How do you cue?

Self-generated retrieval cues and successful recall
HOW DO YOU CUE?
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Dissertation in partial fulfilment for the Degrees of Doctor of Philosophy, Department of Psychology, University of Umeå.

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1986
The present thesis deals with the determinants of good memory performance. A more specific objective of the thesis was to examine prerequisites for successful recall performance from the point of view of cue effectiveness. The concept of cue effectiveness was proposed as a superordinate construct underlying the act of remembering in general as well as exceptional memory performance. It was argued that to the extent that effective cues are provided when retrieval is attempted, good recall would be obtained even without use of specific mnemonic systems. Two characteristics of cue effectiveness were assumed to determine the level of recall performance. First, a retrieval cue has to provide a compatible description of the information encoded, and second, an optimal cue is the one that also represents a distinctive description of that information. Provided that these two characteristics of cue effectiveness are fulfilled, successful recall was expected to occur. In order to optimize cue efficiency an experimental paradigm was introduced. The main feature of the self-generation paradigm is that, in contrast to traditional cued-recall experiments, subjects are provided with cues, which according to the individual's own conceptualization constitute an appropriate description of the previously encoded information. The four studies composing the empirical section of the thesis, demonstrated, first, that self-generated cues serve as extremely powerful retrieval aids. Secondly, it was demonstrated that compatibility and distinctiveness may be the cardinal concepts underlying the empirical phenomenon per se and the essence of the notion of cue effectiveness. Finally, it was proposed that the methodological contribution is of such a nature that it may apply successfully to more practical situations.

Key words: Successful Recall, Cue Effectiveness, Compatibility, Distinctiveness, Self-generation.

The present doctoral dissertation consists of a summary and the following studies:


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Self-generated retrieval cues and successful recall

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Preface

The present doctoral dissertation consists of a summary and the following studies:


Good memory performance

The importance of good memory has been recognized for thousands of years. According to some priests and philosophers of the Middle Ages, good memory showed "...how to reach Heaven and avoid Hell..." (Lorayne and Lucas, 1974), and for the ancient Greeks and Romans, the faculty of memory was of vital importance due to the absence of handy note-taking devices.

One of the most famous demonstrations concerning the value of excellent memory, is the one given by the poet Simonides of Ceos. Simonides was commissioned to write a lyric poem praising a certain nobleman of Thessaly named Scopas, and to recite it at a banquet where many people were assembled. After delivering his poem, Simonides was called out, and during his absence, the roof of the banqueting hall fell in, crushing all the guests to death beneath the ruins. The catastrophe was so devastating that even relatives could not recognize the mutilated bodies one from another. Simonides, however, remembered the names of the guests by using the spatial layout of the banqueting hall as a cuing structure. This experience suggested to the poet the principles of mnemonic techniques, or the art of memory of which the poet is said to have been the inventor (Yates, 1966).

The importance of good memory has not only been recognized by the ancient Greeks and Romans, but even today people are concerned about questions related to good memory performance, and, especially, about questions related to exceptional memory. One indicate of this general interest is the fact that many people have capitalized the public concern for memory by selling memory courses that promise to increase memory in "a few easy lessons".

Although most of our everyday remembering relies on external memory aids, such as notebooks, clocks, and signs, few would deny the value of possessing good memory. This faculty of mind is not only valuable in specific situations in which we are specifically supposed to remember certain appointments or events, but good memory is also a powerful
resource in thinking, problem solving, decision making and other cognitive activities in general. That is, in order to produce new ideas by combining old ones, we need good access to our knowledge base. Or, as Aristotle expressed it: "These habits will make a man readier in reasoning" (Clark, 1975).

Good memory performance is also theoretically interesting in the sense that the issue can be seen as a research strategy with an intention to understand and explain human memory by examining a form of "abnormal" functioning. As research on memory disorders seeks to gain knowledge about normal memory by studying deficit functions, something might be learned about the basic processes of remembering by studying the subject under conditions in which good memory performance is expected. Furthermore, if some general principles underlying successful remembering can be identified, such knowledge may also have certain practical implications. That is, systematic knowledge about prerequisites for good memory performance can be applied in order to improve already existing memory training programmes, to construct new ones, and to understand their basic operating characteristics.

The focus of the thesis

The main objective of the present thesis was to examine prerequisites for good memory performance in relation to the concept of cue effectiveness. Although it may be presumptuous to expect that such an examination would show "how to reach Heaven and avoid Hell", this particular perspective on the concept of good memory performance was conceived of as theoretically fruitful because cue effectiveness can be assumed to play a central role in the act of remembering in general as well as in forgetting. Moreover, the concept of cue efficiency plays a central role in those situations in which exceptional memory performance is obtained by means of specific mnemonic systems (e.g., Bellezza, 1978), or in which persons with different skills are able to attain good memory performances in domains of their expertise (e.g., Ericsson, 1985).

In the following sections of the thesis, a more detailed discussion of the arguments summarized above is first presented. The general purpose of
this discussion is to emphasize the importance of effective retrieval cues in successful memory performance. It is argued that good memory performance is not exclusively associated with the feats of mnemonists or experts but that the level of memory performance depends on the quality of the available retrieval information. Following this section, a conceptualization of the notion of cue efficiency is presented and two prerequisites (compatibility and distinctiveness) for the effectiveness of retrieval cues are proposed. On the basis of this conceptualization, it is argued that in order to optimize cue effectiveness, retrieval cues should be defined in relation to each individual's own representation of the TBR-information. To test the viability of this reasoning, a new experimental paradigm is introduced. In contrast to traditional cued-recall experiments, subjects are, according to the self-generation paradigm, instructed to describe their own conceptualizations of the encoded information, and at the subsequent test, these descriptions are provided as retrieval cues.

Retrieval cues and the act of remembering

One of the few assumptions that most students of memory agree upon, is that successful retrieval presupposes access to some form of retrieval information. If it is assumed that an event E is encoded, in the sense that a representation of E is constructed, and that the rememberer's intention is to recall this specific event, then retrieval of E is possible if, and only if, an appropriate retrieval cue is available. Or, by using a more elegant phrasing by William James: "Suppose I am silent for a moment, and then say, in commanding accents, 'Remember! Recollect!' Does your faculty of memory obey the order, and reproduce any definite image from your past? Certainly not. It stands staring into vacancy, and asking, 'What kind of a thing do you wish me to remember?' It needs, in short, a cue" (James. 1899, pp. 117-118).

