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Rice University

Context-Free Inhibition and the Episodic-Semantic Memory Distinction

by

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree

Doctor of Philosophy

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For CANIM

the one who has the blue bead
Abstract

Memory inhibition has been the subject of much thought and, in this century, much research. Laboratory findings of inhibition to date, however, have virtually all involved creating an incongruity between the study and test contexts, the conditions under which a memory is formed and those under which it is evinced. Studies reported here demonstrate what can be construed as a qualitatively different type of memory inhibition, one that is in some sense context-free.

When a just-studied word is tested for recall with word-fragment cues of successively increasing strength (e.g., R-----P; R----R-P; R-I--R-P; R-I--ROP), each presented for 4 seconds, performance is impaired compared to when only the strongest fragment cue (R-I--ROP) is presented for 4 seconds, even though in the first case there is additional opportunity for subjects to recall the word (RAINDROP). Indeed, level of performance varies systematically with initial cue strength. Thus, for example, if cuing starts with a 3-letter fragment, the word is recalled less often than if it starts with a 4-letter fragment but more often than if it starts with a 2-letter fragment. Moreover, the effect remains essentially undiminished even if subjects are allowed an additional full minute with the critical cue (R-I--ROP). Since the procedure used here involves manipulating only the graphemic aspects of a given word and not the context in which it was learned, the inhibition is context-free. The inhibition is discussed in light of a theoretical distinction
(Mandler, 1980) between elaboration and integration processes in list learning.

Another finding of interest is that no such inhibitory effect occurs when the to-be-discovered words are not studied before the test. When subjects try to complete the word fragments on the basis of their general knowledge of words, or "semantic memory," performance between the successive and single-level cuing conditions does not differ. The overall pattern of results therefore provides strong support for the episodic-semantic memory distinction formulated by Tulving (1972).
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Contents

Abstract----------------------------------------------- 1
Acknowledgements-------------------------------------- iii
List of Tables---------------------------------------- vi
List of Tables in the Appendix------------------------ vii
List of Figures---------------------------------------- viii
Chapter 1  Inhibition in Episodic Memory--------------- 1
  1.1 Introduction-------------------------------------- 2
  1.2 Context Effects----------------------------------- 5
  1.3 Classical Retroaction and Proaction Studies------- 9
  1.4 Part-Set Cuing Effect------------------------------- 17
  1.5 Effect of Recall on Subsequent Recognition-------- 22
  1.6 Effect of More Recalling Items on Less
      Recalling Items-------------------------------------- 24
  1.7 Effect of Suggestion and Implanting Inconsistent
      Information at Test------------------------------- 25
  1.8 Conclusion---------------------------------------- 28
Chapter 2  Demonstrating Context-Free Inhibition in
      Episodic Memory: Experiment 1---------------------- 30
      2.1 The Elaboration-Integration Distinction---------- 31
      2.2 Context-Free Inhibition in Episodic Memory------ 34
      2.3 Experiment 1------------------------------------ 39
Chapter 3  The Episodic-Semantic Memory Distinction and
      Inhibition in Semantic Memory---------------------- 44
## Chapter 3

3.1 Introduction

3.2 The Episodic-Semantic Memory Distinction

3.3 Evidence for Inhibition in Semantic Memory

3.4 Conclusion

## Chapter 4

Context-Free Inhibition Only in Episodic Memory: Experiments 2, 3, and 4

4.1 Introduction

4.2 Experiment 2

4.3 Experiment 3

4.4 Experiment 4

4.5 Summary and Conclusion

## Chapter 5

The Temporal Course of Inhibition:

Experiment 5

5.1 Introduction

5.2 The Present Paradigm

5.3 Experiment 5

5.4 Conclusion

## Chapter 6

Summary, Conclusions, and Speculations

Reference Notes

References

Appendix
List of Tables

Table 1  Cumulative number of items recalled at each cue level in the episodic condition as a function of starting level in Experiment 3------------------- 78

Table 2  Cumulative number of items recalled at each cue level in the semantic condition as a function of starting level in Experiment 3------------------- 79
List of Tables in the Appendix

Table A1  Words used in the experiments------------------- 125

Table A2  Mean cumulative recall probability at each cue
level in the successive cuing condition
(Experiment 1)----------------------------- 126

Table A3  Mean cumulative recall probability at each cue
level in the successive cuing condition
(Experiment 2)----------------------------- 127

Table A4  Mean cumulative recall probability at each cue
level in the successive cuing condition
(Experiment 4)----------------------------- 128

Table A5  The moment weights assigned to the differences
of scores recalled cumulatively at each level of
cuing as a function of starting level
(Experiment 3)----------------------------- 129
List of Figures

Figure 1 The time course of inhibition in episodic memory. Experiment 5---------------------- 96
Chapter 1

Inhibition in Episodic Memory
1.1 Introduction

Being unable to remember what one had for dinner the previous night, being unable to produce the words of a newly learned song because all that comes to mind are those of another song with a similar melody, or suddenly being unable to think of the name of the great Brazilian soccer player, are just a few everyday examples of memory inhibition. Such inhibition of previously learned material, or mental or memory "blocking" to use layman's jargon, has been the focus of an experimental enterprise that extends back to the earliest days of memory research.

Not surprisingly, even before the advent of the experimental study of memory, usually traced to the publishing of Ebbinghaus's Monograph in 1885, considerable attention had been devoted to this topic. Plato, for instance, distinguished between having and possessing memory. In Theaetetus, he likened the distinction to that between having an aviary at home and a bird actually in one's hand—a distinction, incidentally, that has come to be known in modern psychology as one between availability and accessibility of memories (Tulving & Pearlstone, 1966)—and in Philebus he called these two types of memories the faculty for retention and the faculty for recollection, respectively. He also noted that it was the faculty for recollection that was prone to error and, more relevant to present purposes, to blocking or inhibition.

This distinction has subsequently been elaborated by Aristotle, in his De Memoria et Reminiscentia. Memoria (or faculty for reten-
tion) was conceptualized as a "state," and as being derived from the impressions or implantations of actual perceptions; reminiscentia (or faculty for recollection), on the other hand, was conceptualized as an associative process, based on similarity, order, and contiguity. The latter type of memory was subject to error because of interference from "movements," or previous habits that ran counter to what one was trying to remember—an obvious parallel to not being able to remember the words of a newly learned song because of a countering previous habit, the recollection of words of an old song with a similar melody.

Herbart, a 19th century philosopher and educator, was also interested in the idea of mental blocking or inhibition. He put forth the idea that a concept could be raised into consciousness (i.e., be recollected) with the help of another concept, but it could also be depressed below the recollection threshold, or consciousness, and be prevented from emerging (i.e., be inhibited) because of a stronger and opposing concept (Herbart, 1824, 1825/1886, 1888).

In clinical psychology, Freud developed the notion of "repressed memories." He hypothesized that one way of coping with consequences of traumatic events was to repress the memories for those events. Such memories did not cease to exist but were simply blocked. If a person was experiencing a psychological disorder, "unblocking" of these memories usually revealed the traumatic event that was the source and root of the disorder (e.g., Freud, 1886-1899/1966). Although Freud's theory is not testable through experi-
mentation, numerous case studies interpreted as being consistent with his way of thinking has given credence to his methods of therapy. Indeed, the idea of subconscious repression of unwanted memories is still quite popular today. It is commonly believed that memories can be repressed without being lost, and there is ample interest in psychoanalysis and hypnosis as ways of disinhibiting such memories.

Given the general interest in memory inhibition, it is not at all surprising that in experimental psychology the topic was among the first to be studied. In the last 80 years or so, much effort has been directed to simulating such inhibition in the laboratory. The purpose of the present study is to describe one more laboratory example of memory inhibition, one that has not been shown before. To better understand the theoretical significance of this particular effect, however, it is necessary to first briefly sketch the other major demonstrations of inhibition. In the subsequent sections of this chapter, a few of the more influential studies on inhibition will be reviewed. It should perhaps be mentioned that in reviewing such studies the main emphasis will be on the actual experiments and the findings from these experiments rather than the various theoretical explanations that have been proposed. Thus, although an occasional theory or interpretation of a set of findings will be discussed, the focus will be on the different conditions under which memory inhibition has been demonstrated.
An important point to note in the following sections, and indeed throughout this study, is the way the word "inhibition" is used. The term is restricted to the concept of "memory blocking," rather than to a broader meaning encompassing the idea of cognitive impairment in general. For instance, psychologists acknowledge that a subsidiary task performed simultaneously with the learning of a set of items has an inhibitory effect on the later remembering of these items. Such an inhibitory effect is not relevant to present purposes. What is considered in this study is the blocking of memories through some manipulation that is independent of the actual learning of the to-be-tested material. Also, manipulations that reduce memory performance by affecting variables not directly related to memory per se, such as giving subjects a distractor task (e.g., an arithmetic task) during test so as to decrease the available time for recall, is also not relevant to present purposes. Thus, in this study, rather than referring to any induced impairment of memory performance, inhibition refers only to the actual blocking of memories.

1.2 Context Effects

Perhaps underlying all experimental paradigms that have demonstrated memory inhibition to date is the manipulation of some form of context. Broadly speaking, then, context effects are the source of all inhibition relevant to present purposes. It would thus be valuable to look first at inhibition caused by context effects in a general sense of the term. This section focuses on studies that
have concentrated on manipulating context in a general and direct way. Subsequent sections focus on studies in which some form of a context effect is achieved only indirectly.

The basic idea behind most context effect studies is one of common sense, and can be summarized by a quote from Carr: "Any experience can be reinstated only in those environmental situations with which it is associated" (1925; p. 251). Recently, this basic idea has been expressed more formally as the "encoding specificity principle," which states that how a particular memory can be accessed depends on how it was originally learned (Tulving & Thomson, 1973). Thus, according to this principle, what controls the remembering of any event is how well the contextual cues present at the time of test match those present at the time of acquisition.

It is often believed that the suppressed memories of a witness to a crime can be unleashed by taking the witness back to the scene of the crime. Then there are cases like "the old story of the Irish porter who misplaced a package while drunk and was able to recall its location during a subsequent period of drunkenness" (Carr, 1925, p. 252). Another frequently encountered situation is the loss of a train of thought, which can be easily remedied by a few hints. When a speaker forgets what he or she was about to say, a listener may successfully remind the speaker of what was being said just prior to forgetting. In these examples, the memories are still potentially retrievable but the would-be recaller is blocking on them and needs some help in removing the source of inhibition. These examples
further imply that this can be achieved simply by recreating the context in which the memories were originally formed.

As it happens, context-effect studies are usually described from the perspective of reinstating the context as a means of enhancing memory and removing inhibition. It is not difficult, however, to view the same studies from the perspective of changing the context as a means of creating inhibition. Thus, in all studies where memory performance has been said to be enhanced by having the study context reinstated at the time of test, it can equally be said that memory performance has been impaired by having the appropriate context removed at test.

