded at test when the to-be-remembered item is presented in a changed context.

2. Recognition Failure of Recallable Words.

Recognition failure of recallable words can be regarded as a special instance of context effects in recognition memory but,due to the research interest and theoretical speculation that the phenomenon has generated,will be treated separately here. While recognition failure may be accompanied by higher recall than recognition (e.g. Tulving, 1968; Tulving and Thomson, 1973), recognition failure of recallable words can also be found when overall recognition levels are higher than overall recall levels (Wiseman and Tulving, 1976) with the magnitude of the recognition failure effect being inversely related to the overall level of recognition (Tulving and Wiseman, 1975). Like context effects in recognition memory, the phenomenon of recognition failure of recallable words has been interpreted by some researchers (e.g. Martin, 1975; Reder, Anderson and Bjork, 1974) as evidence that each different sense of a verbal item has a separate representation in long-term memory. When the target item is presented in a different context at the recognition test, the changed context may result in a different long-term memory representation of the word being examined for an occurrence tag. The original input context is reinstated in the cued recall test, however, thus guiding the learner to access the same sense of the target word as that which was marked with occurrence information during the study phase of the experiment. Consequently, the subject may fail to recognise a to-be-remembered word in the changed context of the recognition test, but succeed in recalling the same word in response to a weak intralist recall cue. As was argued in Chapter two, perhaps the strongest evidence against such an explanation of the recognition failure phenomenon comes from studies that have demonstrated recognition failure for words with a single meaning (Tulving and Watkins, 1977) and novel stimuli such as unfamiliar faces (Watkins, Ho and Tulving, 1976; Winograd and Rivers-Bulkeley 1977) neither of which should have multiple representations in long-term memory.

Within the present theoretical framework the phenomenon of recognition failure of recallable words can be explained as follows: when the word pair is originally presented for study, the target word is encoded in relation to the weak associate. This results in a collection of features relevant to the weak semantic relationship between the two words being encoded. When recognition of the target word is tested in a different context consisting of strong associates or unrelated lures (Watkins and Tulving, 1975) a set of features of the target word that are appropriate to the new context will be encoded. In the absence of the weak input cue a different set of semantic features are likely to be encoded at test from those encoded at study. At the recall test, however, the reinstated weak intralist cue will be encoded and if a sufficient number of features that were encoded at input are encoded at retrieval, its episodic memory representation will be accessed. Due to the initial relational encoding of the word pair at input retrieval of the target item will occur, since the two members of the pair will be stored together in episodic memory, linked by a small subset of shared semantic features. While it could be argued that the intralist recall cue should also suffer from the detrimental effects of context change upon its recognisability and hence its ability to retrieve the representation of the target item, it would appear that context deletion has less deleterious effects than the context substitution that occurs in the recognition test (e.g. Light and Carter-Sobell, 1970). Accordingly, the subject may fail to recognise the target word because different features associated with the word are encoded at the recognition test from those which were encoded at input, but may subsequently recall the same word because the encoded form of the recall cue may share more features in common with the joint representation of the cue and to-be-remembered word.

Generation-recognition models such as that of Anderson and Bower (1974) could be modified in such a manner as to be able to explain findings of context effects in recognition memory and recognition failure of recallable words if it is assumed that some sort of stimulus sampling mechanism exists which operates in the selection of a collection of features that then comprise the episodic representation of the item. As has already been indicated, however, such a modification would render this theory virtually indistinguishable from the present model and others with a similar orientation (e.g. Tulving, 1976).

The present framework can account for the findings of recognition failure with novel stimuli and words with a single meaning without the need for any additional assumptions - the two fundamental assumptions are that the same nominal stimulus can be encoded in very different ways depending upon the prevailing context and that successful retrieval will depend upon similar features being encoded at the study and test phases of the experiment.

3. Ineffectiveness of Strong Extralist Associates as Retrieval Cues.

According to the generation-recognition theorists, the function of a strong extralist retrieval cue (or indeed of any effective cue) is to facilitate the search through the long-term memory network and the generation of response candidates. As a consequence, strong associates, when provided as recall cues, should facilitate retrieval relative to an uncued recall situation. While, generally speaking, this is found to be the case (e.g. Postman, 1975 Santa and Lamwers, 1974;) Thomson and Tulving, (1970) found no such beneficial effect of cued over uncued recall when the to-be-remembered utems were initially encoded in the context of a weak associate. According to modified generation-recognition theory, the strong associate in this experiment is said to result in a different node in long-term memory being accessed from that which was tagged at input.

In terms of the present formulation, the function of input context and retrieval cues are fundamentally similar - to guide the subject in the selection of a more or less specifically defined subset of features (particularly semantic) for activation. A weak input cue will bias the subject towards the encoding of a certain set of semantic features appropriate to the relational encoding of the word pair. At test, the strong extralist associate will be encoded and due to the strong extra experimental relationship between the cue and the target word, a subset of features that are associated with the target word are likely to be activated. These encoded features appropriate to the target word, however, are not necessarily the same features activated during the study phase since the weak intralist associate is likely to bias the encoding of a different set of semantic features from those biased by the strong associate. Consequently, the strong associate will prove rather ineffective as a cue for recall of the to-be-remembered word. When the target word is presented alone during the study phase of the experiment, the strong extralist cue will facilitate recall since it is probable that the strong cue will induce encoding of similar features associated with the target word to those that were encoded when the target item was studied in the absence of a biasing input context. The reason for the ineffectiveness of weak associates as extralist recall cues is more obvious. Since the two words share only a weak pre-experimental relationship, when the cue is encoded at test very few features associated with the to-be-remembered word are likely to be activated. An extralist cue will facilitate recall only if the features encoded at retrieval have already been encoded and are contained in the episodic trace of the target item.