Thus, as was pointed out by William James almost 100 years ago, successful retention presupposes that some kind of cue is provided at retrieval. Even if such cues or reminders can be externally provided, (e.g. from note-books, instructions etc.), or internally generated, (e.g.
by means of free associations, dreams, images etc.) the main issue, still, is that some form of cuing procedure is always involved in retrieval (Jones, 1976; Tulving, 1983; Watkins, 1979). Recall has sometimes been called cued or non-cued (Tulving and Pearlstone, 1966), or prompted or unprompted (Bahrick, 1969), but such terms refer to methodological distinctions which only describe experimental treatments in particular experiments (Tulving, 1983; Watkins, 1979, Watkins & Gardiner, 1982).

Retrieval cues and forgetting

Throughout the history of memory research, two general hypotheses have provided two logically different vantage points for conceptual analysis of forgetting. According to one conceptualization, forgetting is a trace-dependent phenomenon which occurs because certain changes take place in the specific traces of encoded information. The traces decay or are lost due to interference (e.g. Jenkins & Dallenbach, 1924; Melton & Irwin, 1940; Underwood, 1949). The second idea holds that forgetting is a cue-dependent phenomenon. We fail to recall E, not because it has decayed or been obstructed, but because the cuing conditions are different from the conditions where encoding took place (e.g. Tulving, 1974). This view was actually expressed two hundred years earlier by the German philosopher Johan Nicholas Tetens: "Each idea does not only leave a trace or a consequent of that trace somewhere in the body, but each of them can be stimulated - even if not possible to demonstrate this in a given condition" (Tetens, 1777, p. 751).

Experimental support for cue-dependent forgetting has been reported by Tulving and his colleagues (e.g. Tulving & Pearlstone, 1966; Tulving & Psotka, 1971). For example, in the study of Tulving and Psotka (1971), the subjects were presented with lists of 24 words, each of which consisted of six semantic categories of four words each. It was made clear to the subjects that the words composing a list were grouped according to categories. Different groups of subjects learned different numbers of lists. One group of subjects learned one list, another group learned two lists, and so on, such that the sixth group of subjects learned six lists. After three presentations of each list, a free-recall
task was given in which the subjects had to recall as many words from the list as possible. After having learned their last list and being given the subsequent free recall test on this list, the subjects in a given group were asked to recall all the the words they had seen in the experiment. In this final free recall test no specific cues were given to the subjects. After 10 minutes of interpolated activity subjects were given the names of all the semantic categories and were then asked to recall all words presented.

The results of the study showed that non-cued recall decreased as a function of interpolating list. In light of the notion of retroactive interference, this result was entirely expected. However, when a category name was presented as a retrieval cue, delayed recall was as good as the original immediate recall. Thus, although recall decreased as a function of retention interval, forgetting could be reversed by providing effective retrieval cues at test. Thus, the retroactive interference observed in the overall noncued recall test reflected changes in the retrieval information, rather than a loss of information from the memory traces. The changes in the informational content of the retrieval environment were brought about by interpolated learning and recall of other lists. The presentation of category names restored the missing information to the learner’s cognitive environment at the time of cued-recall test, thereby making possible recovery of the information laid down in the memory store at the time of initial learning (Tulving, 1974, p. 78).

The question of explaining forgetting either as information loss or as retrieval failure may be impossible to answer in an absolute sense (see e.g. Loftus & Loftus, 1980; Neisser, 1967; Tulving, 1983). However, it can certainly be argued that the effectiveness of retrieval cues plays a crucial role in remembering and that the lack of such effectiveness underlies forgetting. Furthermore, the concept of cue effectiveness is theoretically interesting in the sense that the structure of the memory trace might be conceptualized in terms of cue effectiveness rather than in terms of input-output relations. Retrieval cuing as a method of describing memory traces emphasizes the idea that a memory trace can be specified as a set of cue efficiencies, or valences represented by a
"cuegram" (e.g. Tulving & Watkins, 1975; Watkins, 1979), and that the level of memory performance is a function of the amount of information subsumed by a retrieval cue. As a cue comes to subsume more and more events, its probability of affecting recall of any particular event declines. This general principle, i.e. the cue-overload theory, is a promising alternative to the different spatial metaphors of memory (see Roediger, 1979) in the sense that the principle integrates results from a wide variety of experimental paradigms and provides a straightforward interpretation of a number of memory phenomenon such as the list-length effect (Murdock, 1960), extralist cuing (Bahrick, 1969; Bilodeau, 1967), buildup and release from proactive inhibition (Keppel & Underwood, 1962), recall of categorized lists and subjective organization (e.g. Tulving & Pearlstone, 1966; Mandler, 1967).

Since retrieval cues play such a central role in memory performance in general, it is reasonable to assume that also the conditions where exceptional memory performance is traditionally observed can be characterized in terms of cue effectiveness. Thus, the second reason for taking the concept of cue effectiveness as a point of departure of the present thesis was the idea that retrieval cues were expected to serve as an essential component underlying the effectiveness of mnemonic systems as well as the exceptional memory performances of experts of different domains.

Retrieval cues and exceptional memory

As already mentioned, since the time of ancient Greeks a great variety of mnemonic systems has been developed for aiding recall in such cases where external retrieval cues are inapplicable. For example, the method of loci, the peg-word, the link, and the story mnemonics to mention a few. Although there are slight variations among mnemonic systems (e.g. Fürst, 1957; Lorayne & Lucas, 1974 Nutt, 1941; Roth, 1961) the basic components are essentially the same. The first phase of most systems involves the memorizing of a series of "pegs". For example, in the method of loci a well-learned series of locations is utilized. Then, when learning a series of items, one converts each item into an image and deposits this image at some salient location along the path. At retrieval, the
well-learned information is used as a cuing structure for recalling the to-be-remembered (TBR) information. That is, when the series of items is to be recalled, the method of loci is used once more for travelling the path "looking" at each location and reporting the name of the item deposited there. A mnemonic system provides a well-organized structure that can be used in order to "hook" the information to be remembered, and more importantly, this structure provides a consistent retrieval plan when recall is attempted.

Thus, preexisting cuing structures are essential for the effectiveness of mnemonic systems, but, as will be argued here, cuing structures also compose a prerequisite for good memory performance in general. In other words, the notion may be generalized in the sense that high levels of recall would be expected even under conditions where subjects do not use specific mnemonic systems, but are able to use some other well-organized knowledge structure as a retrieval cue. At least two empirical observations support this line of reasoning. First, a number of studies have demonstrated how persons with different skills are able to attain good memory performances in domains in which they are experts — in chess (Charness, 1979; de Groot, 1966, Lane & Robertson, 1979), in bridge (Charness, 1976; Engle & Bukstel, 1978) and in diagrams of electronic circuits (Egan & Schwartz, 1979). Secondly, even in situations in which the rememberer is not an expert of a specific domain, some other form of well-organized knowledge structure such as the individual's past experience, or "self-reference" (Rogers, Kuiper and Kirker, 1977), can be used as an effective retrieval cue during future recall.