In early studies, context effects were obtained by manipulating physical surroundings. Indeed, the fluctuation of such contextual cues from the learning phase to the test phase was one of the factors McGeoch (1942) proposed to explain memory inhibition; there are always incidental cues in the learning environment, and the absence of these cues at test may impair memory performance. Abernathy (1940), for example, found that students performed more poorly on an examination when it was held in a room other than in their regular classroom, or when the proctor was not the regular instructor; and performance was poorest when both the room and the proctor were different. Abernathy's study and findings were typical of the research conducted on this particular type of context change (e.g., Dulsky, 1935; Greenspoon & Ranyard, 1957; Pan, 1926; S. Smith & Guthrie, 1921; Wong & W. Brown, 1923). In each case, recall performance was
impaired when the test context was changed so that it no longer matched the learning context.

Following such findings, interest shifted to state-dependent learning. The contextual cues manipulated in this research are induced internal cues. Thus, in essence, the state-dependent learning studies have brought Carr's (1925) example of the drunk Irish porter into the laboratory. The internal contexts are created by giving subjects alcohol or various drugs or by otherwise inducing different emotions and moods during the learning and test phases. Again, memory performance is found to vary with the degree of match between study and test contexts (e.g., Bower, Monteiro, & Gilligan, 1978; Eich, 1980; Goodwin, Powell, Bremer, Hoine, & Stern, 1969; Leight & Ellis, 1981; Macht, Spear, & Levis, 1977; Weingartner, H. Miller, & Murphy, 1977).

Another approach to exploring context effects has been to intentionally incorporate specifically defined contextual cues into a study list and then to either include or exclude them at test. Such research, in which explicit contextual cues are manipulated to create inhibition, has been mainly motivated by interest in the encoding specificity principle—the most recent, formal description of context effects. Findings from these studies have in turn been a major force in the development of more specific contemporary theories of memory. In such studies, it has been shown that even as simple a change in context as making the testing order different from the presentation order reduces memory performance (Jacoby, 1972). In a
slightly more sophisticated vein, after subjects are presented with, for instance, the word *piano* in a context that emphasizes its weight, their memory performance is worse when at test the cue for *piano* is *something with a nice sound* rather than *something heavy*; conversely, if subjects are presented with *piano* in a context that emphasizes its sound, the opposite is true (Barclay, Bransford, Franks, McCarrell, & Nitsch, 1974). In general, performance can be impaired quite predictably by decreasing the extent to which cues reinstate the context in which items were learned (e.g., R. C. Anderson & Ortony, 1975; Fisher & Craik, 1977; Tulving & Osler, 1968). In short, one way of demonstrating inhibition in memory is to change at test the context in which items were learned.

1.3 Classical Retroaction and Proaction Studies

As was mentioned earlier, the experimental study of memory is usually dated from the Ebbinghaus Monograph published in 1885. Soon after that, the first experiments on memory inhibition were conducted, initiating an era of intense interest in retroactive and proactive inhibition, an era that lasted for over 60 years. Indeed, it would be safe to say that, in the study of memory, no other topic has received as much attention as has the topic of retroactive and proactive inhibition. Certainly, no finding has enjoyed as many replications as have those generated by this research effort.

Not being able to remember the words of an old song because all one can think of are those of a newly learned similar song is an example of retroactive inhibition. What is learned subsequently
makes it harder to remember what was learned initially. The converse situation, not being able to remember the words of a newly learned song because all one can think of are the words of a similar old song, is an example of proactive inhibition. What was learned initially makes it harder to remember what is learned subsequently. Applying a strict "blocking" interpretation to the forgetting found in a proactive inhibition paradigm seems theoretically more questionable than applying such an interpretation to the forgetting found in a retroactive inhibition paradigm. Nevertheless, experiments in both paradigms do indeed demonstrate memory inhibition through a manipulation that is independent of the learning situation. Of these two ways of demonstrating inhibition, the first to be considered is retroactive inhibition.

In 1900 Müller and Pilzecker conducted an experiment in which two groups of subjects were given a list of nonsense syllables to study. Before the memory test, however, one group performed another task such as studying a different list of nonsense syllables while the other group simply rested. The recall performance of the former group was found to be far inferior to that of the latter group, and Müller and Pilzecker coined the term retroactive inhibition to describe this kind of a memory impairment. Addressing the same issue, J. G. Jenkins and Dallenbach (1924; see Ekstrand, 1967 for a better controlled study that replicated these results) gave subjects lists of nonsense syllables to study and then tested for recall after intervals of 1, 2, 4, or 8 hours which were filled either with
sleep or normal wakeful activities. Performance of subjects who remained awake after learning a to-be-recalled list was lower on the subsequent memory test than was that of subjects who went to sleep immediately following learning.

Müller and Pilzecker (1900) explained such inhibition as the result of inadequate consolidation of the learned items due to a premature cessation of appropriate neural activity. A more sophisticated version of this physiological explanation was later proposed by Hebb in 1949. The other major explanation that attempted to account for retroactive inhibition was the classical interference theory. In fact, the bulk of the retroaction studies were motivated by this particular theory.

As the classical interference theory gradually evolved, there became a need for a more analytic method of investigation, and a new paradigm, the paired-associate paradigm and more particularly the basic A-B, A-D version of this paradigm, emerged. In the A-B, A-D paradigm, two groups of subjects each learn two series of "paired associates." For both groups the first series comprises A (stimulus) terms paired with B (response) terms. The second series differs between the two groups. For the experimental group, the stimulus terms are as before (A) and the response terms are new (D); for the control group, both stimulus (C) and response (D) terms are new. After learning the second series, both groups are tested for recall of the original response terms (B) in the presence of their stimulus terms (A). The experimental group recalls the B terms at a lower
level than does the control group. As a real life counterpart of this situation a child in a geography lesson might first be told that Cambridge is associated with England and then that Hamburg is associated with Germany. This child would be more likely to recall that Cambridge is associated with England than would be a child who is first told that Cambridge is associated with England and then that Cambridge is also associated with Massachusetts. The second child would have a more difficult time remembering that Cambridge is associated with England because of the subsequent association of the same nominal stimulus (Cambridge) with another response (Massachusetts).

McGeoch (1932, 1942) suggested that retroactive inhibition was due to competition between the two response terms, and that in the A-B, A-D paradigm it occurred when the stronger unwanted memories (of the D terms) blocked those being tested. The amount of inhibition had been shown to vary as a function of the similarity between the task at hand and the interfering task (Robinson, 1927; Skaggs, 1925). Thus, it was harder to remember a response when the interfering response was of a similar nature—although when the two responses were sufficiently similar, the inhibition disappeared. Note that underlying McGeoch's account is the assumption that memories are permanent. He uses the word inhibition as a synonym for blocking. In fact, Martin (1971) observes that McGeoch's hypothesis was one of independence and dominance, in which the two stimulus-response pairs were acquired independently, with one
dominating and inhibiting the other at the time of recall. It was assumed, then, that the memory for the first series of stimulus-response pairs was no different from that for the second series of pairs; the former pairs were merely blocked.

Over the years, classical interference theory has undergone substantial modification. It is not necessary to trace the various stages of this theory nor even to review in any detail the experiments that shaped its evolution. It is, however, of interest to mention certain variations of the standard retroactive inhibition paradigms that emerged during the development of the theory.

In the standard paradigm, what was tested was memory for the B terms, and inhibition was observed for these terms in the A-B, A-D situation compared to that in the A-B, C-D situation. Melton and J. M. Irwin (1940) varied the amount of learning of the A-D list before giving the memory test for the A-B list. They found that the total retroactive inhibition increased with the amount of learning on the interfering A-D list, but that "intrusions" from the A-D list in the A-B test—which was the prime evidence for interference through competition—first increased but then decreased with the amount of learning on the A-D list. This led Melton and J. M. Irwin to conclude that not all the impairment on the B-term recall could be attributed to inhibition alone. Briggs (1954) asked his subjects to recall either of the two response terms (the "modified free recall," or MFR procedure) at various points during the learning of the A-D list. He found, consistent with the findings of Melton and
J. M. Irwin, that the total retroactive inhibition increased. The B terms were recalled less often as the amount of A-D list learning increased. A new twist to this procedure was added by Barnes and B. J. Underwood in 1959. In a "modified modified free recall" (MMFR) test they asked their subjects to recall both responses, and found again that the memory for B responses declined steadily as the A-D list learning increased. In 1968, L. Postman, K. Stark and Fraser designed yet another procedure, the MMMFR procedure. During the test phase in this procedure, the experimental subjects were given the A term and asked to remember the B term; but at the same time they were also reminded of the D terms. As L. Postman et al. expected, giving the interfering D terms further increased the retroactive inhibition of the B terms. As will shortly be seen, the logic behind this last procedure, reminding the subject of the potential interfering terms to increase inhibition, has been taken up on more than one occasion to investigate inhibition in memory under quite different theoretical settings.

Retroactive inhibition has indeed been demonstrated many times and with a variety of procedures, and the basic finding is now a standard one in memory research. Memory for events can be inhibited by a post-learning manipulation.

Interest now focuses on proactive inhibition. This is the converse of retroactive inhibition, and refers to not being able to remember an item of information because of blocking by other, previously learned items. The first report of such inhibition was
by Whitely in 1927, who noted that the recall of a list of items suffered if other activities or tasks preceded its acquisition. Then, in 1936, Whitely and Blankenship explicitly demonstrated proactive inhibition, and formally introduced the concept to the memory literature. Two groups of subjects were given a list of monosyllabic words to study. But prior to this target list, one group was given another list of items to study. The recall test, given after 48 hours, showed a significant detrimental effect of this prior learning.

The proactive inhibition research that followed largely paralleled that being conducted on retroactive inhibition. As with retroactive inhibition, the amount of proactive inhibition increased systematically with increasing number of prior lists learned (B. J. Underwood, 1945; Slamecka, 1961). Unlike retroaction findings, however, it was not quite clear whether the degree or amount of learning on prior lists increased the magnitude of inhibition on the target list (L. Postman & Riley, 1959). There were studies that found a definite effect of degree of learning (e.g., Atwater, 1953; B. J. Underwood, 1949) but also studies that did not (e.g., Dallett, 1964; B. J. Underwood & Ekstrand, 1966). Also, although the similarity of the interfering lists to the critical lists was of some importance, proactive inhibition built up quickly even if the lists were of the A-B, C-D, E-F type (e.g., Keppel, L. Postman & Zavortink, 1968; Warr, 1964).
Perhaps the best known demonstration of proactive inhibition comes from the Brown-Peterson paradigm (J. Brown, 1958; Peterson & Peterson, 1959). Subjects are given a to-be-recalled trigram (usually three letters such as CMW), and are then asked to count backwards from a specified number by threes or some other number for a certain time before recalling the trigram. What is observed is that, with increasing number of such trials, performance on as simple a task as remembering three letters steadily deteriorates (see Wickens, 1972, for a review). As an ironic aside, the Brown-Peterson studies were initially taken as evidence for memory decay--forgetting caused by only the passage of time. It was Keppel and B. J. Underwood (1962) who showed that the decline in memory performance did not occur for the first trigram of a testing session, but built up with the number of previous trials. The decline in performance was due mainly to having had previous trials with other items and hence to proactive inhibition.