4. Repetition Effects and Spacing Effects

The research presented in the present thesis is of direct relevance to the area of repetition effects in memory. Why do two presentations of a study item result in better retention of the item than does a single presentation and, more interestingly, why does increasing the spacing between the two occurrences of a repeated item lead to a much stronger repetition effect? Some researchers (e.g. Hintzman, 1976; Hintzman and Block, 1971) have argued that repetition benefits retention through the formation of a separate memory trace for each occurrence of the repeated item. The more traces there are present in episodic memory, the more likely it will be that one will be accessed at retrieval. However, it is difficult to account for the lag effect with such a formulation. The contextualist position of the present theoretical framework provides an explanation of repetition and lag effects that is similar to that of Madigan (1969) and other exponents of the differential encoding hypothesis (e.g. Bower, 1972; Melton, 1970) who argue that with increasing lag the repeated item is more likely to be encoded differently on its second occurrence. The more features that are encoded the more accessible will the item be at retrieval.

According to the present conceptualisation of episodic memory, when an item is first presented for study a set of associated features are encoded which then constitute the episodic memory representation of the item. If the item is later repeated within the list the representation of its earlier occurrence will be accessed and the features encoded on the second occurrence added to the existing memory trace. The further apart the two occurrences of the repeated item are, the more likely it will be that a different set of features will be encoded on the second occurrence of the item due to a gradual change in context, and as a consequence the resulting episodic representation of the item will contain a fairly large proportion of encoded features. The greater the number and variety of features present in the memory trace of the item, the more likely will it be that a successful match between the trace information and the information available at retrieval is obtained. As the spacing between the two occurrences of the repeated item increases, a point will eventually be reached at which the second occurrence of the item fails to access the representation of its earlier occurrence. Since very different semantic features are encoded on the second occurrence, retrieval of the previously established trace will be mainly dependent upon the matching of encoded nonsemantic features which are likely to remain relatively invariant across widely varying contexts. In such a situation a separate episodic memory representation will be formed on the second occurrence of the repeated item. If the original representation of an item cannot be accessed upon the item's subsequent occurrence, due to the changed context inducing the encoding of a different collection of semantic features, it should also prove inaccessible at the time of the retention test since the context that prevails at test should be even more different from the initial encoding context than that present on the second presentation of the item. If the representation resulting from the first occurrence of a subsequently repeated item cannot be accessed upon its second occurrence which constitutes a copy cue, it is unlikely that it will be later recalled in a situation in which even less specific retrieval information is provided. With long lags then, when two separate traces of the repeated item are formed, retention of the item is likely to be no better than of an item that has been presented once in a later part of the list. Winograd and Raines (1972) have shown this to be, indeed, the case. That increasing the lag between the two presentations of a repeated item leads to increasingly independent memory traces has been demonstrated by Paivio (1974) who showed that while at short lags the two encodings of a repeated item were stored nonindependently, at longer lags the two occurrences were represented independently of one another.

Within this conceptualisation, the effect of providing a different context word with the two occurrences of a repeated item is the same as that of lag. With increasingly different encodings of the two occurrences of a repeated item, the greater will be the resulting repetition effect, even at short lags. An experimentally induced change in context assures that even at short lags a different set of semantic features are encoded on the two presentations resulting in establishment of a memory trace containing a relatively large number of encoded semantic features. With such a variety of features comprising the episodic representation of the repeated item it is highly probable that when retention is subsequently tested at least some of the encoded trace features will be matched by the available retrieval information and mediate retrieval of the to-be-remembered item.

The most dramatic change in context occurs when two completely different meanings of a homonyn are biased, one on each of two different occurrences of the homonym. In this case, two completely independent sets of semantic features associated with the two different meanings of the homonym are encoded, one on each of its occurrences. Consequently, the representation resulting from the first occurrence should be retrievable only through the matching of nonsemantic features. This being the case separate representations for different meanings of homonyms should be expected to occur at somewhat shorter lags than different representations for different senses of nonhomonyms, since in the latter case both semantic and nonsemantic retrieval information may be used to access the original representation of a repeated word. As long as the original encoded representation of a homonym can be accessed when upon its subsequent presentation a different meaning is encoded, the second meaning encoded, although represented by a totally independent set of semantic features, will be stored with the originally encoded meaning of the homonym.

5. Rehearsal

In the sixties it was generally accepted that the function of rehearsal was to transfer an item from short-term storage to long-term storage through recoding of the item (e.g. Atkinson and Shiffrin, 1968; Waugh and Norman, 1965). The more rehearsals that an item received, the more likely it was to be transferred to secondary memory (Rundus, 1971). Craik and Watkins (1973) obtained evidence contrary to the notion that rehearsal necessarily facilitated retention of an item. They found that the number of rehearsals that an item received was uncorrelated with the subsequent retrievability of that item. Craik and Lockhart (1972) have postulated two qualitatively different types of rehearsal: maintenance rehearsal which they argued involves rehearsing the item at one level of processing or simply keeping the item in consciousness, and elaborative processing in which the item is progressively processed to "deeper" levels. Only the latter type of rehearsal is held to increase the subsequent retrievability of the item. In terms of the present theoretical framework, maintenance rehearsal will occur when the target item is held in consciousness, but no further encoded features are added to the trace. Beneficial effects for subsequent memory performance will occur when the rehearsal of the item involves the sampling and encoding of additional features to those activated on the initial encoding of the word. Those additional encoded features mean that the representation of the item is composed of a fairly large number of encoded features thereby increasing the probability of a match between the trace information and retrieval information when retention is subsequently tested. Such a conceptualisation is consistent with the results obtained by Goldman and Pellegrino (1977) who found that forced multiple encoding both within and across processing domains resulted in better memory performance than that obtained with a single encoding. Why, as Craik and Watkins have shown, do subjects employ apparently inefficient rehearsal strategies? It is suggested here that when the subject is engaged in maintenance rehearsal, the majority of the encoded features comprising the episodic trace of the item are accessible since the item is held in consciousness. Since the item is in such a state of high accessibility, it is argued, the subject perceives no necessity to further encode the item, but merely rehearses it in its originally encoded form. Consequently, little benefits for subsequent memorability are accrued over items that have not been rehearsed or have been rehearsed over a shorter duration of time. In Experiment 8 of the present studies it was found that when a word pair was presented on two successive trials, little or no further relational encoding occurred on the second presentation, presumably because the current high accessibility of the word pair obliviated any need to perform further processing activities.