Ericson, Chase and Faloon (1980) have substantiated this point by showing that extremely good recall of a random series of digits can be obtained by instructing the subject to use his specific skills and past experience as a mnemonic technique. In their study, a college student, who was a long-distance runner, constructed effective retrieval cues based on running times that enabled him to recall sequences of about 80 digits. The subject encoded series 2, 1, 4, 7 as two hours, 14 minutes and seven seconds, or "an excellent marathon time", and when running did not provide effective cues he used ages and dates, e.g. 1, 9, 4, 4, was encoded as "near the end of World War II". The subject was, due to his
specific knowledge, able to use different aspects of long-distance running as effective cues in order to recall long series of digits.

The usefulness of previous knowledge as an effective cuing structure has been demonstrated in situations where the subjects are not experts of specific domains, but rather experts of their own past experience. Rogers, Kuiper and Kirker (1977) have proposed self-reference as a superordinate schema for organizing information, and they have also argued that "it is difficult to conceive of an encoding device that carries more potential for the rich embellishment of stimulus input than does self-reference" (p. 687). They describe the self-concept as a superordinate cognitive schema that contains an abstracted record of a person's past experience with personal data. When individuals use this schemata to organize new information, they refer to the process as "self-reference". Once new information is subsumed by the self-concept in this manner, the self-concept can presumably be used as a retrieval cue during future recall.

Several studies have provided data concerning the effectiveness of self-reference as a retrieval cue. Rogers et al. (1977) instructed subjects to rate adjectives on four tasks designed to compel varying kinds of encoding: structural, phonemic, semantic, and self-reference. Incidental recall of rated words indicated that adjectives under the self-reference task were recalled best. McCarthy and Schmeck (1982) reported that self-disclosure by a lecturer improved memory for the lecture. They argued that the lecturer's self-disclosure had encouraged the students to engage in self-reference by modelling that strategy for them. Bower and Gilligan (1979) demonstrated, however, that relating the words in a list to specific events from one's past, or to one's concept of one's mother, was as effective as asking the subject to judge whether the words described their self-concepts. They report that memory established by reference to autobiographic events significantly exceeded that due to semantic analysis or a surface analysis of the phrase itself (p. 426). The self-concept per se is, however, not the crucial factor, but according to the authors, "any well-differentiated cognitive structure can serve as a 'hitching post' for evaluating and attaching items to be remembered" (p. 429).
The different findings presented here indicate that the concept of cue effectiveness is a central factor underlying the phenomenon of good memory performance. Since the phenomenon can, at least in most cases, be attributed to the availability of effective retrieval cues, it is reasonable to expect that to the extent that effective retrieval cues are provided, good memory performance can be demonstrated even under conditions where no specific mnemonic systems are used. This strategy may seem relatively straightforward. However, the notion of cue effectiveness is a complex issue in itself; so, before dealing with any concrete experimental solutions, a thorough consideration of the various characteristics of this concept is needed.

Characteristics of cue effectiveness

Traditionally, most memory research is based on the basic assumption that the subject matter -- the memory -- is an entity or a record that can be understood in its own right by identifying and studying certain of its properties (see Nilsson, 1979, 1984, Watkins, 1981). This research strategy has, no doubt, produced a wide variety of important concepts, methods, and techniques. However, as pointed out recently by some theorists in the field (e.g. Bransford, 1980; Jenkins, 1979), the traditional entity view faces some critical difficulties by ignoring the components "outside" the memory entity. The components stressed by Bransford (1980) and Jenkins (1979) are: materials, type of encoding and retrieval operations, the internal and external context, and interactions between these and other components.

A similar view is to conceive of memory as an interactive and contextually determined system rather than an entity where perceived events are preserved as intact discrete records (Craik, 1983, 1985; Nilsson, 1979, 1980, 1984). These recent and interactive views of memory imply in a certain sense a complication for demonstrating and dealing with good memory performance.

The demonstration of excellent memory might be quite a simple task if the TBR event E was well-defined in terms of physical information, and the
process of encoding was such that the representation of E was identical to its physical equivalence. Encoding under such conditions does not mean an interpretative process, but rather a process of registration of the stimulus and a process of activation of its fixed meaning (Begg & White, 1985). In this hypothetical situation, the representation of E could be defined on the basis of observable dimensions, and, hence, an effective retrieval cue would be the one that describes some of these dimensions.

There are at least two principal arguments against this particular line of reasoning. First, the physical environment can, reasonably, never be fully described, since it is constantly changing and it is never exactly the same as it is in other occasions; any description of the environment can always be made more complete (Watkins, 1979, p. 348). Second, when a person is perceiving an event, he or she is not passively registering the information; the individual's cognitive state, or the cognitive environment, provides a context for the information and an interpretation of that information as it is integrated with the individual's knowledge base (e.g. Bower, 1972; James, 1890; Tulving, 1983).

There are many ways of manipulating and influencing the rememberer's cognitive environment and to demonstrate the effect of such variations on memory performance. It has been shown that retention is affected by shifting the semantic context between acquisition and retention testing. For example, by changing adjectival bias between study and test (e.g., strawberry jam vs. traffic jam) recognition memory of target nouns has been significantly impaired (Light & Carter-Sobell, 1970); and Tulving and Psotka (1970) have shown that the restoring of semantic context (by providing a cuing category) markedly decreased the retroactive interference produced by interpolated word lists.

Evidence that dramatic changes in environmental context can influence recall was reported by Godden and Baddeley (1975). Changes in environmental context in this study were accomplished by having subjects learn list of words either on dry land or under water. Godden and Baddeley found that subjects who learned and recalled words in the same environmental context demonstrated better recall performance as compared to those who learned and recalled words in different environmental
contexts. Similar results have also been obtained by varying the time of the day, the appearance of the experimenter, and the room where the experiment took place (Smith, Glenberg & Bjork, 1978).

In a related vein, context effects have also been demonstrated by manipulating different internal states of the rememberer. Using hypnosis to vary affective conditions, Bower, Monteiro and Gilligan (1978) found that the particular mood employed (e.g., happy vs. sad) was less important for retention than was the similarity of emotional conditions at training and testing. Similarly, different drugs, such as alcohol (Parker, Birnbaum & Noble, 1976) and marijuana (Eich, Weingartner, Stillman & Gillin, 1975), have been used in order to demonstrate effects of state-dependent learning (see Eich, 1980 for a review).