Retroactive and proactive inhibition research dominated the experimental study of memory for such a long time that it still constitutes the most obvious source of evidence for inhibition in memory that is brought about independently of what happens in the learning interval. Although the theories that prompted these experiments are no longer fashionable, the findings themselves are still of relevance to understanding human memory. They are excellent examples of how everyday memory blocking can be predictably simulated in the laboratory.
1.4 Part-Set Cuing Effect

A particularly puzzling set of findings comes from the part-set cuing paradigm. In this paradigm, a manipulation that by conventional wisdom should aid memory is found to inhibit it. If items are presented as cues for the recall of other items of the same sort, then level of recall of these other items is less than if no cues are given. Typically, both the cue words and the target to-be-recalled words are from a just-studied list. Thus, if the memory test for the studied list of items contains of some of these items themselves, slightly fewer of the remaining items are recalled. As well as being counterintuitive, this finding seems contrary to the context effect research reviewed in Section 1.2.

The part-set cuing effect was first shown by Slamecka (1968), who was expecting the cues to facilitate the recall of the remaining items. The role of organization in memory was especially prominent in the theorizing of the time, and it was taken for granted that in a list learning situation subjects mentally organized the items in some fashion (Bower, Clark, Lesgold, & Winzenz, 1969; Mandler, 1967; Tulving, 1962). An implication of this idea was that if subjects could access more of their separate organizational units, more items would be recalled (J. J. Jenkins & Russell, 1952). Indeed, it was shown experimentally that remembering one member of an organized unit could indeed help elicit the other members (Deese, 1959). Such results were intuitively plausible, and also consistent with the thinking on memory at the time (e.g., J. R. Anderson & Bower, 1973;
Collins & E. F. Loftus, 1975; L. Postman, 1971), according to which recall was based on interitem associations. Thus, Slamecka, in his first study, expected no more than to demonstrate the obvious, and yet the obvious did not occur: Giving some of the list items as memory cues slightly inhibited memory performance for the other items.

Slamecka's (1968, 1969) findings have since been replicated many times, using a number of variations on the basic procedure. Roediger (1973) and Rundus (1973) presented subjects with categorized lists to study for a subsequent memory test, and showed that, at test, the greater the number of items from a category given as cues, the lower was the level of recall for the remaining items from that category. Roediger also showed that giving some of the items from a category along with the category name inhibited recall compared to giving only the category name—even though according to conventional wisdom the two types of cues should have been equally effective in accessing the other items in that category. Later, Watkins (1975) showed that the category items accompanying the category names as further cues did not have to be from the just-studied list to cause inhibition. Extra-list cues also caused inhibition, and moreover, the magnitude of the inhibition with such cues was no less than that with intra-list cues. Finally, the inhibition resulting from part-set cuing has also been observed when the memory test is one of recognition instead of recall (Todres & Watkins, 1981).
Although an inhibitory effect of part-set cuing is now well accepted, it remains counterintuitive, and thus some of the explanations that have been offered are worth mentioning. It may also be worth noting that Slamecka's (1968) original proposal addressed not the inhibitory finding but only the lack of a facilitatory finding. He proposed that, contrary to the organizational theory, items are learned independently of one another, and that organization occurs at the time of test. Thus, since there is no organization during list presentation, and no organizational units to be accessed at test, giving some of the items as cues does not help the subject. Basden, Basden and Galloway (1977) went one step further and argued that giving some of the items at test actually confuses the subjects; the re-presentation of some of the list items disrupts the normal order of output, creating a nonspecific damaging effect. Roediger's (1974) hypothesis is also one of output interference: Giving list items as cues causes subjects to involuntarily recall the presentations of these items, which effectively hinders further attempts to recall the presentations of the remaining items.

On a more sophisticated level, Rundus (1973) has proposed a three-level hierarchy for representing a categorized list. The highest level contains the list-wide context and subsumes the middle level which contains the category names. The lowest level contains the individual items, access to which is controlled only by the middle level. The stronger the association between an item in the lowest level and its category name in the middle level, the better
the recall probability, since the only way that an item could be recalled is through its category name. Further, when an item is recalled, the association between this item and its category name is strengthened even more. Presenting one of the items as a cue, then, results in its "recall" before any other items are recalled, and strengthens this item's association to its category. Since the strength of its association to its category is increased, this particular item tends to be retrieved repeatedly, which decreases the probability of the subject's sampling of other items and effectively hinders the recall of the other category members.

Raaijmakers and Shiffrin (1980, 1981) have an even more elaborate account of the part-set cuing findings, one which derives from their general model of memory, SAM (Search of Associative Memory). Very briefly, in this model cues initiate or guide a search in memory. Each cue is used until it no longer accesses new material. The part-set cuing inhibition arises because, whereas the control subjects initiate their memory search with general context cues, the experimental subjects initiate it with the specific cues that are provided for them. Since the control subjects begin with context cues, the first list items they recall and then use as specific cues are "better" (with the strongest context-to-item associations). Also, because these first-recalled items tend to be the ones that were processed the most during study, they tend to have stronger associations to other items in the same organized unit. The experimental subjects, on the other hand, are forced to begin their
search with arbitrary cues, which on average are not as strong as self-generated cues would be. Since these arbitrary cues are weaker, they elicit the recall of the remaining items less effectively, leading to a poorer level of recall than obtained with the stronger self-generated cues.

Another explanation of the part-set cuing inhibition is the cue-overload principle, proposed by Watkins (1979; see also Mueller & Watkins, 1977). This explanation, while offering no "mechanism," can account for inhibition not only with the standard procedure, but also with extra-list cuing and with recognition as the memory test. It is well established that as the length of a list increases, the probability of recalling any one constituent item decreases (Murdock, 1962; Tulving & Pearlstone, 1966). The cue-overload principle says that the more items a retrieval cue subsumes the lower the probability of recalling any one particular item. In the part-set cuing paradigm, the items given as cues at test can be assumed to have become functional members of the set of to-be-recalled items, adding to the length of the set, and thereby reducing the probability of recalling any one to-be-recalled item from that set.

Clearly the inhibitory effect of part-set cuing, though quite small, has generated much interest. For present purposes, irrespective of the particular theories it has motivated, the procedures used in obtaining the part-set cuing effect are all ways of demon-
strating inhibition in which blocking of memories comes after list learning is complete.

1.5 Effect of Recall on Subsequent Recognition

Although in some cases giving a recall test before a recognition test improves performance on the recognition test (e.g., Hanawalt & Tarr, 1961; Lockhart, 1975), in other cases it impairs performance. The interest for present purposes lies in those conditions under which a recall test impairs recognition performance.

It has long been known that if a recall test is followed by a recognition test, correct recall will have a positive effect and incorrect recall will have a negative effect on recognition (e.g., Zangwill, 1937, 1939). The systematic study of this phenomenon was begun by L. Postman, W. O. Jenkins, and D. L. Postman in 1948, who investigated the effects of both prior recall and recognition on each other. Two groups of subjects studied a list of 48 nonsense syllables. The study interval was followed by a 10-minute free-recall test for one group and a 10-minute four-alternative, forced-choiced recognition test for the other. Immediately following this phase, the tests were switched; the group that had received the free-recall test was given the recognition test and vice versa. L. Postman et al. observed that, though having a prior recognition test facilitated recall performance, the converse did not occur. In fact, trying to recall the just-studied list of nonsense syllables impaired subsequent discrimination of these items from lure items. Though statistically reliable, the detrimental effect was unexpected
and L. Postman et al. did not dwell on it beyond noting that perhaps weak associations that were strong enough only to effect recognition diminished further during the recall test, thus lowering the level of subsequent recognition performance.

This unexpected inhibitory finding was investigated by Belbin (1950). After viewing a complex picture in an incidental learning paradigm, half Belbin's subjects were given a recall test prompted by questions, while the other half, the control group, engaged in an unrelated task. In the recognition test that followed, subjects in the recall group did considerably worse in recognizing the picture than did those in the control group. This result was later replicated with a slightly different procedure by Kay and Skemp (1956).

A similar inhibitory result was found by Packham (1968), using yet another variation on this procedure. Subjects studied a 40-word list and were then given a free-recall test. The free-recall test was followed by two types of recognition tests. First, the experimenter took five of the words that were recalled, ten words that were not, and ten other, distractor words that had not been presented, and he asked his subjects to rank these words according to familiarity—i.e., the likelihood that they had been members of the just-presented list. In the second recognition test, the same ranking procedure was applied to the remainder of the nonrecalled words and to still other distractor words. Including the already-recalled words in the first recognition test produced an inhibitory
effect on the recognition of the other list words. Subjects performed better on the second recognition test where there were no "freely recalled" words to be recognized.

Watkins and Todres (Note 6) showed that if subjects are first cued for the recall of a studied word, they are less likely to identify it on a subsequent forced-choice recognition test than if the intervening cued-recall test is not given. The inhibitory effect of recall on subsequent recognition was also observed on a list by list basis, where each list comprised items from a different category. When subjects first attempted to free recall and then to recognize the studied items from a given list, or category, they performed more poorly on the recognition test than they did when they were given just the recognition test.

1.6 Effect of More Recallable Items on Less Recallable Items.

Another way of phrasing McGeoch's (1942) response competition theory is to say that more readily recallable items block or inhibit the recall of items that are less readily recallable. In memory experiments, a standard procedure for rendering one item more recallable than another is to present the item more than once within the study list (e.g., Melton, 1967). With this procedure, Tulving and Hastie (1972) demonstrated an intriguing form of response competition. As in typical repetition experiments, they presented some words once and others twice. But during recall, subjects were tested on each actual occurrence of the words; so a repeated word was to be written down twice. The interesting finding was that the
recall of once-presented words (the less recallable items) decreased as the number of twice-presented words (the more recallable items) increased. That is, when subjects were asked to recall each presentation of a given word, memory performance for once-presented words became poorer as the ratio of twice-presented words to once-presented words increased. Similar results were obtained even when subjects did not have to recall the twice-presented words twice but were asked to demonstrate memory only for the word itself rather than its specific presentations (Roediger, Stellon, & Tulving, 1977).

There is some evidence, contrary to the Roediger et al. (1977) finding, that not requiring the subjects to recall twice-presented words twice eradicates the inhibition (Hastie, 1975; Robbins, Bray, & J. R. Irwin, 1974). Nevertheless, it still remains the case that, at least under some conditions, such inhibition of once-presented words can be demonstrated. After list learning is complete, when memory is tested for individual episodes, the more recallable episodes can inhibit memory for the less recallable ones.

1.7 Effect of Suggestion and Implanting Inconsistent Information at Test.

There is evidence that memory for a studied set of items can be reduced simply through an instruction to forget (e.g., R. A. Bjork, 1978). Thus, after studying certain items or even a whole list, subjects are sometimes signaled to "forget" or "erase their memory for" those items. Although it is hard to imagine how one could will
oneself to actually forget a witnessed item, the results from such experiments usually show the instructions to have a detectable effect, at least on free recall. It could be argued that within this paradigm learning may not have been complete--perhaps for lack of rehearsal--when the inhibitory manipulation is introduced, and hence the to-be-recalled and to-be-forgotten items may not have had equal opportunity to be learned. It is conceivable, however, that the observed impairment is due to a self-generated inhibition of memory on the part of the subjects. A somewhat different form of blocking is obtained through suggestion and the implanting of inconsistent information at the time of test. Persons in the legal profession are well aware that leading questions may lead to false memories (e.g., Münsterberg, 1908; Muscio, 1916; Weinberg, Wadsworth, & Baron, 1983), and more generally, everyday experience surely indicates that man's imagination is powerful and malleable enough to create false memories and alter existing ones; after all, people can misremember, and they can do so with confidence. A classic illustration is Piaget's distinct memory of an incident pertaining to the bravery of his nanny which, later in his life, he discovered to be a fabrication. Even though Piaget had "remembered" the event as personally witnessed, the memory was false, and presumably conceived through inconsistent information implanted by his unsuspecting parents and the lies implanted by his nanny.