6. Homonym Studies

Homonyms have been employed in several studies, particularly those concerned with the effects of context change on recognition memory and the effects of changed context on repetition and context effects. A fundamental premise of the framework for episodic memory representation that has been developed here is that different encoded meanings of homonyms are represented together within the same memory trace,with the different meanings each being associated with a different, independent set of semantic features. In the present section the framework will be applied to a selection of experiments that have employed homonyms as the to-be-remembered material, in an attempt to demonstrate the general applicability and validity of the framework.

First, with regard to recognition memory, Light and Carter-Sobell (1970) found that changing the semantic interpretation of homonyms at test led to a reduction in recognition performance compared to when the same meaning was biased at test or no context was provided at test (also, Davies, Lockhart and Thomson, 1972). Winograd and Conn (1971) showed that in the absence of study context homonyms were better recognised when the more frequent meaning of the homonym was biased at test. In terms of the present framework, the above results are attributable to different sets of semantic features being encoded at the input and test phases. Although the representation of the homonym in episodic memory may be accessed via the matching of nonsemantic features, the subject may fail to recognise the homonym when a different meaning is encoded at test since the semantic features encoded at test are entirely different from those comprising the episodic representation of the target word.

A similar type of context effect with different meanings of homonyms has also been found in several studies in which retention was tested by cued recall. Studies by Goldstein, Schmitt and Scheirer (1978), Roediger and Adelson (1980) and Murphy and Wallace (1974) all demonstrated that cues which biased the same meaning of a homonym as that encoded at input were more effective in the recall of the homonym than cues which were semantically related to a different meaning of the homonym from that encoded during the study phase. In the present view, an extralist cue that is related to a different meaning of the homonym from that encoded at input will prove relatively ineffective since the encoded features of the cue that are also associated with the homonym are unlikely to be the same features that were encoded during the study phase when a different meaning of the homonym was biased. When the extralist cue is semantically related to the previously encoded meaning of the homonym, however, certain encoded features of the cue are likely to already be present in the episodic representation of the homonym and will therefore effect retrieval of the target word. In the first experiment of the present studies, extralist cues related to a nonencoded meaning of the homonym were as ineffective in providing access to the homonym as were totally unrelated cues.

Homonyms have been employed in several studies to examine the effects of differential encoding on repetition and lag effects. In the majority of these experiments in which different meanings of homonyms have been biased on their two occurrences, repetition effects at short lags and the elimination of the lag effect have been observed (e.g. Gartman and Johnson, 1972; Thios, 1972; Winograd and Raines, 1972), one exception being a studyby Johnston, Coots and Flickinger(1972). According to the present framework, the biasing of a different meaning on the second occurrence of a homonym results in a totally different set of semantic features being encoded on that second occurrence even at short lags at which, it is argued,there is generally little processing of additional features to those encoded on the first occurrence. The resultant large increment in the number of features comprising the episodic memory trace of the homonym increases the probability that at least some trace features are matched by semantic features encoded at retrieval, thereby increasing the retrievability of the homonym. While Gartman and Johnson (1974) have suggested that the greater accessibility of homonyms when two different meanings have been encoded is a result of the homonym being incorporated into more than one "higher-order unit", the present research suggests that, on the contrary, the increase in accessibility of the homonym is a consequence of a single representation of the homonym being composed of two independent, nonoverlapping sets of encoded semantic features.

7. The Levels of Processing Effect

A large body of studies have now been reported which have demonstrated that when retention is tested by free recall, cued recall or recognition, semantic processing of an item results in superior retention of the item than does phonological processing which, in turn, has superior memorial consequences than orthographic processing (e.g. Arbuckle and Katz, 1976; Craik, 1973; Craik and Tulving, 1975; Glanzer and Koppenaal, 1977). While the original levels of processing theorists attributed the levels of processing effect to the greater durability of semantic traces (Craik and Lockhart, 1972), this view was subsequently modified to accommodate findings of encoding/retrieval interactions, although the notion of the inherent superiority of semantic encoding was still adhered to (Fisher and Craik, 1977). Within the present framework, semantic processing is regarded as being generally more effective in terms of subsequent retention than nonsemantic processing, although not inherently so. The reason for the generally observed superiority of semantic processing, it is argued, lies in the fact that under most circumstances, predominantly semantic retrieval information is encoded at test. Since successful retrieval involves the matching of trace and retrieval information, predominantly semantic memory traces will be more likely to be retrieved than traces that are composed of predominantly nonsemantic features. If predominantly phonological retrieval information is encoded at test, then episodic memory representations containing predominantly phonological features will be accessed with a higher probability than those containing predominantly semantic features (Morris, Bransford and Franks, 1977).

Semantic processing followed by a semantic retention test, however, still results in higher levels of performance than does nonsemantic processing followed by a nonsemantic retention test (e.g. Moscovitch and Craik, 1976). Such an observation can be accounted for in terms of the larger number of potentially encodable semantic features that are associated with a particular word, compared to the numbers of associated orthographic and phonological features. Furthermore, nonsemantic features tend to be shared by a great many itmes, and in the absence of defining semantic features may fail to specifically define and differentiate a particular encoded verbal stimulus. There is no suggestion in the present formulation that nonsemantic features are less durable than semantic features. Rather, it is proposed that semantic features are simply more accessible in a standard retention test and are more effective in the definition of an output response.