Thus, the functional information of an event is not a one-to-one copy of its physical or nominal reference; the meaning of that information is determined by the process of interpreting that event in some context. In principle, the functional information can be represented as being composed of two interdependent components: (1) physical features representing the event, and (2) the individual's cognitive environment. A more formal expression of this general notion can be expressed as:

\[ E(n) \times C \Rightarrow E(f) \]

indicating that the functional information \( E(f) \) is a combination or a joint product of the nominal information \( E(n) \) provided by the physical environment and the individual's cognitive environment \( C \) in a given situation.

It should also be pointed out that although the concept of cognitive environment refers to the individual's previous knowledge, the external context determines the specific state of the cognitive environment. Furthermore, even though the nominal event is conceived of as a fixed entity, the internal representation of this, in a nominal sense identical event changes when the cognitive environment is changed:
Thus, when subjects are presented with a TBR-word in a given situation, the meaning of that word can vary between subjects because of differences in subjects' cognitive environments, and it can also vary within subjects when the TBR-item is encountered in different situations, i.e. subject's cognitive environment is C in one situation and C' in another situation.

In principle, the same state of affairs can be assumed to be prevalent with respect to retrieval. That is, when a retrieval cue is presented and the subject is asked to recall the previously encoded item, the effectiveness of that cue depends on how the retrieval cue is represented in a given situation. By using the same formal expression as above, the meaning of a cue is determined by:

\[ \text{Cue}^{(n)} \times C \Rightarrow \text{Cue}^{(f)} \]

and by relating this expression to the one used when encoding was characterized, the effectiveness of a retrieval cue can be defined as the relation between \( E^{(f)} \) and \( \text{Cue}^{(f)} \). That is, if the functional cue represents some of the dimensions composing the functional event, then a retrieval cue is regarded as compatible.

In Figure 1. encoding and retrieval of a TBR-item is characterized in terms of nominal information, cognitive environment and functional information: Suppose that the nominal information consists of the word JAM (cf. Light & Carter-Sobell, 1970), and that the rememberer knows the meaning(s) of that word (1). At the time of encoding the rememberer's cognitive environment is (due to a number of external factors) in such a state that he or she perceives the word JAM in the sense of "crowd" (2). Note that the specific content of that state is not known and that "crowd" is used here only as a label in order to symbolize a specific state of the rememberer's cognitive environment. The process of encoding results in a representation of JAM in such a sense that the preexisting knowledge corresponding to the rememberer's representation of JAM are
combined with the contextual features of the event where the item is encoded. Given a certain state of the rememberer's cognitive environment, the functional information can be assumed to be composed of features (Bower, 1967; Estes, 1959; Underwood, 1969) which represent the specific meaning of JAM (3). Furthermore, one or several features can be assumed to represent a particular dimension of the encoded information. In the present example, the features f1, f2, f3 represent one aspect of the encoded information. Let us assume that this specific aspect of JAM can be described as "traffic", for example (4). Furthermore, it is assumed that if these features are activated at the time of retrieval the representation of JAM can be reconstructed. Next, when retrieval of JAM is attempted, the word TRAFFIC is presented as a retrieval cue (5). Since JAM was encoded in a way that "traffic" constituted one of its aspects, the word TRAFFIC should serve as an effective retrieval cue. However, the effectiveness of that cue depends on how the meaning of TRAFFIC is represented. If the rememberer's cognitive environment is in a similar state at retrieval as it was at the time of encoding, i.e. "crowd" (6a),
then the functional information representing TRAFFIC match the features that compose the representation of JAM (7). In that case, the previously encoded item can be reconstructed on the basis of the information provided by the retrieval cue. That is, the encoded retrieval cue is compatible with the encoded TBR-word (8) On the other hand, if the cue is represented in some other sense, i.e. a different cognitive environment, then the functional cue of TRAFFIC is not a compatible description of the encoded word, and retrieval does not lead to a successful reconstruction of that item (6b).

The general notion, that the more the environments in which an organism learns and is tested on a response are like, the better the performance will be, has repeatedly been "discovered" and relabeled over the years. In the conditioning literature, the notion is referred to as stimulus generalization: Organisms trained to respond in the presence of a particular stimulus tend to respond more strongly to other stimuli the more closely they match the original conditioned stimulus on various physical dimensions (e.g. Guttman & Kalish, 1956). Students of human memory have proposed a similar principle that governs the act of remembering. For example, McGeoch's law of context asserts "that the degree of retention, as measured by performance, is a function of the similarity between the original learning situation and the retention situation" (Hilgard & Bower, 1966, p.312). Furthermore, Hollingworth (1928) formulated a "principle of reinstatement of stimulating conditions", whereby the successful recall of an experience was thought to depend on, among other things, the completeness of reinstatement at recall of the context in which the event originally occured (Roediger & Adelson, 1980, p. 65).

One of the most influential variants of this old idea is the encoding specificity principle proposed by Tulving and his associates (Tulving & Osler, 1968; Tulving & Thompson, 1973). The principle 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" (Tulving & Thompson, 1973, p. 369).
Although the encoding specificity principle has much in common with previous ideas concerning the influence of context on the act of remembering, there is a shift in focus from some previous conceptions in that one cannot infer the properties of encoded information from the overt, observable properties of the TBR-information. Furthermore, the encoding specificity principle has been made more precise than its predecessors were. For one thing, the application of some basic assumptions of Estes' (1959) stimulus-sampling theory have made this possible. The functional information is regarded as a collection of features which are sampled from the nominal information, and, similarly, the internal representation of the retrieval information is assumed to be represented as a set of features. According to the encoding specificity principle (Flexser and Tulving, 1978), successful retrieval is assumed to occur when there is a sufficient match of features representing the encoded TBR-information and those representing the encoded retrieval information.

In line with the encoding specificity principle compatibility between retrieval cues and TBR-information was, in the present context, assumed to serve as one necessary characteristic of cue effectiveness. Considering the focus of the thesis, this notion was, however, not conceived of as a sufficient one. Even though, the encoding specificity principle provides a consistent description of the concept of cue effectiveness, the principle is quite general in the sense that cue effectiveness is defined on the basis of overlap or match between encoded retrieval information and memory trace, and not on the basis of qualitative and quantitative properties of the features per se. That is, in addition to the compatibility notion, the degree of memory performance would be expected to depend on what dimensions of the encoded information a specific retrieval cue represents.