Such inhibition of real memories by mere suggestion or implanting of false memories has been studied extensively under
laboratory conditions. Half a century ago Bartlett (1932) observed and made a systematic study of the way in which memories evolved. This evolution was manifested by omissions, ommissions, and alterations, the last of which Bartlett said arose from the fitting of the remnants of memories into a familiar schema that helped a person to come up with or to preserve a satisfactory memory. More recently, Elizabeth Loftus and her associates have embarked on an impressive enterprise of exploring such inhibition of memories through implanting inconsistent information. In a sense these researchers have picked up where Bartlett left off, in that, instead of just observing these memory changes, they have induced them experimentally. Their basic method has involved creating new memories either through suggestion or through inconsistent information.

In one study, subjects viewed a film of a car accident, and immediately afterwards were asked either "Did you see a broken headlight?" or "Did you see the broken headlight?". In a later memory test, regardless of whether there had actually been a broken headlight in the film, subjects were more likely to "remember" having seen a broken headlight if the question they had been exposed to included the definite article the rather than the indefinite article a (E. F. Loftus & Zanni, 1975). In a similar study, subjects' memories for the actual color of the car in the film was shifted towards the color that was suggested to them after the viewing was complete (E. F. Loftus, 1977).
In yet another study, one that perhaps exemplifies most studies of its genre, all subjects viewed the same film of a car accident and afterwards were exposed to information that was consistent, inconsistent (misleading), or irrelevant. Those given inconsistent information remembered the events in the film less accurately than did those given consistent or irrelevant information (E. F. Loftus, D. G. Miller, & Burns, 1978); memories the subjects had formed of a recent event were impaired or inhibited simply by suggestion. These and numerous other studies (e.g., Cole & E. F. Loftus, 1979; Gentner & E. F. Loftus, 1979; E. F. Loftus, 1975; E. F. Loftus & Palmer, 1974) clearly demonstrate the susceptibility of memory to the influence of subsequent information.

1.8 Summary and Conclusion

The inhibition or blocking of memories is observed in many guises in a variety of everyday situations. Not surprisingly, therefore, it has been much pondered and discussed. More recently, memory psychologists have brought it into the laboratory for systematic investigation.

In this chapter, some of the more prominent examples of the various laboratory paradigms used in this investigation have been reviewed. Broadly speaking, all of these paradigms have relied on the detrimental effects of a mismatch between the learning and testing contexts. Some studies were designed directly to determine the effects of changing, from learning to test, the contextual cues—whether environmental, internal, or explicitly built-in.
Others involved less direct learning-to-testing context changes. In the classical retroaction and proaction studies, inhibition for a set of items was created merely by having the subjects learn another set of similar items after or before the critical study period. The part-set cuing paradigm showed that re-presenting some of the to-be-recalled items as cues at test inhibited the recall of the remaining items. In other studies, giving a recall test prior to a critical recognition test lowered performance on the recognition test compared to that when no recall test intervened. In yet other studies, some words in a study list were repeated with the result that memory for once-presented words was inhibited; moreover, as the number of twice-presented words increased, recall of once-presented words decreased. Finally, in studies conducted by E. F. Loftus and her associates, inhibition was produced by suggestion of different memories and implantation of inconsistent information at test.

In the literature today, there are countless laboratory demonstrations of memory inhibition brought about by a manipulation that is independent of the learning procedure. While some of these findings have stemmed from studies conducted for the purpose of exploring inhibition, others have been incidental by-products of studies conducted for other purposes. All, however, can reasonably be characterized as the product of changing the context of an item between study and test. The next section will present evidence of a kind of inhibition that might be construed as somewhat different.
Chapter 2

Demonstrating Context-Free Inhibition in

Episodic Memory: Experiment 1
2.1 The Elaboration-Integration Distinction

In his recent theory of recognition, Mandler (1979; 1980) makes the distinction between interitem and intraitem associations. Since this theory does not explicitly address inhibition in memory, it is not considered in detail here. An idea that is central to Mandler's theory is, however, highly relevant to present purposes, motivating as it does a crucial distinction to be proposed in this study—that between context-dependent and context-free inhibition. This chapter focuses on that particular idea and its origins.

The origins of the idea can be traced to the widely-held assumption that there is organization during list learning, and more specifically, to the notion that there are different kinds of organization. To use Mandler's (1979) terms, two or more items can be organized in a coordinate (relational), subordinate (categorical) and a proordinate (serial) fashion. Such different organizations can be useful for different kinds of tasks. For instance, coordinate structures are important in paired-associate learning, subordinate structures in free or categorized-list recall, and proordinate structures in serial learning tasks where correct ordering of items is crucial—although, of course, more than one kind of organization can be used in the same task.

Orthogonal to these kinds of organization between items, there is also organization within items. Such organization is realized by directing attention to the specific properties of the respective items independently of their relation to other items or to the
context in which they occur. Mandler (1980) calls the general between-item organization the **elaboration** process and the specific within-item organization the **integration** process. The elaboration processes are particularly important in free recall; they are assumed to underlie effective (or Type 2) rehearsal (cf., Craik & Watkins, 1973), the beneficial effects of categorized lists (Bower et al., 1969), and the tendency for clustering of responses (J. J. Jenkins & Russell, 1952). The effectiveness of specific contextual cues (Tulving & Thomson, 1973) and the results of context effect experiments in general (Eich, 1980) are also accounted for by the elaboration process. The integration process, on the other hand, accounts for improved performance in recognition, but not in free recall, following "maintanence" (or Type 1) rehearsal (Woodward, R. A. Bjork, & Jongeward, 1973), equal performance in incidental and intentional learning paradigms in word-fragment cuing recall but not in free recall (Graf, Mandler, & Haden, 1982), and the lack of an effect of repetition and orienting tasks in word-fragment cuing (Watkins & Peynircioğlu, Note 5).

The integration process increases the "familiarity" of an item by helping a person focus his or her attention on the item's perceptual and intrastructural aspects, independently of its relation to other items. Such increased familiarity, in turn, increases memory performance in certain recognition, discrimination, and cued-recall tasks (cf. Atkinson & Wescourt, 1975; Juola, Fischler, C. T. Wood, & Atkinson, 1971). The formulation of the elaboration-integration
distinction is not only central to Mandler's (1980) theory of recognition, but the basic idea has been proposed by other researchers in other contexts as well. For example, Tversky (1973) has made the statement that "recognition is enhanced by integration of the details of each item while recall is enhanced by interrelating the items within a list" (p. 285). While free recall is largely dependent on retrieval cues created by extratemporal elaboration, and on structural and conceptual organization between items, recognition and perceptual cued recall are also very much dependent on intratemporal organization.

Indeed, the elaboration-integration distinction is offered as an explanation for various interactive effects in free-recall and recognition tests (Mandler & Rabinowitz, 1981). Among them are the word-frequency and the test-expectancy effects. The word-frequency effect refers to better performance on recognition tests with low-frequency words and better performance on recall tests with high- than low-frequency words (e.g., Sumby, 1963). The test-expectancy effect refers to better recall performance when the expected test is one of recall and better recognition performance when the expected test is one of recognition (e.g., Tversky, 1973). In terms of the elaboration-integration distinction, the word-frequency effect arises because a low-frequency word allows more integration due to its relative novelty, whereas a high-frequency word can, because of its high associative value, be elaborated more readily than can a low-frequency word (Mandler & Rabinowitz, 1981).
A similar argument concerning the different study strategies of subjects in the different expectancy conditions can account for the test-expectancy findings.

Mandler's (1980) distinction between elaborative and integrative processes makes intuitive sense. It seems, however, that memory research conducted to date has concerned itself much more with elaborative than with integrative processes. Memory performance for individual items has been measured mostly in the context of their relations to other items. Blocking of memories, in particular, has been explored solely in the context of the items' relations to one another and to the study environment in general.

2.2 Context-Free Inhibition

Laboratory demonstrations of memory inhibition to date have tended to involve, in one way or another, the context in which the items were studied. The source of the inhibition has thus been thought of as the presence of other interfering memories for items from the same context or as the absence of appropriate contextual cues. In the explanations of such context-dependent inhibition, the recourse has been to the elaborative processes. Theories trying to explain inhibition have all entailed, in one guise or another, the proposal that inhibition arises because manipulations interfere with access to memories created through some kind of an elaborative process.

Can memory for an item be inhibited in a way that does not implicate the context in which it was learned? In other words, can
a variable that could reasonably be supposed to affect access to memories formed through an integrative process produce inhibition? If memory for an item per se can be blocked, regardless of how and in what list the item was learned, the inhibition could be assumed in some sense to be rather basic. Since "context" could not be held responsible for the memory block, the theories would have to rely on some other, less obvious, inhibiting agent. Thus, in the event of such context-free inhibition, the task of explaining it would be rather more difficult than that of explaining context-dependent inhibition.

One approach to creating context-free inhibition may be to vary the test environment in such a way that a given set of cues helps access memory--assumed to have been formed through an integration process--more easily under some conditions. An obvious candidate for such a procedure would be to cue with word-fragments. Although the nature of word-fragment cuing is still little understood, and explorations of the topic are only just beginning, it has been hypothesized that the word-fragment cuing procedure accesses a different type of memory, one that may have a perceptual basis (cf., Tulving, Schacter, & H. A. Stark, 1982). Since part of the integration process in visual word-list presentations would have to involve the words' graphemic representations, giving some of the letters of a word as recall cues would be one of the most straightforward ways of tapping memories that would have been formed through the integration process.
As support for this prediction, verbal memory tests with amnesic subjects have shown that, even though performance on standard free-recall and even recognition tests is extremely poor, when the test format is word-fragment cuing, performance is at the same level as that of normal subjects (e.g., Warrington & Weiskrantz, 1970, 1974). This finding has been explained in terms of a different type of memory, a type of memory that a word-fragment cuing test taps and that recall and recognition tests do not. Within the framework of Mandler's (1980) distinction, it would seem that while a free-recall procedure tests mainly for the effectiveness of elaboration processes (which give rise to what is conventionally known as good memory and the lack of which give rise to amnesia), the word-fragment cuing procedure tests mainly for the effectiveness of the integration processes—which perhaps give rise to a different type of memory.

Prompted by such findings reported with amnesic subjects, there has emerged, during the past few years, an interest in testing for the effectiveness of these proposed integration processes. For example, Jacoby and Dallas (1981) used a tachistoscopic testing procedure where the dependent variable was the probability of word identification. They found that many variables that affected performance on a standard recognition test, such as the mode of processing, had no affect on the identification thresholds as determined by the tachistoscopic test; the tachistoscopic test presumably reflected the effectiveness of only the integration
processes. Jacoby and Dallas also found that other variables, such as the mere presentation of a word, affected performance on the tachistoscopic test to a much greater extent than that on the standard recognition test; that is, the difference between being able to identify or "see" a presented and a nonpresented word in the tachistoscopic test was much greater than the difference between being able to correctly judge in the recognition test whether or not a word was the presentation list. The interpretation was that while the standard recognition test measured the effectiveness of elaborative processing, the tachistoscopic identification test measured the effectiveness of integrative processesing.