8. The Congruity Effect

One result that has been consistently obtained in typical levels of processing studies is the finding that target words which are congruous with their encoding question are generally better remembered than items that are incongruous with their encoding context and elicit a negative response to the encoding question (e.g. Craik and Tulving, 1975; Glanzer and Koppenaal, 1977; Mayes and McIvor, 1980). Such an effect has been observed in free recall and recognition and in the cued recall situation when the encoding question is provided as a cue at test. The term "congruity effect" was originally coined by Schulman (1974) who found a large memorial advantage of congruous over incongruous encodings.

An effect similar to that obtained in the levels of processing studies was found in the present studies. Here it was found that homonyms encoded in the context of one semantically related and one unrelated encoding stimulus were retrieved with a substantially lower probability than were homonyms which were encoded in the context of two semantically related encoding stimuli. The patterns of results obtained were consistent with the proposal that semantically related items are stored together in a unitised fashion (assuming that semantic features shared by the items in question have been encoded at input) while two separate representations in episodic memory will be formed when a semantically unrelated pair of items are presented for study since no subset of semantic features common to the two words is encoded at input to form a unitising link in episodic memory between the two items. Since the encoded features which assume the greatest salience and retrievability are those shared by two or more words, isolated representations will be less accessible at test due to their not containing such salient features. In cued recall, moreover, one member of an unrelated word pair will prove generally ineffective as a cue for recall of the other member since cued recall with intralist cues is argued to be mediated by encoded features that are shared by the cue and the target item. One slightly anomalous finding was obtained in Experiment 4 of the present studies. It was found that when retention was tested by free recall the unrelated encoding stimulus in the UNR condition was recalled with a higher probability than the semantically related encoding stimulus. 1/3 of all homonyms in each list were encoded in the UNR condition, so that only 1/6 of all comparisons should be expected to elicit a negative response in the orienting task. It is possible that, due to a positive response bias the subjects processed the unrelated encoding stimuli more extensively than the semantically related encoding stimuli in this condition, in an attempt to find a semantic link between the homonyms and the unrelated encoding stimuli. Accordingly, although the unrelated encoding stimuli would be stored separately and would not benefit from the presence of salient shared features in its representation, its trace would nevertheless contain a proportionately higher number of unique semantic features. The greater number of unique semantic features would thus render the representation of the unrelated encoding stimulus comparatively highly accessible at test.

The congruity effects obtained in the Shulman study and in the levels of processing studies can be explained in similar terms. When two related items or a congruous query and target are presented for study, and their commonality detected, the items will be stored together in episodic memory. If the items are incongruous then they will be represented separately. Since, all other things being equal, the representation of an item is most accessible if it contains a proportion of salient shared features, items encoded in a congruous context will be better remembered than items encoded in an incongruous context. If the original encoding is predominantly semantic then the shared semantic features, being focal to the task, will be most salient. If the encoding is predominantly nonsemantic, then shared nonsemantic features will link the items in episodic memory. Since with nonsemantic processing, nonsemantic features are focal to the task these shared nonsemantic features will assume greater salience than nonsemantic features that are unique to a particular item.

Craik and Tulving (1975) have shown that the congruity effect disappears when the positive and negative responses to the encoding question lead to equivalent amounts of elaboration of the target word. In terms of the present framework, no difference in recall following positive or negative responses would be expected in this situation since positive and negative response will lead to equivalent amounts of relational encoding of the target and encoding context.

9. P.A. Learning, Transfer Effects and Release from P.I.

Since the studies reported in the present thesis were concerned essentially with relational encoding, the representational framework proposed should be applicable to studies involving paired-associate (PA) learning. Effects of proactive interference (PI) and retroactive interference (RI) have been found using the AB-AC paradigm in which the stimulus from the first list are paired with different response members on the second list. RI and PI effects have traditionally been attributed to unlearning, response competition, or both (e.g. McGeogh, 1942; Melton and Irwin, 1940; Postman, 1969; Underwood, 1948).

A somewhat radical (in the interference theorists' view) alternative interpretation of interference effects has been proposed by Martin (1968, 1971, 1972) based upon the principle of encoding variability. According to Martin, the subject encodes different features of the stimulus on the two lists in the AB-AC paradigm. RI is assumed to occur as a result of the subject continuing to sample the A-C features of the stimulus while attempting to recall A-B, while PI occurs when the subject continues to encode the A-B features while learning A-C.

The present interpretation of PI and RI effects in paired-associate learning is in the same vein as that of Martin. It is proposed that when the A-B association is learned, a subset of features of A are encoded in relation to B. If A and B are associated in some way then their resulting episodic memory representation will be linked by encoded features that are common to the two members of the word pair. If A and B are totally unrelated, then their traces will be linked by some form of contextual (e.g. temporal) information. When learning of the A-C pairing is subsequently required, A will then be encoded in relation to C and a subset of features relevant to that encoding will comprise the representation of A. A and C will also be represented together, linked by a set of shared encoded features or by a contextual association peculiar to the experimental presentation of the items. Presumably, when a list is learned the shared features or contextual link between the items are reinforced so that when the stimulus member is presented and its representation accessed, the representation of the response word can be more readily accessed through the episodic link between the two items.

An additional assumption that will be made is that because A occurs on two separate lists, the subject forms two separate representations of A in episodic memory in an attempt to differentiate the two different occurrences of A. When the A-C pair is being learned and recall of C is tested in response to A, it is possible that the alternative representation of A will be accessed and B retrieved since similar features of the stimulus may be encoded on both lists. The effects of PI would be expected to be greater, then, if the two responses B and C are similar, since this similarity is likely to induce similar encoding of A on the two lists. Once A-C has been learned to criterion and recall of B is tested, the features of A that are encoded at test are likely to be similar to those that were encoded on the most recent presentation of A. Consequently, the A-C representation may be accessed and C produced as a response. If the features of A encoded on the two lists are sufficiently different the representation of A from the first list may be inaccessible at test. This is consistent with Melton and Irwin's (1940) finding that not all forgetting of B results from the intrusion of the C response. Intrusion of the C response would seem more likely to occur when the B and C responses are similar. At recall, both representations of the A response would tend to be accessed since both would be composed of similar encoded features, and the subject would then be faced with a list discrimination problem. In such a situation the subject would be likely to produce the incorrect response.