To clarify this notion, suppose a hypothetical situation where the memory trace consists of features f₁, f₂, f₃, ... fₙ, and we have three retrieval cues, C₁, C₂ and C₃. The first cue, C₁, consists of features f₁, f₂; and the second, C₂, of features f₁, f₂, f₃, and finally, C₃ of features f₁, f₂, f₅, for example. According to the encoding specificity principle, all three cues should be effective since they represent a
compatible description of the encoded information. There are, however, differences between them. First, C1 represents a less distinctive description of the memory trace than C2 and C3, because the amount of retrieval information (defined in terms of features) is lower. In this hypothetical situation, it is quite reasonable to assume that, even if C1 is appropriate in the sense of the encoding specificity principle, C2 and C3 should be more effective than the C1 because they provide, in a quantitative sense, a more distinctive description of the encoded information.

Second, it can be assumed the effectiveness of a specific cue is also determined by the qualitative properties of the features composing a cue. That is, even if C2 and C3 are equal in terms of the number of features composing a cue, it does not necessarily imply that they are equally distinctive descriptions of the information encoded. If, for example, the feature f3 represent a more salient description of the memory trace than f5, then C2 should serve as a more effective retrieval cue than C3.

Finally, the distinctiveness of a retrieval cue can be assumed to be determined by the relations between the features composing the cue. That is, it should be easier to reconstruct the word APPLE when, for example, the features "fruit", "forbidden", "Eve" are provided than when the features "computer", "delicious" and "Tell" constitute the functional retrieval information because the features of the first example are more systematically related to each other than those of the second example.

Thus, in addition to the notion of compatibility between retrieval cues and encoded information, distinctiveness of retrieval cues is regarded as another basic characteristic of cue effectiveness. This view is based on the cue-overload theory proposed by Watkins (1975). That is, the effectiveness of a retrieval cue depends on the number of target items subsumed by a given retrieval cue, and an optimal cue should be the one that represents a unique description of the encoded information.

The two characteristics of cue effectiveness, compatibility and distinctiveness, are assumed to serve as two fundamental prerequisites for excellent memory performance. That is, if both compatible and
distinctive retrieval cues are constructed and later presented at test, good memory performance would be expected.

Self-generation as a paradigm for optimizing cue effectiveness

Following the line of reasoning outlined above, the main practical problem in trying to obtain good memory performance, is, thus, the question of how to optimize cue effectiveness. In traditional memory experiments subjects are instructed and required to process information according to certain rules and restrictions defined by the experimenter. Even though these restrictions are, in most cases, well-motivated from a theoretical as well as from a methodological point of view, the traditional memory paradigm was here regarded as a less appropriate method for optimizing cue effectiveness.

In spite of the fact that the level of memory performance can be increased by presenting, for example, category names as cues (Tulving & Pearlstone, 1966), there are also conditions in which the retrieval cues presented by the experimenter are no more effective than are the free-recall instructions (Barhard, 1967). Furthermore, retrieval cues can have an inhibiting effect on memory performance (Slamecka, 1969), and there are even conditions where the "ultimate retrieval cue" (Darley & Murdock, 1971), the "old" test item in the recognition situation, is less likely to effect recall than is a cue which merely reinstates the study context of the item (Tulving & Thompson, 1973).

As suggested in the previous section of the thesis, the effectiveness of retrieval cues should be defined on the basis of the functional TBR-information. Since this information was conceptualized as a combination of the nominal information encountered and the individual's prior knowledge, it is, if not impossible, at least quite difficult to determine a priori the effectiveness of a particular retrieval cue. Provided that a TBR-item is encoded according to a given cognitive environment, the experimenter cannot decide what kind of retrieval cue is the most effective one. The only person who knows which aspects of the information encountered he or she attends to is the rememberer.
Consequently, in order to obtain effective retrieval cues, the subject should be instructed to generate his or her own descriptions of the information encoded rather than to be provided cues defined by the experimenter.

To examine this notion empirically an experimental paradigm was introduced in the first study of the thesis (Mäntylä & Nilsson, 1983). Figure 2 represents a schematic representation of the paradigm.

The main characteristic of the paradigm is that subjects are instructed to generate features or properties of each TBR-item encountered, and at the subsequent recall test these self-generated properties are presented as retrieval cues. In other words, instead of providing experimenter-defined retrieval cues, subjects are provided with cues, which according to the individual's own conceptualization constitute an appropriate description of the previously encoded information.
Summary of the empirical studies

The four studies composing the empirical section of the thesis were designed with the purpose of examining the concept of cue effectiveness in relation to good memory performance. The primary aim of the first study was to establish the general paradigm. The second study aimed to demonstrate that good memory performance can be obtained even under conditions where the level of recall is based on extremely large amounts of learning materials. Study 3 focused on the effectiveness of self-generated retrieval cues in relation to delayed recall, and demonstrated that the level of delayed recall can be manipulated as a function of the specific task demands of generation. In Study 4, the relation between cue effectiveness and the effect of generation per se, was examined. Moreover, the purpose of the fourth study was to examine whether the paradigm could be generalized to more complex materials as well.

Before a summary of the empirical studies is presented, the use of certain central terms should be clarified. With the exception of Study 1, property is used as a general term referring to the product of self-generation. A property is a single word that subjects provide as a description of the item presented. Moreover, a retrieval cue can be composed of one or more properties. In Study 1 the term aspect is used instead of property. In principle, both these terms can be regarded as synonyms. Thus, in the present context, aspect and property should be regarded as general terms rather than specific theoretical constructs (see Nilsson, Mäntylä & Sandberg, 1985).

Study 1: Are my cues better than your cues?

The primary aim of the three experiments composing Study 1, was to demonstrate that excellent memory performance could be obtained by providing self-generated properties of the TBR-items as retrieval cues when recall was attempted. The orientation of the first study was explorative with the idea being that once established and fully described the phenomenon can serve as a point of departure for a more detailed analysis.
In Experiment 1 subjects were presented with 30 common nouns and were instructed to generate three properties/aspects that according to subjects' own conceptualization constituted an appropriate description of each word encountered. The TBR-items were presented on a TV screen by means of a video recorder, and the rate of presentation was 20 sec per word. Subjects were instructed to write down their descriptions in a booklet with three properties on each page. At test, these properties were presented again with different order between pages in the booklet than at the generation phase. Half of the subjects were presented with their properties 15 min after the generation phase and the second half of subjects was given the test two hours after study. At this unexpected recall test, the subjects were presented with their own sets of descriptions in a random order and were instructed to recall the TBR-words by using the self-generated properties as retrieval cues. The performance level of both groups was remarkably high; on the average, more than 96% of a 30-word list was correctly recalled. Considering the fact that incidental rather than intentional learning instructions were employed and that recall performance was based on a single learning trial, these findings indicate that the paradigm provided a promising and adequate method for optimizing cue effectiveness.