More relevant to present purposes, Tulving (1969) found that including a salient word in a study list (such as including the name of a famous person in a list of randomly chosen common nouns) selectively decreased the recall performance for the word immediately preceding the salient word. When the test procedure was one of word-fragment cuing instead of free recall, however, performance for a word that immediately preceded a salient word was no longer impaired. The experimental analogue of retrograde amnesia observed in normal subjects was eradicated (Detterman, 1976). Such a result, just as the results from above-mentioned similar experiments with amnesic subjects, is consistent with the idea that the word-fragment cuing test taps a memory created through the integration process. Also, as was mentioned in the last section, it has been found that presentation manipulations that lead to markedly higher levels of
performance in conventional free-recall and recognition tests, such as intentional learning, repetition, deeper encoding, and slower presentation rates, have little if any effect on performance in word-fragment cuing tests (Graf, Mandler, & Hader, 1982; Watkins & Peynircioğlu, Note 5). Such results are again consistent with the idea that word-fragment cuing tests are more sensitive to integrative than to elaborative processing.

If it is at all possible to produce context-free inhibition for a word, then, a logical means of doing so would be to use word-fragment cuing. More particularly, perhaps inhibition could be obtained with a procedure that is similar to the part-set cuing procedure discussed in the last chapter--one that takes advantage of the detrimental effect of presenting cues at test. In other words, a detrimental effect on recall could perhaps arise from the presentation at test of, not only related words, but also fragments of the individual word being cued. If there is indeed a detrimental effect observed in recall by varying the word-fragment cues, then it would be reasonable to assume the inhibition to be a result of blocking access to memories that were formed through an integration process. Such a finding would be a demonstration of memory inhibition that is qualitatively different from the type of inhibition observed thus far. Indeed, the first experiment to be reported in this study can be viewed as a test for context-free inhibition, inhibition for a particular item created without recourse to any elaborative processes.
2.3 Experiment 1

In this experiment, studied words were tested with one of two types of word-fragment cuing procedures. For both types, the task was to discover, with the aid of letter cues, the word that was being tested. One type, however, involved presenting a series of successively more powerful word fragments, whereas the other involved presenting only the last of these fragment. Logically, as long as the final and strongest cue is presented for an equal time in both types of test, the test in which weaker cues precede the final cue should not reduce the probability of recall. After all, extra time to think, especially with the aid of letter cues, should, if anything, help recall. But, although counterintuitive, it is also conceivable—especially in light of the findings from part-set cuing studies, where giving extra cues impairs recall—that preceding the strong cues with weaker ones inhibits recall. If the latter alternative were true, then inhibition of a given word would be obtained by manipulating only the graphemic cues that are specific to that word. Thus, the inhibition would be word-specific or, in other words, context-free.

a. Method

i. Materials and design. For this experiment, 123 8-letter words were obtained from the Puzzle Solver's Handbook (developed and published by D. R. Corron, 4321 N. Bearclaw Way, Tucson, AZ 85715). The words were chosen so that the first letter in each word plus one other letter specified that word uniquely. These words and
their unique cues are shown in Table A1. Three of the words were used for practice, and the remaining 120 were randomly divided into six lists of 20 words each. For presentation, subjects were given a sheet of paper with the words typed one under the other. Presentation of each list was followed by a word-fragment cuing test in which words were tested in a new random order. For each subject, half of the words were cued with progressively stronger cues. Cue strength was defined by the number of letters included. Thus, in this condition cuing for a given word started with the two letters unique to that word (e.g., R------P) and ended with five letters (R-I--ROP). The other half of the words were cued with only the strongest level, 5-letter cue. The successively increasing fragments for each word were written one underneath the other on a separate sheet of paper (R-------P; R----R-P; R-I--R-P; R-I--ROP). When a word was discovered, it was written on a specially prepared answer sheet described below. The words tested in the two types of cuing conditions—the successive and the single-level conditions—were interchanged across two groups of subjects, although the lists and the words in the lists were presented and tested in the same order for all subjects.

ii. Subjects and procedure. The subjects were 12 adults recruited on Rice University campus. They were paid for participating, and were tested individually or in groups of four or fewer. Each session began with detailed instructions on the entire procedure, followed by three practice trials with the testing
procedure. Subjects were told that, after studying a list, their task would be to discover the words that were being cued. The words would always be from the list just studied, and cuing for some of the words would start with a 2-letter cue and increase to a 3-letter, then to a 4-letter, and finally to a 5-letter cue, whereas cuing for other words would involve just the 5-letter cue. To write the words that they discovered, subjects were given answer sheets which contained a separate four-slot box corresponding to each to-be-cued word. When a word was cued with just the 5-letter fragment, subjects had 4 seconds to discover and write it in the fourth slot of the corresponding box. When a word was cued starting with a 2-letter fragment, on the other hand, if they could think of the word in the first 4 seconds they were to write it in the first slot of the corresponding box; if they could not, they were to put a cross in that slot and go to the next slot. They would then be given one more letter of the word and 4 more seconds to think, and the procedure would continue until the last cue level in which 5 letters of the 8-letter word would be in view.

The successively stronger cues were exposed at 4-second intervals; the cue sheet was initially covered with a cardboard and this cover was moved down by the experimenter to expose each new cue level. Guessing was permitted and subjects were told that a wrong guess would count merely as a cross. Before each test, subjects were given the 20 words to study. The study phase involved moving down a list of words at a rate of one word every 2 seconds. A
beeper signalled the 4-second intervals at test and the 2-second intervals during presentation.

b. Results and Conclusion

The comparison of interest is the recall levels for the two cuing conditions. Thus, the focus is on the proportion of words discovered with single-level cuing and that discovered by the end of the last cue level with successive cuing. Proportions of words discovered at lower cue levels in the successive-cuing condition are not relevant to present purposes and are given in Table A2. The results of main interest were straightforward. Recall performance was at a higher level in the single-level cuing condition than in the successive-cuing condition. The proportion of items recalled was .78 when cuing was successive and .85 when subjects were given just the 5-letter fragment for 4 seconds. This difference was statistically reliable, t(11)=3.113, p<.01.

This experiment thus shows another procedure for obtaining inhibition in memory. But this time, the inhibition is not brought about by any other interfering items in that list, nor is it dependent on the context in which the item was presented. Rather, it appears to be an item-specific inhibition brought about by a particular testing procedure.

As mentioned previously, a weak cue plus a strong cue might, from an intuitive standpoint, be expected to be at least as effective in eliciting recall as the strong cue alone. After all, the strong cue appears in both cases, and if the weak cues have any
effect on memory at all, they should facilitate recall by at least providing more thinking time and perhaps even by lowering the threshold for a word's eventual discovery. Yet the results proved otherwise; with this word-fragment cuing procedure, giving more time to recall an item in the presence of weak cues actually reduced the effectiveness of the final strong cue in eliciting recall. It thus seems that memory for words is subject to a context-free form of inhibition.
Chapter 3

The Episodic-Semantic Memory Distinction and Inhibition in Semantic Memory
3.1 **Introduction**

The results of both the research discussed thus far and Experiment 1 demonstrate inhibition in only one of two types of memory systems, the episodic memory system. The inhibited memories have been of events that still retained their episodic nature. In other words, the knowledge of the precise conditions under which these memories were acquired remained intact; the temporal and spatial information about the events' occurrences were still in memory. The other type of memory system is the semantic memory system, which includes memories whose origins and details of acquisition have long been lost. Memories in this latter system no longer preserve their autobiographical referent.

An example of episodic memory inhibition would be not being able to remember what one had for dinner the night before. An example of semantic memory inhibition would be a failure to remember the name of the great Brazilian soccer player. One can be absolutely sure that one knows the name since one has demonstrated memory for it so many times in the past. Yet, for some reason, at that particular moment one blocks on it.

In this chapter, first the proposed distinction between the episodic and semantic memory systems is discussed in some detail and the empirical evidence for the utility of such a distinction evaluated. Focus then shifts to the blocking of memories in the semantic memory system and, in Section 3.3, some of the more prominent laboratory studies addressing such inhibition are reviewed.
3.2 The Episodic-Semantic Memory Distinction

a. Introduction

Episodic memory refers to recollections of unique personal events for which the particular details of acquisition are still present. Semantic memory refers to recollections of general knowledge items, such as one's native language, rules, concepts and abstractions, and recollections of any other information which one does not remember acquiring. The distinction is one between the "remembering of" an event and the "remembering that" the event took place.

The distinction was spelled out clearly and brought to the attention of experimental psychologists by Tulving in 1972. But it had also been made on earlier occasions. Even Ebbinghaus made reference to it (1885/1964):

"In ordinary life it is of the greatest importance, as far as the form which memory assumes is concerned, whether the reproductions occur with accompanying recollection or not,—i.e., whether the recurring ideas simply return or whether a knowledge of their former existence and circumstances comes back with them" (p. 58).

Bergson (1913), a philosopher, also distinguished between two types of memory, and unlike Ebbinghaus, considered the distinction in detail. Memory could be in the form of a motor mechanism or a habit, "acquired by the repetition of the same effort" (p. 90). Or it could be in the form of independent recollections, each one a
unique event, temporally dated and unable to occur again. He likened the distinction to that between a well-learned lesson and each piece of study effort that is exerted towards learning the lesson. Memory for each reading of the to-be-learned material would be in the form of an independent recollection while memory for the material in general would be like a habit system.

Certain other philosophers, among them Ayer (1956) and Locke (1971), also postulated a distinction between episodic and semantic memory, calling them, respectively, event or personal memory and habit or factual memory. In the neurological literature, Penfield (1975) differentiated experiential record from concepts. In psychiatry, Schactel (1947) and Reiff and Scheerer (1959) drew similar distinctions; Schactel called the two types of memory autobiographical memory and rememberance, and Reiff and Scheerer called them practical memory and memoria.

Such variants of the distinction, formulated in different contexts and at different times, each made a certain amount of intuitive sense. In psychology, the distinction was finally crystallized by Tulving (1972). He formally introduced it to the memory psychologist, and used the terms "episodic" and "semantic" memory. Although by no means uncontested, these terms have now become a part of the accepted psychological jargon.

According to Tulving (1972), episodic memory entails a faithful representation of a given experience. The unique attributes of the experience, such as its temporal and spatial relations to other
events, as well as its perceptible properties, are also remembered. Semantic memory, on the other hand, is vague; an experience can have rough temporal and spatial relations to other events but this is not necessary. The details of the experience are lost. The reference for episodic memory is autobiographical; an example would be remembering what one had for breakfast that morning. Semantic memory, on the other hand, has no autobiographical reference, and is presumably an accumulated residue of many episodic memories; an example would be remembering, or knowing, what kinds of food are eaten at breakfast. While episodic memory cannot involve more than a faithful or photographic representation of an event, semantic memory is capable of inferential reasoning and generalization. To give Tulving's example, "a person may have never learned that March follows June in the alphabetical listing of months, and yet be able to retrieve this bit of knowledge upon an appropriate query" (p. 390). Episodic memory is more susceptible to interference. Veridicality of episodic memory is personal whereas that of semantic memory is common knowledge. Access to episodic memory is deliberate whereas access to semantic memory is automatic. Finally, episodic memory remains bound to its context, since the occurrence of any one event is unique and within a context, whereas semantic memory is free from a given context, since it is memory acquired through the occurrence of many events in many different contexts.