The absence, or at least reduction, of RI effects when the subject is required simply to match the stimuli and responses at test (e.g. Garskof and Sandak, 1964; Postman, Stark and Fraser, 1968) can also be explained in terms of the present framework. When the response member is presented in such a situation, its representation in episodic memory can be accessed and the stimulus member A accessed via the response. If, on the other hand, the subject attempts to access the representation of the stimulus, then access the representation of the response via the representation of the stimulus, the A-C pairing rather than the A-B pairing may be retrieved since the encoding of A at test is likely to be more similar to the A-C encoding than the A-B encoding. Thus depending upon the subject's strategy, some RI effects may occur, but are likely to be much reduced since the correct pairing can be accessed via retrieval of the representation of the B response.

One interesting phenomenon that has been extensively studied by Wickens and his colleagues (e.g. Wickens, 1970; Wickens, Born and Allen, 1963) is the release from PI that is observed to occur when the class of items that has been studied for several trials is changed on a subsequent trial. It is suggested here that build-up of PI occurs over successive trials if the material learned on these trials is similar because at retrieval the effective retrieval cue is likely to provide access to the majority, if not all, of the previously presented items. Consequently a discrimination problem is introduced since the subject must decide which items accessed were presented on the immediately preceding trial. When the nature of the study material is changed on a subsequent trial, for example if the taxonomic category that the material is drawn from is changed, then the effective retrieval cue (e.g. some type of information concerning class membership) will successfully access only those items from the most recently presented trial that share encoded features in common with the retrieval information. As a consequence, a discrimination problem is avoided and the items on the release trial are recalled with a higher probability than those on the preceding trials. Evidence for such an interpretation of the phenomenon comes from two studies. Watkins and Watkins (1975) found that when tested by final free recall, all study items were equally well remembered, regardless of how well they had been remembered during the build-up and relase-from PI trials. This suggests that the representations of the items were equally accessible, but when several trials with simila1 materials occur, a list discrimination problem affects the successful retrievability of the correct list items. Gardiner, Craik and Birtwistle (1972) showed that small changes in the nature of the study material did not cause a release from PI to occur if the change was undetected by the subject. If the subject was informed of the change, however, a release effect occurred (also, O'Neill, Sutcliffe and Tulving, 1976). Thus release from PI seems to depend upon the use of a retrieval cue that effectively differentiates between the present and previous list items. The present formulation would seem to suggest that the magnitude of the release effect would be dependent upon the degree of the change in materials on the release trial, since the more similar the release material is to the previous study material the more likely it should be that the retrieval information on the release trial accesses the representations of items from previous lists. Such an effect has been reported by Wickens, Dalezman and Eggemeier (1976) who found that the magnitude of the release effect was proportional to the number of attributes of the stimulus material that were changed on the release trial. Release from PI, then, would seem to be a purely retrieval phenomenon based upon the ability of the retrieval cue to access the present list item and differentiate them from items from previous lists.

CONCLUSIONS

The results obtained in the present studies are consistent with a conceptualisation of episodic memory in which successive encodings of the same item are represented within a single memory trace. When the successive encodings involve two or more different meanings of a homonym, each of the different meanings will be represented in episodic memory by an independent, nonoverlapping set of semantic features. When the same meaning is encoded on two separate occasions, certain features will be activated at both encodings, with the overlap in the features encoded on the two occasions varying as a direct function of the similarity of the two encodings. Such similarity will be mainly determined by the similarity of the prevailing encoding contexts. Words will be represented together in a unitised fashion if a subset of features common to each of the items is encoded at input. These shared encoded features will form the unitising link between the representations of the items in question. Successful retrieval is achieved through the matching of trace features with information provided by the functional retrieval cue. When relational encoding occurs, shared features, being generally more focal to the encoding of the to-be-remembered item or items will be more accessible at test than encoded features that are unique to a particular trace. When representations are linked in an integrated fashion in episodic memory, access to one part of the linked structure can be achieved if another part of the structure is retrieved, with access of the remainder of the unit being mediated through the unitising shared features.

The present finding that different encoded meanings of homonyms and different senses of homonyms and nonhomonyms are represented within a single memory trace has positive implications in terms of cognitive economy. Instead of the necessity to form a separate representation for each encounter with the same nominal stimulus, a single representation for the item can be formed upon its initial occurrence and subsequent encoding simply added to the extant episodic structure. In this way successive encounters with the same verbal item can be represented in episodic memory in a highly economical fashion.

The general applicability of the present framework has been demonstrated in the present chapter where it was shown to provide an interpretation of a range of episodic memory phenomena with the need for few, and in the majority of cases, no additional assumptions. The contextualist position adopted emphasises the flexibility of the learner in terms of processing activities, but also stresses the strong influence exerted upon these activities by the prevailing context, both at the initial input and subsequent retrieval phases. While it could be argued that the present approach is somewhat circular as a consequence of its emphasis upon the necessary compatibility of encoding and retrieval operations for successful retrieval, the existence of a structural framework in which to conceptualise the representational consequence of any particular encoding and a formalization of the relative accessibility of different types of encoded features lends the framework a certain degree of predictive power that cannot be achieved through an emphasis on process or structure alone. The empirical emphasis in the present thesis has been upon the representation of single versus multiple meanings of homonyms in episodic memory. By virtue of the nature of the stimulus material itself, however, it has proved possible to demonstrate the manner in which different types of encoding are represented in episodic memory and to provide an interpretative framework that is sufficiently general to constitute a widely applicable conceptualisation of episodic memory storage.