The purpose of Experiment 2 and 3 was to rule out certain alternative explanations of the phenomenon, and to provide a baseline performance level against which the efficiency of self-generated retrieval cues could be compared. Moreover, in contrast to Experiment 1, relatively infrequent nouns were used as TBR-item in Experiment 2 and 3.

The first comparison considered the efficiency of self-generated cues in relation to experimenter provided retrieval cues. As suggested previously, self-generated retrieval cues were expected to be effective because they reflect each individual's idiosyncratic representation of the TBR-item encountered. According to this notion, significantly lower recall performance should be obtained when subjects were presented with properties generated by someone else.

To provide empirical support for this notion, subjects were instructed to generate three properties of each item encountered. At test, subjects were, however, not presented with those properties, but rather with sets of general properties generated by someone else. Three different methods
were used for defining the general properties: In Experiment 2, these properties were randomly selected from a pool of properties generated by another group of subjects. In Experiment 3, one group of subjects was presented with sets of properties generated by someone else; and in another condition, subjects were presented with sets of three properties that according to a total of 50 independent subjects constituted the most frequent descriptions of each TBR-item. Thus, the three conditions were basically identical with the exception of that different methods being employed to define general properties.

The results revealed that self-generated properties produced significantly higher levels of recall than did general properties. The mean recall performance was less 60% when randomly selected and subject-specific properties were presented as retrieval cues, and about 83% when the most frequent properties were provided as cues. A more detailed analysis of this latter condition revealed that the overlap between the most frequent and self-generated properties was more than 80%. Thus, these experimenter-provided retrieval cues constituted relatively compatible description of subjects' own descriptions of the TBR-words.

The second comparison examined the relative effect of the properties per se. It could be be argued that the properties given at test were such a powerful description of the target item that good recall would be obtained even without a preceding study phase. In order to evaluate the general cuing power of the properties per se, three groups of subjects were not presented with the TBR-items at all; instead they were provided with sets of three properties, and were instructed to produce the corresponding target items. In the first no-study condition (Experiment 2) subjects were presented with randomly selected general properties, and the two other groups of subjects (Experiment 3) with sets of general properties generated by a specific subject, and with sets of the most frequent properties, respectively.

The mere presentation of properties resulted in very low performance scores in all three no-study conditions. The performance of the subjects who were presented with sets of three most frequent properties was about 15%, and when randomly selected or subject-specific properties were presented without any preceding study trial, approximately 10% of the 30 target items were correctly identified. On the basis of these findings,
it was concluded that the high degree of recall obtained by means of self-generated retrieval cue, results from retention and cannot be explained in terms of the general cuing power of the properties per se.

In contrast to the two previous comparisons, the third control measure was focussed on the encoding phase of the paradigm. The main objective of that comparison was to demonstrate that good recall is obtained mainly due to the effectiveness of self-generated retrieval cues rather than due to the process of generation per se.

To obtain an estimate of the relative effect of the encoding operations involved in self-generation, recall performance for two conditions was compared. One group of subjects was instructed to recall the TBR-items presented during the generation phase without providing any properties as retrieval cues. These subjects generated properties to each item, but were given a free-recall test when retrieval was attempted. Another group of subjects was given not instructed to generate properties at study and there were no properties presented at test. In this standard free-recall condition the subjects were instructed to learn the presented TBR-items in such a way that they would be able to recall as many words as possible, i.e., intentional learning instructions. It was reasoned that if the self-generation per se was a central factor underlying the phenomenon, recall performance for the first group should be superior to that of the second group.

The results indicated that the high levels of recall demonstrated in Experiment 1, cannot be explained in terms of the process of generation per se. Although the demands at encoding differed considerably, the mean recall performances did not. Furthermore, recall levels for both conditions were approximately 60% lower than those of the conditions in which self-generated properties were provided as retrieval cues.

**Study 2: Optimizing cue effectiveness: Recall of 500 and 600 incidentally learned words**

The purpose of the second study was twofold. The first objective was to demonstrate that the extent to which effective retrieval cues are provided at test, good recall of very large amounts of verbal materials would be obtained. Secondly, cue effectiveness was manipulated by varying amount of retrieval information, type of cues and retention interval.
In Experiment 1, subjects were presented with 504 randomly selected words, and were instructed to generate one or three properties to each item presented, i.e., number of properties was manipulated within-subjects. The effectiveness of retrieval cues was expected to increase as a function of the number of properties provided. A set of three properties was assumed to provide a more distinctive description of the information encoded than a single property.

Retention interval was manipulated within-subjects by giving tests immediately, after 1 day, after 2 days, and after 7 days. The effectiveness of self-generated retrieval cues was expected to decrease as a function of increasing retention interval because of a loss in compatibility between the retrieval cue provided at a delayed test and the information encoded. Although self-generated cues can be assumed to provide an appropriate description of the individual's conceptualization of the TBR-information at an immediate test, these cues are not compatible after longer retention intervals. It was reasoned that the cause for this decline in compatibility is that subtle contextual changes occur as the retention interval increases. A previously potent cue is less effective at a delayed test because the meaning of that cue at this later test is different from the meaning of the cue generated at study, i.e., the functional cue does not constitute a compatible description of the information encoded. The manipulation of retention interval was also considered in part a control for the possibility that the recall performance could be explained in terms of the general cuing power of the properties generated at study. Namely, if these properties were such good descriptions that they would enable the construction of the correct word at test without any preceding study, then the recall level should not decrease as a function of increasing retention interval. On the basis of this reasoning, it was predicted that the best recall would be obtained when three self-generated properties are presented as retrieval cues immediately after the study phase.

In line with the predictions, approximately 90% of the TBR-items were correctly recalled when three self-generated properties were presented as retrieval cues immediately after the generation phase. The data also indicated that the level of recall performance is directly related to the amount of retrieval information provided. Three properties produced almost 40% higher recall level than one property did. Furthermore, the results revealed that the level of recall decreased as a function of
increasing retention interval. When the subjects were presented with self-generated properties one week after the study phase, the level of recall was about 30% lower than initially indicating that the high recall level cannot be explained as due to confabulation.

The purpose of Experiment 2 was to provide a baseline performance against which the obtained recall levels could be evaluated, and to replicate the findings of Experiment 1. In addition to the manipulation of retention interval and the amount of retrieval information, two more conditions were included in the design of this experiment. In one condition, subjects were presented with 504 words with the instruction to generate their own properties, and then at an unexpected test, subjects were presented with their own or another person's properties as retrieval cues. In line with the findings of Study 1, self-generated cues were expected to produce significantly higher levels of recall than properties generated by someone else. In another condition, subjects were presented with properties generated by other subjects, and were instructed to construct the target items without any preceding study. The purpose of this no-study condition was to demonstrate that the high degrees of recall cannot be explained in terms of the general cuing power of the properties per se.