As was mentioned earlier, Tulving's (1972) episodic-semantic memory distinction is now widely recognized and accepted. The
utility of such a distinction, as well as its specific formulation, however, are still being debated. In particular, the rules for classifying memories as being episodic or semantic remain vague and inadequate. Indeed, there is evidence that pieces of information that are usually characterized as being from semantic memory can still exhibit some of the properties specific to those usually characterized as being from episodic memory (Peynircioğlu, Note 1).

For present purposes, however, the focus will be not on the precise definitions of episodic and semantic memory, but on the utility of the distinction itself. A distinction is of value only if it can also be made on grounds of objective experimentation and, thus far, evidence for or against the episodic-semantic distinction is scarce and inconclusive. Arguments against the distinction have usually revolved around the criterion of parsimony. Claims have been made that there is no processing or functional difference between the two types of memories, and support for these claims has come from studies demonstrating similar effects of various manipulations on both episodic and semantic memory (e.g., J. R. Anderson & Ross, 1980). Such demonstrations can, however, at best claim an interdependence between the memory systems; any stronger claim would require proving the null hypothesis. As it happens, there is no dispute about the fact that episodic and semantic memory are interdependent. More critically, therefore, are studies showing distinct functional differences between the two kinds of memory. In the fol-
lowing subsections, the principal experimental evidence supporting the distinction is reviewed.

b. Evidence from Amnesic People

In advocating two distinct memory systems, Bergson (1913) based his arguments mainly on introspection. He also cited as evidence, however, some observations with amnesic people, especially with those who had certain types of brain damage. These brain damaged amnesic patients demonstrated memory for a particular event through their behavior even when they claimed not to remember the event. As was mentioned in Section 2.2, recent research has investigated such observations and has documented many more such cases (e.g., Warrington & Weiskrantz, 1970). Influenced by these demonstrations with amnesic people, Jacoby and Dallas (1981) have addressed the same issue using nonamnesic people. These researchers identified a number of variables that affect the performance of people with normal memory in different ways depending on whether the tests given are tachistoscopic perceptual tests or standard recognition tests. Such findings led Jacoby and Dallas to propose that perhaps under some conditions the presentation of a study item activates its semantic representation without forming a new episodic trace. The different types of tests tapping the two distinct memory systems would then give rise to differential memory performance depending on whether recall was from episodic or semantic memory.

Claparède (1911) also distinguished between episodic and semantic memory. He observed that Korsakoff amnesic patients could often
demonstrate memory for information but could not remember their personal experiences. That is, these patients could remember the semantic content of an episode but fail to associate it with their personal past (cf., Janet, 1901; Prince, 1910). According to a famous anecdote, Claparède once pricked one of his patients with a concealed pin while shaking hands, and after that the patient refused to shake hands again; she could not, however, tell Claparede the reason why she refused, only that "sometimes pins are hidden in people's hands." She did not have an episodic memory for the event but retained some of its semantic content. Nielson (1958) also observed such dissociations in amnesic patients, and applied the terms **temporal** and **categorical** amnesia to refer, respectively, to deficiencies in autobiographical memory and in general knowledge.

Kinsbourne and F. Wood (1975) and F. Wood, Ebert, and Kinsbourne (1982) have looked at a wide array of evidence from studies with amnesic patients, as well as conducting many studies of their own. They were struck by the fact that even though amnesic patients had trouble remembering episodic events, they could still use language and their general knowledge was usually intact. They concluded on the basis of these observations that amnesia represented an impairment of only the episodic memory system. In support of this conclusion, Cermak, Reale, and Baker (1978) asked both non-amnesic people and Korsakoff amnesic people to generate category instances when given the category name and the first letter of the to-be-generated instances (e.g., Sport-F; Fruit-W). In this task
they found no difference between the performances of the two groups of subjects. Semantic memory systems of amnesic people functioned normally. Similarly, in a different study, performance on general vocabulary tests remained unimpaired even in severly amnesic people (Baddeley & Warrington, 1970). In yet another study, when amnesic people were given simple sentences such as *canaries can fly* or *canaries have fins*, and asked to make truth judgments, their performance was no worse, in terms of either speed or accuracy, than that of nonamnestic people (Baddeley, 1982). All these studies showing a dissociation between episodic and semantic memory in amnesic subjects seem to point to a real distinction between the two systems.

c. **Physiological evidence**

Researchers have also sought evidence for an episodic-semantic memory distinction using rather sophisticated physiological techniques. For example, Ojemann (1978) electrically stimulated various areas of the cortex while the subjects were engaged in a short-term verbal memory task. The task was patterned after that of Brown-Peterson (described in Section 1.3b). Subjects viewed the picture of an object, and were asked to say the phrase "This is a" followed by the name of the object. This was the semantic task—being able to name an object. Subjects then counted backwards from a given number by threes and, after a certain time interval, received a free-recall test on the name of the object, followed by a forced-choice recognition test. Ojemann stimulated different parts
of the brain at many different points during this task. He found that he could alter semantic memory performance by causing anomia—an inability to name an object even though speech capacity is intact. Thus, subjects could read and speak the phrase "This is a" but could not name the object (cf., Penfield & Roberts, 1959). In addition, Ojemann obtained predictable errors in episodic recall by stimulating different cortical areas during object naming, the distractor task, or the time of test. These findings led him to conclude that the areas of cortex that controlled semantic memory (as measured by object naming) were separate but adjacent to the areas that controlled verbal episodic memory (as measured by performance on the recall and recognition tests).

In another study, F. Wood, Taylor, Penny, and Stump (1980) have also claimed to have found an anatomical basis for the episodic-semantic distinction. They measured regional cerebral blood flow during an episodic recognition task as well as during a semantic classification task, using two groups of subjects. The two groups studied the items under identical conditions. At test, however, the recognition group received a free-choice recognition test while the classification group received a classification test. The recognition test involved making a decision as to whether an item was from the study list, and the classification test involved making a decision as to whether an item was a "concrete object which could fit into an area about the size of one's living room." During the test phase, subjects in the semantic classification group showed a
significantly greater change in left hemisphere measurements from resting baseline—determined by blood flow measurements in a quiet, eyes closed state—to activation from those in the recognition group. In fact, whereas the former group showed an increase, the latter group showed a slight decrease. More importantly, although regional cerebral blood flow and task accuracy were not significantly correlated for the classification group (and the correlations tended to be positive in general), the recognition group showed a significant inverse relation between blood flow and accuracy of memory performance—that is, the more accurate the recognition memory performance, the less was the blood flow in the left hemisphere. Such differential effects of a semantic and an episodic task on this physiological measure led F. Wood et al. to propose an anatomical basis for the distinction.

d. Evidence from Word-Association Tasks

In a study by Slamecka (1965) two groups of subjects were given a word-association task; the task for each subject was to give one free associate to each of the presented words. Then, while the control group rested, the experimental group learned a second, interfering list of paired associates. Thus, for example, if the subject had given dog as a response to cat, and table as a response to chair, the second list he or she would learn would contain the word-pairs cat-table and chair-dog. The test that followed involved recalling the original associative responses that the subjects had generated. Slamecka found that learning the
interfering list had no effect on being able to remember the self-generated semantic associations. The performance for the two groups was the same. It might be useful to note that, as was discussed in detail in Section 1.3a, such a manipulation would have caused a sizeable detriment in episodic memory, had the subjects studied a list of paired associates such as cat-dog and chair-table instead of generating such pairs themselves. This finding led Slamecka to conclude that pre-experimental associations were not unlearned during list acquisition. In this procedure, the semantic and episodic memory systems could be kept separate without any interference from one task to the other.

Petrey (1977) was interested in how semantic memory evolved. She studied word associations and made a very interesting observation. It was well-known that young children's and adults' free-associations to a word are quite different (e.g., Entwisle, 1966). While adults' associations are usually based on taxonomic category relations (e.g., cat-dog, table-chair) or contiguity (e.g., high-school, key-chain), children's associations often seem irrelevant and chaotic. Entwisle had collected and published massive data on word associations given by children of all ages. Petrey scrutinized this data and noticed that younger children's associations were actually not irrelevant as they seemed at first glance, but were based on episodic memory for external events rather than semantic memory for the words' internal contents. To give one of Petrey's examples, while the older children would give subtract as a
response to add, younger children would give a response like a cup of water. Even though such a response in isolation might seem irrelevant, when a lot of responses of the same sort occurred, it was not too difficult to see that a child was completing a common cooking instruction he or she had heard, probably while helping mom in the kitchen. Petrey concluded that the crucial difference between children's and adults' word-associations was not that between structure and chaos, but that between different sorts of structure, namely those based on episodic and semantic memory systems.

e. Semantic Relatedness

More support for the distinction has come from studies in which some variables have been shown to affect episodic and semantic memory tasks in different and opposite ways. For instance, Herrmann and Harwood (1980) asked subjects to make a positive response if two words presented simultaneously at test were both previously studied, a negative response if neither was studied, and a mixed-response if only one of them was studied. Analyzing the negative responses (when neither word was studied), the researchers found that the response times were faster if the two words belonged to the same taxonomic category than if they were from different categories, provided that other items from that particular category had been previously studied. However, when the words were from categories that had not been encountered at study, the negative response times were the same regardless of whether the words belonged to the same
category or not. The authors concluded that recognition was influenced by recent episodic organization but not by preexisting semantic organization.

In another study, Shoben, Wescourt, and E. E. Smith (1978) found that semantic relatedness affected response times in sentence verification (a semantic task) but not in sentence recognition (an episodic task). Conversely, the number of predicates stored with a concept affected the response times in the episodic recognition task but not in the semantic verification task. Such interactive effects were interpreted as evidence for the episodic-semantic memory distinction.

In another study, although McKoon and Ratcliff (1979) concluded that their results provided evidence against a functional distinction between the two memory systems, Tulving (Note 3) has observed that there was hidden in their data an interaction that supports the distinction. McKoon and Ratcliff examined the effects of priming just studied paired-associates by means of either a lexical decision (semantic) task or an item recognition (episodic) task. The data show that when the prime was semantically related to the target item, the recognition latency was much higher than when the prime was episodically or both episodically and semantically related, whereas this was not true in the lexical decision latency; in fact, the lexical decision latency was slightly lower when the prime was semantically related compared to when it was episodically or both episodically and semantically related. That is, whether a prime was
episodically or semantically related to a target item affected performance in different ways depending on whether the task was an episodic or a semantic memory task.

f. Summary and Conclusion

Since its formal enunciation by Tulving in 1972, much research has been directed toward evaluating the distinction between episodic and semantic memory. In particular, the utility of such a distinction has been questioned. The argument against the distinction rests on grounds of parsimony and on the scarcity of strong evidence for a functional difference. The argument for the distinction, on the other hand, rests on grounds that, although evidence is indeed scarce, to the extent that any variable can be shown to affect performance based on the two memory systems in different ways, the distinction is worth making.