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APPENDIX I.

Thorndike-Lorge Frequencies* of Homonyms and Corresponding Encoding Stimuli and Production Frequencies of Encoding Stimuli.

* Frequency of occurrence per million words in the Thorndike and Lorge (1944) norms.

The production frequencies represent the percentage of subjects producing the encoding stimulus as a response to the homonym in the word association study.

Homonym	Common ES	SM ES	DM ES	UNR(1) ES	UNR(2)** ES
ARM - AA	LEG - AA 33.33%	HAND - AA 45.61%	RIFLE - 31 1.75%	SNAKE - 28 0%	MAP - A 0%
BALL - AA	BAT - 19 28.07%	NET - A 1.75%	DANCE - AA 10.53%	HORSE - AA 0%	CASTLE - AA 0%
BAND - A	DRUM - 40 6.90%	TRUMPET - 17 6.90%	RUBBER - 35 13.79%	MOUSE - 34 0%	GIANT - A 0%
BANK - AA	RIVER - AA 14.04%	STREAM - AA 1.75%	MONEY - AA 77.19%	GIRL - AA 0%	TENT - A 0%
BARK - A	BRANCH - AA 1.72%	LOG - A 0%	DOG - AA 79.31%	LAMP - A 0%	
CALF - 14	KNEE - AA 3.51%	THIGH - B 3.51%	COW A 22.81%	ISLAND - AA 0%	
CASE - AA	BAG - AA 14.04%	TRUNK - 48 3.51%	COURT - AA 8.77%	CHAIR - AA 0%	
CELL - A	BLOOD - AA 6.90%	BRAIN - A 3.45%	PRISON - A 60.34%	PARK - A 0%	

Homonym	Common ES	SM ES	DM ES	UNR(1) ES	UNR(2)** ES
CHEST - 41	DESK - A 0%	TABLE - AA 0%	BACK - AA 0%	SEED - A 0%	
CLUB - AA	STICK - AA 3.45%	TRUNCHEON - 1 1.72%	NIGHT - AA 0%	GOAT - A 0%	FLOOD - A 0%
CROOK - 10	THIEF - 28 37.95%	CRIME - A 6.90%	STAFF - 37 10.34%	ICE - AA 0%	MOUNTAIN - AA 0%
DECK - A	BOAT - AA 14.04%	SHIP - AA 68.42%	CARDS - A 21.81%	MONEY - A 0%	FILM - 31 0%
FOOT - AA	SHOE - AA 42.10%	HEEL - A 0%	INCH - AA 1.75%	MAP - A 0%	GOAT - A 0%
GUM - 11	JAW - 11 1.75%	TOOTH - 47 24.56%	GLUE - 15 7.02%	FIELD - AA 0%	
JAM - 16	BREAD - A 20.69%	BUTTER - AA 10.34%	TRAFFIC - 36 6.90%	DOCTOR - AA 0%	WITCH - 24 0%
KEY - A	SONG - AA 0%	TUNE - 32 0%	LOCK - A 63.79%	COAT - AA 0%	
LACE - 32	SILK - A 5.26%	WOOL - A 0%	BOOT - 37 26.32%	WALL - AA 0%	KNIFE - A 0%
LARK - 22	ROBIN - 48 0%	NEST - A 1.75%	FROLIC - 11 0%	BELL - A 0%	DESK - A 0%
LID - 16	BOX - AA 12.07%	COVER - AA 12.07%	EYE - AA 6.90%	TICKET - A 0%	FLAG - A 0%

Homonyn	Common ES	SM ES	DM ES	UNR(1) ES	UNR(2) ES
MARCH - AA	WALK - AA 14.04%	ARMY - AA 14.04%	MONTH - AA 22.8%	HOUSE - AA 0%	SOIL - AA 0%
MATCH - A	GAME - AA 8.77%	CONTEST - 31 1.75%	FIRE - AA 17.54%	FLY - AA 0%	CAP - A 0%
MINT - 13	PLANT - AA 5.17%	HERB - 14 5.17%	COIN - A 3.45%	BABY - AA 0%	FINGER - AA 0%
NAIL - A	HAMMER - 34 72.41%	PLIERS - 17 per 4 million	TOE - 35 6.90%	DAY - AA 0%	
NOTE - AA	LETTER - AA 29.82%	LIST - A 0%	CHORD - 8 0%	HAT - AA 0%	SEED - A 0%
NUT - A	BOLT - 27 22.81%	SCREW - 10 10.53%	SQUIRREL - 14 12.28%	CASTLE - A 0%	LIP - AA 0%
ORANGE - A	BLUE - AA 1.75%	RED - AA 5.26%	APPLE - A 22.81%	FLOOD - A 0%	COAT - AA 0%
ORGAN - 48	PIANO - 26 8.62%	CHURCH - AA 39.66%	HEART - AA 10.34%	MOUNTAIN - AA 0%	
PAGE - AA	WORD - AA 13.79%	BOOK - AA 79.31%	BOY - AA 15.52%	SUGAR - AA 0%	GRASS - AA 0%
PALM - 37	TREE - AA 73.68%	DATE - AA 3.5%	WRIST - 17 0%	WHEEL - A 0%	
PLOT - 36	SCHEME - 46 10.53%	PLAN - AA 26.32%	LAND - AA 22.81%	LIP - AA 0%	SHELL - A 0%