The data of Experiment 2 demonstrated that self-generated retrieval cues, presented immediately after the study phase, produced very good recall performance. It was also shown that self-generated retrieval cues produced significantly higher recall than those generated by someone else. Moreover, the results indicated that the good recall performance obtained here and in the previous experiments cannot be explained in terms of general cuing power of the properties per se.

Since amount of retrieval information, type of cues and retention interval were manipulated within-subjects in Experiment 1 and 2, the recall scores were, actually, not based on the total number of TBR-items, but on randomly selected subsets. Thus, it could be argued that the high levels of recall obtained in Experiment 1 and 2 do not necessarily justify the conclusion that good recall of large sets of words was demonstrated. The purpose of Experiment 3 was to rule out this argument.

Two groups of subjects were presented with 600 words in a single study session. One group of subjects generated three properties and another
group generated one property to each presented TBR-item. In contrast to Experiments 1 and 2, 600 words were presented in a single study session, and at the unexpected recall test immediately following the generation phase, the subjects were instructed to recall all the items presented at study. Recall performance was, thus, based on the total number of TBR-items, and not on small subsets as in the two previous experiments.

The results of Experiment 3 demonstrated again that self-generated cues serve as extremely powerful retrieval aids. Even though the experiment was very demanding in the sense that it took almost seven hours, and the subjects were required to recall all the 600 words, more than 90% of these items were correctly recalled when sets of three properties were provided as retrieval cues.

Study 3: Effectiveness of self-generated retrieval cues in delayed recall

The results obtained in Study 2 indicated that self-generated properties serve as very effective retrieval cues in immediate recall but not in delayed tests. The purpose of Study 3 was to examine in more detail the effectiveness of self-generated retrieval cues in relation to delayed recall.

In Experiment 1, the interval between the generation phase and the subsequent recall test was manipulated. Whereas the retention interval in Study 2 varied up to one week, tests here were given immediately after the generation phase, 3, 6, and 12 weeks thereafter. The results of Experiment 1 replicated the findings of Study 2 in the sense that the level of recall decreased as function of an increasing retention interval. High degrees of recall were obtained in the immediate recall test, whereas a recall performance of less than 40% was obtained when self-generated properties were presented six or twelve weeks after the generation phase.

The decrease in recall performance was assumed to occur because the meaning of a retrieval cue was represented differently in the delayed and the immediate tests: First, the meaning of a cue was assumed to be determined by the context whereby the cue was encountered initially. Secondly, the external/internal context was supposedly different at the delayed test as compared to the immediate test. Thus, the assumption was
that the meaning of the same nominal cue also varied.

The purpose of Experiment 2 was to demonstrate that the descriptions of the same nominal item vary as a function of context, and that the variability of the descriptions generated by the subjects can be reduced by manipulating the explicit demands of the generation task. The degree of overlap between the properties generated at two separate sessions was expected to increase if subjects were instructed to focus their generation on certain distinctive properties of the words presented. One group of subjects was given instructions about such a goal-directed generation, and as a control another group of subjects was given instructions to generate properties in the same way as the subjects in Experiment 1 did, i.e., a non-directed generation. The interval between the two consecutive generation sessions was three weeks.

The results indicated that the overlap between properties generated at two sessions was relatively low when no explicit instructions of how to generate properties were provided. The degree of intrasubject overlap increased significantly when subjects were instructed to focus their generation on distinctive properties of the items presented. The data also revealed that the properties produced in the goal-directed condition were more idiosyncratic than those generated in the non-directed condition. That is, even if the degree of intrasubject overlap increased in the former condition, the corresponding intersubject overlap decreased as a function of the explicit task demands of generation.

The main objective of Experiment 3, was to demonstrate that high levels of delayed recall could be obtained under conditions in which the task demands emphasize a goal-directed rather than a spontaneous, non-directed generation. Type of instructions and retention interval constituted the main independent variables of Experiment 3. It was predicted that good immediate recall would be obtained independently of the explicit instructions provided, whereas high levels of delayed recall were expected only in the goal-directed condition.

In line with the predictions, the results revealed an interaction between type of instructions and retention interval. No differences in memory performance were obtained at the immediate test, whereas the difference between the conditions was more than 40% at the delayed test.
Study 4: Learning by doing or learning by cuing? Self-generation vs. cue effectiveness as a prerequisite for perfect recall

The first three studies of the thesis have demonstrated that excellent memory performance can be obtained by instructing subjects to define their own retrieval cues. An essential feature of the paradigm used in these studies is that subjects are actively engaged in the task of property generation. Accordingly, one might argue that the primary reason for the effectiveness of the paradigm is this active engagement on the part of the subjects, and secondarily, because of the characteristics of the retrieval cues provided by self-generation.

The experiment reported in Study 4 was designed to deal with this issue. More specifically, the study addressed the question of whether good recall was obtained because of extremely effective retrieval cues provided by self-generation, or because generation per se was a crucial factor underlying the phenomenon. An additional purpose of the study was to demonstrate that the paradigm can be generalized to conditions where sentences rather than single words constitute the TBR-items.

To examine the effect of generation, encoding and retrieval conditions were manipulated orthogonally. During encoding, one group of subjects generated properties to each sentence presented, and another group of subjects were presented with properties together with each TBR-item presented. Instead of generating own properties, subjects in the latter group were instructed to carry out other forms of semantic encoding operations; the subjects were instructed to rate the appropriateness of each property as a description of the corresponding target item. Retrieval was manipulated by presenting subjects either with the same or different properties at test as those generated/presented at study. The first half of the subjects in both encoding conditions were presented with compatible retrieval cues at test, and the other half of subjects with non-compatible cues at test. Moreover, the effects of the manipulations employed were evaluated through of immediate as well as delayed tests.

The relative importance of generation and cue effectiveness was evaluated on the basis of these four conditions. The results of Study 4 demonstrated that the effectiveness of self-generated retrieval cues was not limited to single, unrelated words as TBR-items. Instead, the data
indicated that good recall of incidentally learned sentences can be obtained by providing subjects with self-generated retrieval cues at test. Moreover, the results indicated that self-generation does affect the level of recall performance. On the average, the two generation conditions produced about 25% higher recall performance than the two non-generation conditions. The data also revealed that the level of recall was dependent on the quality of the retrieval information provided. In conditions in which generation was the encoding operation, the level of immediate recall was about 78% when compatible retrieval cues were presented at test, but less than 30% when non-compatible cues were provided at test. These findings indicate, thus, that although generation facilitates recall performance, also the prevailing retrieval conditions should be taken into consideration when evaluating the effect of self-generation. In other words, it is not feasible to argue that the high levels of recall were obtained merely because of the process of generation. Instead, the findings of Study 4 are in accordance with the notion that the effect of a particular type of encoding activity is relative to the characteristics of the subsequent recall test (e.g. Fisher & Craik, 1977; Morris, Franks & Bransford, 1977; Stein, 1977).