In fact, there are several findings that point to a distinction between episodic and semantic memory. They suggest that, even if episodic and semantic memory are not totally independent of each other, they can be influenced by different variables in different ways and thus should be thought of as separate systems. To convince the skeptic of the utility of such a distinction, however, the existing evidence is indeed weak, and more evidence showing functional differences between episodic and semantic memory would certainly be of value.
3.3 Evidence for Inhibition in Semantic Memory

In the previous section, the distinction between episodic and semantic memory was discussed. The topic of this section is inhibition in semantic memory. As it happens, the existence of inhibition is not a discriminating factor between episodic and semantic memory. There is inhibition in semantic memory just as in episodic memory. Thus, to complete the survey of memory inhibition, this section reviews some of the more influential demonstrations of inhibition in semantic memory.

a. The Tip-of-the-Tongue Phenomenon

Perhaps the most intuitively appealing demonstration of inhibition in semantic memory is the tip-of-the-tongue (TOT) phenomenon. It refers to those situations in which one fails to recall a word or a piece of information, even though one feels sure that one knows it and that it may pop into consciousness any second. This everyday experience is one with which almost anyone can empathize. In such a situation one can often remember correct partial information about the item. For instance, a person might have a fairly good idea that the name he or she is looking for has two syllables, or could know that it is just a nickname having nothing to do with the man's real name, or be almost sure that it starts with a P. The person could experience one or any number of such pieces of information and yet be unable to come up with the desired name "Pele."

In clinical psychology, the TOT phenomenon was one of the more curious "error types" studied by Freud:
"when one has temporarily forgotten a name, one is annoyed, one is determined to recall it and is unable to give up the attempt. Why is [it] that despite his annoyance the individual cannot succeed, as he wishes, in directing his attention to the word which is 'on the tip of his tongue,' and which he instantly recognizes when it is pronounced to him?" (1920, pp. 14-15).

Freud's reasoning was that the person experiencing the TOT state with a name had something against the bearer of this name and did not like to think about him.

Woodworth (1934) and Wenzl (1932, 1936) collected many observations on naturally occurring TOT states, and described them in detail, summarizing the common properties. The first systematic laboratory study of the tip-of-the-tongue phenomenon was not conducted, however, until much later. In 1966, R. Brown and McNeill created TOT states by giving subjects dictionary definitions of low-frequency words and asking them to come up with the words. In most cases, of course, subjects did not experience a TOT state, either because they produced the target word without hesitation or because they had no idea at all of what it was. But occasionally, some subjects felt that they knew the word even though they could not remember it at that moment. What R. Brown and McNeill observed was that when recall of a word failed but the subjects felt that they were about to produce it, and indeed produced words that were similar to the target word in various respects—such as words that
rhymed with it and shared the same number of syllables—that word was recognized with a higher probability when the experimenter finally disclosed it than was a word subjects did not feel close to recalling.

In the TOT state, when subjects were producing words similar to the target word, what they were in effect doing was giving themselves various cues about the word. Yet these subjects were still blocking on the target word. It appears, then, that in the TOT state something similar to the inhibition observed in the part-set cuing paradigm (Section 1.4) was taking place: The self-created cues were actually inhibiting the recall of the target items (Roediger, 1974; Roediger & Neely, 1982). The subjective experiences of a person who has been in a TOT state would certainly seem to be consistent with this view. When one stops trying to remember and lets go of the thoughts, often the target word suddenly pops into mind.

b. The John Brown Effect

Another demonstration of inhibition in semantic memory was reported by John Brown (1968). He asked his subjects to recall the 50 states of America, but immediately beforehand he asked one group of subjects to study a randomly chosen 25 of these states. Not surprisingly, the total number of states recalled was higher for those subjects who had studied half of them than for control subjects, since the just-studied states tended to be recalled more often by the experimental subjects than by the control subjects.
The main interest, however, was on the recall of the remaining 25 states, those that had not been studied. On this, the subjects who had studied the 25 states beforehand did considerably worse than did the control subjects. J. Brown replicated this finding and obtained similar results using the 40 counties of England as the to-be-recalled items. The tentative explanation that he offered was that the strong associations formed during the study of the noncritical items blocked the recall of the weaker ones—an explanation reminiscent of those given for the retroactive inhibition and part-set cuing findings discussed earlier.

John Brown's (1968) findings were also replicated by Karchmer and Winograd (1971), who again used the states of America. These researchers further showed that if subjects who had studied half the states were asked to recall these states first, recall of the other states was inhibited to an even greater extent. Although such a result seemed to imply the role of an output interference in semantic memory recall, it was beclouded by the confound that the time spent on trying to recall the critical states was not controlled for the two groups of subjects. Roediger and Payne (cited in Roediger & Neely, 1982) gave subjects more time to recall, thereby reducing the confound in the Karchmer and Winograd study, and still obtained the John Brown effect. The dependence of inhibition on time and its temporal course will be discussed more fully in Chapter 5.

The John Brown effect refers to an inhibition of semantic memory recall by recall from episodic memory. Using a variation of
the same basic paradigm, Watkins and Allender (Note 4) obtained an inhibitory effect in semantic memory by merely reminding the subject of some other related items that were not to be recalled; this procedure was rather like the extra-list cuing rather than the intra-list cuing procedure mentioned in describing the part-set cuing findings. Subjects were asked to recall as many items from a given taxonomic category as they could in a certain amount of time. They were also told that, during recall they would sometimes be given instances of that particular category as cues but that these instances were not to be recalled. Sometimes they would be given some instances of a totally different category, and at other times they would not be disturbed at all. Compared to performance in the other two conditions, performance in the condition where subjects were given not-to-be-recalled instances of a category while trying to recall instances from that same category suffered considerably. As with the part-set cuing findings in episodic memory, giving items from a specified set as cues actually inhibited the recall of the other items from the set.

c. Inhibitory Effects of Related Primes

Alan Brown (1979) reported a number of experiments in which semantically related cues, or primes, slowed recall from semantic memory. This finding was later replicated by Roediger, Neely, and Blaxton (in press) in one condition where they measured the subjects' response times and accuracy in answering general knowledge questions. The questions were preceded by one of four different
prime types. To take an example, for the question "Who is considered to be the greatest soccer player in the history of the world?", the neutral prime would be the word "ready," the unrelated prime would be a nonsensical answer such as "television," the semantically related prime would be, say, "Didi," and the correct prime would be "Pele." Roediger et al. found that when subjects were given the semantically related primes, the response latencies were slower than when they were given the other three types of primes.

Another curious finding of a similar nature was reported by Rosch (1975). Subjects were asked to decide whether two words that were presented simultaneously belonged to the same taxonomic category. The answer would therefore be "yes" in the case of, say, the pair chair-table and "no" in the case of chair-dog. Some of the word pairs were preceded by a neutral prime (the word "ready") while others were preceded by a related prime, the category name. Rosch found that in the condition where the two words were identical and also relatively atypical in terms of category membership (e.g., rug-rug as opposed to rug-chair or chair-chair), response times of subjects were slower after the presentation of the related prime than they were after the presentation of the neutral prime.

d. Inhibitory Effects of Multiple Priming

It is well-established that in a task in which a subject makes simple lexical decisions about each of two stimuli presented in succession—merely identifying them as words or nonwords—the relatedness of the first word to the second affects the response
time for the second (Jacobson, 1973; Meyer, Schvaneveldt, & Ruddy, 1975; Neely, 1976; Schvaneveldt & Meyer, 1973; Warren, 1977). The decision that nurse is a word is faster if it is preceded by the word doctor than by a semantically unrelated word, such as cheese.

A curious exception to this finding is that if the concept is primed more than once, response times are no longer faster, and this could be due to a counteracting inhibitory effect. For example, Neely (1977) and Cohene, M. C. Smith and Klein (1978) found that there was no longer a difference between response latencies after the item itself or conceptually related items had been presented many times and after either had been presented just twice. R. Schmidt (1976) found also that subjects committed more errors following eight semantically related primes than following only one such prime—although since subjects also responded faster following eight primes, the result might have been due to a simple speed-accuracy trade-off rather than to memory blocking per se. But it remains the case that in a condition where facilitatory effects were expected, none were observed; and the reason could very well be a counteracting inhibitory effect.

While on this topic, it should perhaps be mentioned that memory inhibition with multiple priming has been demonstrated in another study—although this time involving episodic memory. Neely, S. R. Schmidt, and Roediger (1983) gave a response-time, yes/no recognition test after the subjects had studied a categorized word list.
In this test, some of the items were preceded by various semantically related primes, and it was found that response times were slower when six such primes preceded a target test item than when only two such primes preceded it. Further, this inhibition occurred regardless of whether the relevant primes were grouped together or spaced through the section of the test list before the target item appeared. Again, the curious finding was inhibition in memory—albeit one in episodic memory obtained with a semantic memory manipulation; presenting multiple primes slowed down performance instead of enhancing it.

In a related study, A. S. Brown (1981) asked his subjects to generate category instances with specified initial letters (e.g., Sport-F), the same task used by Cermak et al. (1978), mentioned in Section 3.2b. He found that when subjects generated successive instances from a single category (e.g., Sport-F; Sport-B; Sport-T), their response times in generating each instance became increasingly slow. Such was not the case when subjects generated instances from several different categories (e.g., Fruit-W, Animal-C; Sport-T). Note, however, that conflicting results were obtained by G. R. Loftus and E. F. Loftus (1975), who used a slightly different procedure, in which subjects did not know beforehand whether the next instance to be generated would be of the same category or of a different category. A. S. Brown also observed memory inhibition in an object naming task, in which he asked subjects simply to name the object depicted in each presented picture as fast as they could.
Response times in naming a given picture increased with the number of semantically related pictures that had already been named. 

e. Evidence for Inhibition in Semantic Memory through Perceptual Tasks

The studies that are reviewed next have all explored various questions in perception rather than in memory. Nevertheless, they too provide evidence for inhibition in semantic memory. The tasks used are perceptual, but performance on those tasks depends on information from semantic memory, and the obtained results suggest inhibition.

1. The Stroop Effect. Perhaps the most thoroughly investigated inhibitory effect in semantic memory through a perceptual task is the Stroop effect, which takes its name from the person who first observed it (Stroop, 1935). In the standard Stroop task the subject is required to name the color of the ink in which a word is written, and the basic finding is a longer response time if the word is the name of some other color rather than the name of the color of the ink being presented or an unrelated word. The same kind of inhibition with incongruent stimuli has also been manifested using different materials such as word meanings that mismatch arrow directions (Shor, 1970), spatial positions (White, 1969), and geometric shapes (Comptone & Flowers, 1977). Naming a picture that is presented simultaneously with a to-be-ignored word is also slower, or inhibited (M. C. Smith & Magee, 1980), especially when the picture and the word are semantically related (Lupker, 1979;
Lupker & Katz, 1981). The Stroop Effect has generally been explained in terms of one form of or another of the response-competition theory. The basic finding in all these studies is that if the presented perceptual stimuli are not congruent with the semantic memory task at hand, there is inhibition in semantic memory.

ii. The repeated-letter inferiority effect. Another inhibitory effect in a perceptual task was reported by E. L. Bjork and Murray (1977). Subjects were briefly presented with two letters (e.g., AE), and then cued for the report of one. E. L. Bjork and Murray found that performance was better when the two letters were different than when identical. Egeth and Santee (1981) found that this inhibitory effect was still very much present even when the physical features of the repeated letter did not match (e.g., Aa), a finding which suggested that the inhibition was at a semantic level. In a similar study, G. Underwood (1981) found that parafoveal presentation of words interfered with the categorization of a foveally presented target word, but only when the parafoveal and the target words belonged to the same category. In yet another study, Neill (1979) asked his subjects to decide whether two letters or digits that were presented were the same or different. Speed of responding was emphasized for some subjects and accuracy for others. Neill found that when accuracy was emphasized, a prime from the same category as the targets (a letter for letters or a digit for digits) actually hurt accuracy in responding to "same" target pairs (e.g.,
As or 88) in comparison to when the prime was from the other category (a digit for letters or a letter for digits)—a result that can perhaps be seen as a variation on Rosch's (1975) finding discussed in the previous subsection.

iii. Recognition of out-of-focus pictures. Although perhaps in itself no more significant than the other perceptual tasks that show inhibition in semantic memory, a particular experiment by Bruner and Potter (1964) merits special attention. It appears to be, at least in principle, very similar to Experiment 1 of this study.