Homonym	Common ES	SM ES	DM ES	UNR(1) ES	UNR(2) ES
POOL - 34	LAKE - AA 0%	SEA - AA 1.75%	CUE - 3 12.28%	THREAD - A 0%	
PORT - A	WINE - A 14.04%	DRINK - AA 26.32%	DOCK - 16 14.04%	EGG - AA 0%	
POST - AA	STAMP - A 22.41%	MAIL - A 13.79%	POLE - A 0%	KNIFE - A 0%	BROTHER - AA 0%
PUPIL - A	SCHOOL - A 53.45%	CLASS - AA 25.86%	IRIS - 9 1.72%	SNOW - AA 0%	MIRROR - 46 0%
RULER - 32	PENCIL - 40 31.03%	LINE - AA 13.52%	KING - AA 46.55%	TENT - A 0%	
SCALE - A	WEIGHT - AA 22.41%	BALANCE - A 3.45%	FISH - AA 22.41%	DOLL - 46 0%	DOCTOR - AA 0%
STAR - AA	MOON - AA 12.79%	SUN - AA 8.62%	FILM - 31 1.72%	THORN - 24 0%	
STONE - AA	PEBBLE - 19 8.62%	JEWEL - 41 0%	POUND - AA 0%	PEN - A 0%	
TANK - 19	GUN - A 19.30%	WAR - AA 29.82%	OIL - AA 8.77%	DINNER - AA 0%	THORN - 24 0%
TRAIN - AA	RAIL - A 8.77%	BUS - 9 0%	BRIDE - 41 0%	GRASS - AA 0%	
WATCH - AA	CLOCK - A 17.24%	TIME - AA 68.96%	DUTY - AA 0%	WING - AA 0%	

Homonym	Common ES	SM ES	DM ES	UNR(1) ES	UNR(2) ES
YARD - AA	METRE - 12 3.45%	MILE - AA 5.17%	GARDEN - AA 5.17%	CUP - AA 0%	

** The second unrelated encoding stimuli were employed only in the 2 UNR control condition in Experiment 1. Although certain of these items also served as encoding stimuli for other homonyms, the same encoding stimulus was never employed more than once on the same input list.

The mean production frequencies for each of the different classes of encoding stimuli were as follows:

Common ES	EM ES	DM ES	UNR(1) ES	UNR(2) ES
17.18%	13.74%	15.85%	0%	0%

APPENDIX II.

Thorndike-Lorge Frequencies* of Homographs and Corresponding Encoding Stimuli and Production Frequencies of Encoding Stimuli.

Homograph	1st Encoding Stimulus	2nd Encoding Stimulus
BASS - 7	CHOIR - 12 3.45%	FISH - AA 10.34%
BOW - A	ARROW - 37 64.91%	SHIP - AA 3.51%
CLOSE - AA	OPEN - AA 17.54%	NEAR - AA 38.60%
GILL - 8	PINT - 14 5.17%	CHEEK - A 0%
LEAD - AA	IRON - AA 5.17%	CLUE - 4 0%
MINUTE - AA	DAY - AA 8.77%	SMALL - AA 31.58%
ROW - A	RIOT - 14 0%	LINE - AA 8.77%
SOW - 26	STY - 17 per 4 million 1.72%	CORN - A 0%
TEAR - AA	EYE - AA 10.53%	RIP - 19 50.88%
WIND - AA	RAIN - AA 27.59%	CLOCK - A 1.72%

* Frequency of occurrence per 1 million words in the Thorndike and Lorge (1944) norms.

The production frequencies represent the percentage of subjects producing the encoding stimulus as a response to the homograph in the word association study.

APPENDIX III.

Thorndike-Lorge Frequencies* of Homophones and Corresponding Encoding Stimuli and Production Frequencies of Encoding Stimuli.

Homophone	Encoding Stimulus	Homophone	Encoding Stimulus
BEACH - A	SAND - A 70.18%	BEECH - 10	NUT - A 12.07%
BORE - A	HOLE - AA 17.54%	BOAR - 11	PIG - 44 53.45%
MALE - 34	BOY - AA 17.24%	MAIL - A	STAMP - A 35.09%
NIGHT - AA	DAY - AA 22.41%	KNIGHT - AA	KING - AA 7.02%
ORE	IRON - AA 61.40%	OAR - 11	BOAT - AA 93.10%
PEAR - 21	APPLE - A 36.84%	PAIR - AA	COUPLE - A 37.93%
PEEL - 12	LEMON - 27 6.90%	PEAL - 9	BELL - A 57.89%
PLACE - AA	SITE - 21 3.45%	PLAICE - 7 per million	FISH - AA 71.93%
RAIN - AA	SNOW - AA 7.02%	REIN - 25	HORSE - AA 68.96%

Homophone	Encoding Stimulus	Homophone	Encoding Stimulus
TALE - A	STORY - AA 74.14%	TAIL - A	HEAD - AA 3.51%

*Frequency of occurrence per one million words in the Thorndike and Lorge (1944) norms.

The production frequencies represent the percentage of subjects producing the encoding stimulus as a response to the homophone in the word association study.

APPENDIX IV.

Percentages of subjects Responding to each of the Two Meanings of the Homonyms Biased in the Present Studies.

The Table below shows the percentage of subjects responding to each of the two meanings with their primary associative response and the percentage of subjects responding to each of the two meanings of each homonym in any of their three associative responses.

Homonym	Meanings	Primary/ Response	Any Response
ARM	body part	87.72%	94.74%
	weapon	3.51%	29.82%
BALL	spherical object	87.72%	91.23%
	society dance	1.75%	12.28%
BAND	musical ensemble	70.69%	87.93%
	strip of material	25.86%	51.72%
BANK	side of river	5.26%	91.23%
	place to deposit money	84.41%	19.30%
BARK	part of tree	46.55%	75.86%
	noise made by dog	53.45%	81.03%
CALF	part of leg	33.33%	45.61%
	young cow	63.16%	85.96%
CASE	type of luggage	71.93%	85.96%
	legal matter	14.04%	42.10%
CELL	unit of tissue	34.48%	56.90%
	enclosure	63.79%	81.03%
CHEST	type of furniture	39.66%	55.17%
	body part	55.17%	72.41%
CLUB	weapon	29.31%	37.93%
	organisation	43.10%	60.34%
CROOK	criminal	63.79%	81.03%
	shepherd's staff	22.41%	29.31%
DECK	part of ship	77.19%	94.74%
	pack of cards	3.57%	21.05%
FOOT	part of leg	73.68%	94.74%
	measurement	3.51%	5.26%
GUM	part of mouth	17.54%	31.58%
	sticky substance	77.19%	84.21%
JAM	preserve	82.76%	93.10%
	a block	3.45%	12.07%