Conclusions

The main contributions of the present thesis are of three kinds. First and foremost, it has been demonstrated empirically that very high levels of recall performance can be obtained if effective retrieval cues are constructed. Secondly, it has been demonstrated that compatibility and distinctiveness may be the cardinal theoretical constructs underlying the empirical phenomenon per se and the essence of the notion of cue effectiveness. Thirdly, it is proposed that the methodological contribution is of such a nature that it may apply successfully to more practical situations.

With respect to the empirical findings observed, some general prerequisites should be acknowledged. These high degrees of memory performance were obtained without trying to benefit unduly from such conditions which are traditionally known to foster high memory performance. Rather, the ambition was to refrain from profiting on such beneficial procedures. Thus, incidental rather than intentional learning instructions were used, keeping in mind that the latter are usually more profitable if one seeks to accomplish high memory scores. Second, the
high scores were obtained for a recall rather than recognition procedure. With the exception of the paradigm producing recognition failure of recallable words (see e.g., Tulving, 1983; Tulving & Thompson, 1973) recognition is generally known to result in higher performance than recall. Third, the recall performance was based on one learning trial. It is a well established fact that memory performance usually increases as a function of increasing practice over consecutive trials. Fourth, extremely large amounts of TBR-materials were used. The findings of Study 2 are unique in the sense that corresponding studies reporting near perfect recall of large sets of words are practically nonexistent. Fifth, as demonstrated by the retention-interval manipulations and the control conditions employed, the phenomenon is of an episodic-memory nature (Tulving, 1972). Had it been solely a semantic memory phenomenon high performance would have been obtained after long retention intervals and the performance would have been high even without any preceding learning trial. Finally, the phenomenon demonstrated is not restricted to a limited and carefully selected set of TBR-items. The phenomenon applies over a wide range of unrelated words -- both common and rare words -- and it holds for sentences as well. Future research will have to determine if there are any boundary conditions of the phenomenon with respect to the type-of-materials variable. The generality of the phenomenon is reasonably solid to the extent that it has been independently demonstrated in no less than 10 different conditions.

With respect to theory it should be realized, first, that retrieval factors have played a relatively limited role in past and present thinking of memory functions. Primary consideration has been given to encoding at the cost of retrieval factors. A vivid example of this is the enormous impact the levels-of-processing approach (Craik & Lockhart, 1972) has had on memory research during the last decade or so. And before that, acquisition factors were at the forefront when memory research was inspired by the conceptualizations of learning and memory prevalent in textbooks like those of McGeoch (1942) and McGeoch & Irion (1952). The focus on short-term memory during the 1960's also meant an emphasis on encoding rather than retrieval factors.

These trends in relatively recent memory research were of course strongly inspired by the Ebbinghaus (1885) tradition. However, more retrieval-oriented conceptualizations of memory have certainly also existed during the, by now, one hundred year history of memory research. In passing,
the relatively unknown views on memory by Semon (1904, 1909) should be mentioned. Semon’s insight of the important role played by retrieval processes in remembering was not brought to the attention of the contemporary students of memory until very recently (Schacter, 1982; Sachter, Eich & Tulving, 1978).

The reconstructive role of retrieval processes was emphasized by Bartlett (1932) some 50 years ago. From time to time Bartlett’s view of memory has been brought back into the light of modern thinking of memory, but its impact has nevertheless not reached the levels it would seem to deserve. Concurrent with the less dominating role Bartlett’s thinking has, after all, had on memory research during the period of 1950 - 1970, retrieval processes have also remained relatively obsolete at the cost of encoding and acquisition processes.

It is in such a context that the role of retrieval processes and the role of retrieval cues have been emphasized here. However, at a general level it should be observed that the present view does not part company with the mainstream of current thinking of memory and remembering in the sense that it certainly encompasses the importance of the interaction between encoding and retrieval factors (cf., Baddeley, 1982; Bransford, 1979; Craik, 1983; Fisher & Craik, 1977; Nilsson, 1979, 1984; Tulving, 1983). Actually, the data presented here do indeed emphasize the joint roles of encoding and retrieval factors. It would not have been possible to demonstrate the viability of the notion of cue effectiveness if distinctive and compatible retrieval cues had not been formed the way they were at the time of encoding. Thus, in effect the two theoretical constructs proposed as underlying the notion of cue effectiveness also serve the purpose of bridging the gap between encoding and retrieval processes in remembering.

Finally, a few words should be mentioned with respect to the practical applicability of the specific paradigm presented and the conceptual framework proposed. Supposedly, it is reasonable to entertain the idea of how to make use of this paradigm in improving memory performance in practical and clinical situations. The present thesis has not dealt with these question at all, but it would seem to be a great advantage, if the paradigm could be extended to applied conditions as well. Since self-generated retrieval cues serve as extremely powerful retrieval aids, it is quite reasonable to expect even persons with impaired memory
functions to be able to improve their memory performance by using the self-generation paradigm. Actually, Bäckman, Mäntylä & Erngrund (1984; see also Bäckman & Mäntylä, 1986) employed the paradigm in order to examine whether older adults are capable of performing at the same high level as younger adults. Although the results of the Bäckman et. al. (1984) study indicated a superior recall performance of the younger adults as compared to older adults, the latter group of subjects demonstrated high levels of recall as well.

Furthermore, the paradigm has also been used in a clinical context. Karlsson (1985) examined the memory functions of a severely amnesic patient by employing standard free- and cued-recall procedures as well as the self-generation paradigm. According to Karlsson (1985), the patient attained extremely low levels of recall in traditional free and cued recall tests. However, when the patient was allowed to define her own retrieval cues (i.e., self-generation), and when these cues were provided at test, then relatively high degrees of recall were obtained.

Although the findings of Karlsson (1985) as well as those of Bäckman et. al (1984, 1986) indicate that the self-generation paradigm provides a sensitive and useful procedure for clinical purposes, the practical applicability of the paradigm remains to be seen before any unnecessary hopes are induced. The powerful phenomenon demonstrated here would seem to encourage such experimentation as a first step towards more applied enterprises.
References