Homonym	Meanings	Primary/ Response	Any Response
KEY	musical term	0%	5.17%
	instrument for locking	86.21%	96.55%
LACE	material	52.63%	70.18%
	string	43.86%	50.88%
LARK	type of bird	78.95%	89 .47%
	something done for fun	14.04%	35.09%
LID	top of container	96.55%	96.55%
	part of eye	3.45%	6.90%
MARCH	military gait	36.84%	50.88%
	month	59.65%	66.67%
MATCH	contest	33.33%	56.14%
	implement for causing fire	54.39%	82.46%
MINT	type of herb	86.21%	98.28%
	place where coins are made	12.07%	29.31%
NAIL	thin spike	67.24%	84.48%
	covering on finger or toe	29.31%	46.55%
NOTE	short letter	71.93%	87.72%
	musical sound	5.26%	12.28%
NUT	piece of metal	14.04%	26.32%
	type of food	70.18%	85.96%
ORANGE	colour	17.54%	31.58%
	fruit	77.19%	91.23%
ORGAN	musical instrument	79.31%	91.38%
	body part	20.69%	41.38%
PAGE	leaf of book	84.48%	91.33%
	attendant	12.07%	27.59%
PALM	type of tree	49.12%	84.21%
	part of hand	47.37%	70.18%
PLOT	conspiracy	75.44%	87.72%
	area of land	12.28%	38.60%
POOL	area of water	75.44%	89.47%
	game	14.04%	38.60%
PORT	type of drink	26.32%	42.10%
	harbour	64.91%	80.70%
POST	mail delivery	87.93%	93.10%
	pole	10.34%	25.86%

Homonym	Meanings	Primary/ Response	Any Response
PUPIL	school student	55.17%	89.66%
	part of eye	44.83%	58.62%
RULER	drawing, measuring implement	63.79%	81.03%
	sovereign	34.48%	56.90%
SCALE	measuring device	41.38%	56.90%
	covering on fish etc.	15.52%	31.58%
STAR	celestial body	70.69%	86.21%
	celebrated performer	20.69%	34.48%
STONE	small rock	91.38%	93.10%
	weight	6.90%	8.62%
TANK	military vehicle	59.65%	78.95%
	large container	31.58%	57.89%
TRAIN	form of transport	91.23%	92.98%
	bridal attire	0%	0%
WATCH	time-keeping device	74.14%	86.21%
	nautical duty	8.62%	17.24%
YARD	distance	22.41%	39.66%
	enclosed area	44.83%	74.14%

APPENDIX V.

Mean Production Frequencies of the Encoding Stimuli Employed in each Experiment.

Experiment 1.

Common ES	SM ES	DM ES	(1) UNR ES	(2) UNR ES
17.99%	12.20%	16.72%	0%	0%

Experiment 2.

Common ES	SM ES	DM ES	UNR ES
17.18%	13.74%	15.85%	0%

Experiments 3 and 4.

Common ES	SM ES	DM ES	UNR ES
19.53%	12.99%	16.41%	0%

Experiments 5 and 6.

Common ES	SM ES	DM ES	UNR ES
19.03%	14.40%	15.17%	0%

Experiment 7.

Common ES*	SM ES	DM ES
18.84%	12.71%	17.56%

* only the common encoding stimulus was presented in the SP and IR conditions.

Experiment 8.

Common ES*	SM ES	DM ES	UNR ES
17.70%	13.99%	16.47%	0%

* only the common encoding stimulus was presented in the IR condition.

Experiments 9 and 10.

DM Condition	HG Condition	HP Condition	SP Condition
20.12%	14.51%	37.90%	21.30%

APPENDIX VI.

Mean Recall Probabilities - Exp. 9.

1st Retrieval Opportunity

	DM	HG	SP	DM	HP	SP
Auditory	.669	.561	.507	.694	.613	.573
Visual	.557	.500	.497	.675	.662	.507

2nd Retrieval Opportunity

	DM	HG	SP	DM	HP	SP
Auditory	.601	.574	.466	.612	.538	.500
Visual	.523	.462	.428	.602	.628	.428

APPENDIX VII.

Mean Recall Probabilities - Exp. 10.

1st Retrieval Opportunity

	DM	HG	SP	DM	HP	SP
Auditory	.633	.613	.565	.675	.675	.659
Visual	.774	.655	.602	.657	.648	.568

2nd Retrieval Opportunity

	DM	HG	SP	DM	HP	SP
Auditory	.535	.575	.575	.628	.590	.436
Visual	.636	.555	.513	.520	.599	.449

DEFINITION OF LINGUISTIC TERMS

POLYSEMY: One word having two or more senses. In polysemy the different senses are related to one another either etymologically or, more commonly, metaphorically. e.g. LEG which may refer to an animal limb or to a long support (for example, table leg).

HOMONYMY: Generally considered to be two or more words with the same spelling and pronunciation. Unlike polysemous items, the different meanings of the homonym are unrelated historically or psychologically. e.g. BALL which may refer either to a spherical object or to a society dance.

HOMOGRAPHY: Two or more words having the same spelling but different pronunciation. As with homonymy the different forms of a homograph are unrelated to one another in meaning.
e.g. BOW (bou) - part of a ship
BOW (bō) - instrument to shoot arrows.

HOMOPHONY: Two or more words having the same pronunciation but different spelling. Again, the different forms of a homophone are unrelated in meaning.
e.g. PEAR (pâr) - a fruit.
PAIR (pâr) - two things, a couple.