The subjects' task was to identify pictures that were gradually brought into focus. There were three starting focus levels—very blurred, medium blurred, and light blurred—and a picture starting from one of these levels was continuously brought into focus until a stopping focus level was reached, at which point the subjects were asked to identify it. Bruner and Potter (1964) found that the greater the starting blur level, the less likely was the picture's identification. Their interpretation of this systematic impairment in performance was in terms of the difficulty of relinquishing the initial incorrect hypotheses that were formed on the basis of the degraded cues.

As is perhaps obvious, the successive cuing procedure of starting with a 2-letter word-fragment and increasing to a 5-letter fragment could be viewed as being analogous to starting at the very blurred state and gradually coming into focus; similarly, giving
just the 5-letter fragment cue could be viewed as being analogous to starting at the light-blurred state. The results were certainly strikingly alike. One major difference, however, was that Bruner and Potter's (1964) experiment demonstrated this particular inhibition in semantic memory whereas Experiment 1 demonstrated it in episodic memory.

3.4 Summary and Conclusion

In the first part of this chapter, the distinction between episodic and semantic memory was discussed. The utility of such a distinction was considered, and it was concluded that even though more substantial evidence was needed to demonstrate a functional distinction between episodic and semantic memory, there was sufficient evidence to accept, at least tentatively, the case for two functionally distinct memory systems.

The first two chapters were concerned with inhibition only in episodic memory. The studies reviewed in Chapter 1 had simulated inhibition by blocking memories for just-studied items of information. The experiment reported in Chapter 2 demonstrated a qualitatively different inhibitory effect, but again the effect was in episodic memory. In the second part of the present chapter, interest focused on findings of inhibition in semantic memory, and some of the more influential studies showing such inhibition were reviewed. In these studies, memories for everyday information, memories that subjects already possessed as generic knowledge, were blocked through some laboratory manipulation.
Chapter 4

Context-Free Inhibition Only in Episodic Memory:

Experiments 2, 3, and 4
4.1 Introduction

The question addressed in this chapter is whether the inhibitory effect found in Experiment 1 with episodic memory extends to semantic memory. Three experiments are reported in which the existence of the same sort of an inhibitory effect in semantic memory, along with possible differences between episodic and semantic memory in showing such an effect, were explored. In all three experiments the word-fragment cuing procedure of Experiment 1 was used.

4.2 Experiment 2

As was mentioned in Section 3.3d, Bruner and Potter's (1964) finding—that of picture identification being directly related to the degree of focus of its initial presentation—very much resembles the finding of Experiment 1 (Chapter 2). The only difference in principle is that whereas the Bruner and Potter experiment demonstrated inhibition in semantic memory, Experiment 1 demonstrated it in episodic memory. The purpose of Experiment 2 was to see whether an inhibitory effect occurs in semantic memory with the word-fragment cuing procedure used in Experiment 1.

a. Method

The method was identical to that of Experiment 1, except that the study phase was omitted. The subjects tried to discover each word using their general knowledge of the English language, or semantic memory. As before, the subjects were 12 adults recruited
on Rice University campus. They participated for pay, and were tested individually or in groups of four or fewer.

b. Results and Conclusion

The results were very similar for the two cuing conditions. More specifically, there was no hint of inhibition with the successive-cuing procedure: The proportion of words produced in the successive-cuing condition (.53) was no less than that in the single-level cuing condition (.51). The proportion of words discovered at earlier levels for the successive-cuing condition are again of no particular relevance to present purposes; they are shown in Table A3.

It seems, then, there was no inhibitory effect with the present procedure when the words had to be produced solely on the basis of semantic memory. Semantic memory is certainly not immune to inhibition; as was shown in the last chapter, there are many demonstrations of such inhibition in the literature. Indeed Bruner and Potter's (1964) procedure is, in theory, quite similar to the present one—the only major difference being that it used blurred pictures rather than word-fragments as cues—and it too gave rise to inhibition. Yet in the present experiment the word-fragment cuing procedure that creates inhibition in episodic memory failed to create inhibition in semantic memory.

4.3 Experiment 3

The two experiments reported thus far suggest a clear functional difference between episodic and semantic memory. In
Experiment 1 when the to-be-discovered words had just been studied, giving weaker cues reduced the effectiveness of subsequent stronger cues in eliciting recall. In Experiment 2, however, when the words had not been studied beforehand, no such inhibition was observed. The purpose of Experiment 3 was to check this interaction between type of memory and type of cuing procedure directly. Also, in this experiment the strength of the starting cue levels—that is, the number of letters included in the first fragment cue to be presented—was systematically varied so as to provide a more detailed picture of the expected inhibition in episodic memory.

a. Method

i. Materials and design. A random set of 90 words was chosen from the set of words used in the first two experiments. These words were divided into three lists of 30 words each, with the first two and the last three words in each list acting as buffer items to reduce possible primacy and recency effects. Each list therefore comprised 25 critical words. Half of the subjects (the episodic group) were given these lists of words to study, as in Experiment 1 and the other half (the semantic group) were not, as in Experiment 2. Thus, whereas the episodic group studied the to-be-discovered words before each test, the semantic group subjects were given only the tests, without first being exposed to the words.

The tests were similar to those in the previous two experiments in that they involved successively increasing word-fragment cues. This time, however, there were five levels of cuing, starting from a
2-letter fragment and increasing up to a 6-letter fragment. In addition, the starting cue levels involved, not just the first and the last level fragments, but also every cue level in between. Hence, some of the words were cued starting with a 2-letter fragment, some starting with a 3-letter, some a 4-letter, and some a 5-letter fragment, and all of these increased up to the 6-letter fragment; and other words were cued with only the 6-letter fragment, just as in the single-level cuing condition of the previous two experiments. In fact, in each list of 25 words, five words served in each of the five starting-cue-level conditions, so that with data combined across lists there were 15 words per subject in each condition.

The lists and the words within the lists were presented and tested in the same order for all subjects. For each list, both presentation and testing orders of the words were randomized with respect to the starting-cue-level condition and, through rotation across five groups of subjects, each word served equally often in each of these conditions.

ii. Subjects and procedure. The subjects were 100 Rice University students participating either for pay or for course credit. Fifty were assigned to the episodic group and 50 to the semantic group. They were tested individually or in groups of four or fewer.

Apart from accommodating for more starting cue levels, the procedure was much the same as that in the previous experiments. Subjects were given the same testing instructions as in the first
two experiments, except this time they were also told that cuing could begin with any number of letters between two and six. The response sheets were much as before, comprising a five-slot box for each to-be-discovered word. Before being presented with each initial fragment cue, subjects were told to cross off the number of slots in the box that would not be needed for that word. Thus, if cuing started with, say, a 4-letter word-fragment, subjects were told, before being shown the first cue for that word, to "cross two," which meant that they should cross off the first two slots because these slots would not be needed (since a 2-letter and a 3-letter fragment would not be shown for that word) and that they should enter their first response, a word or a cross, in the third slot.

As before, subjects were allowed 4 seconds to discover the word at each cue level. For the episodic group, presentation of the words in the study lists was at a rate of one word every 2 seconds. In the beginning of the session subjects were given detailed instructions regarding the general procedure and then three practice trials with the cuing procedure; for the episodic group these practice trials were given after the presentation of the first list and involved three of the buffer words from this list.

b. Results and Conclusion

The results are summarized in Tables 1 and 2, which show cumulative recall totals at each cue level for the episodic and semantic memory groups, respectively. In the episodic memory condi-
tion, in which subjects had studied the words before being given the word-fragment completion test, the presentation of weaker cues inhibited the effectiveness of subsequent stronger cues. In fact, this inhibition was quite systematic. As can be seen from Table 1, with but a single exception, subjects recalled words less often at any given cuing level if they had already been cued with weaker fragments. This observation was confirmed by statistical analyses. The overall statistic was computed by assigning proportional weights to the difference scores at each cue level (these assigned moment weights—or trend coefficients—can be found in Table A5). The linear was statistically reliable, $t(49)=3.80, p<.001$. Moreover, when trend components were computed at each level of cuing taken separately, significant differences in inhibitory effects occurred at cue levels of both 5- and 6-letter, $t(49)=2.56, p<.01$ and $t(49)=4.25, p<.001$, respectively.
Table 1

Cumulative number of items recalled at each cue level in the episodic condition as a function of starting level in Experiment 3. Maximum score is 750.

<table>
<thead>
<tr>
<th>starting levels</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100</td>
<td>195</td>
<td>305</td>
<td>487</td>
<td>671</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>211</td>
<td>331</td>
<td>522</td>
<td>679</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>332</td>
<td>533</td>
<td>697</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>538</td>
<td>691</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>705</td>
</tr>
</tbody>
</table>
Table 2
Cumulative number of items recalled at each cue level in the semantic condition as a function of starting level in Experiment 3. Maximum score is 750.

<table>
<thead>
<tr>
<th>starting levels</th>
<th>number of letters given</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
</tr>
</tbody>
</table>
In the semantic memory condition the picture was quite different. When subjects tried to generate the words at test using only their lexical knowledge, no inhibition was observed. As can be seen from Table 2, the level at which cuing started was of no consequence; recall performance was about the same regardless. In fact, overall, performance was enhanced when cuing started at a weaker level, though not significantly so, \( t(49) = 0.99, p > .10 \). Neither was there any hint of an inhibitory effect for any of the individual starting levels.

The overall difference in linear trend between the two types of memory, or subject groups, was statistically reliable, \( t(98) = 3.20, p < .001 \). Reliable between-group differences in linear trends also occurred for the 5- and 6-letter cue levels taken individually, \( t(98) = 1.87, p < .05 \) and \( t(98) = 3.64, p < .001 \), respectively.

This experiment replicated the results of both Experiment 1 and 2, and also revealed a more detailed picture of the inhibition in episodic memory. When the words are studied beforehand, the weaker the first word-fragment cue for a word, the less effective the subsequent stronger cues become in eliciting the word. When the words are not studied beforehand, however, no such effect occurs. Recall with the aid of stronger word-fragment cues does not seem to be affected—or at least not negatively affected—by the prior presentation of weaker cues. It appears, then, that giving weaker word-fragment cues before stronger cues affects episodic and semantic memory in different ways.
4.4 Experiment 4

Experiment 3 showed an inhibitory effect of presenting low-level word-fragment cues on the effectiveness of subsequent cues in episodic memory but no such effect in semantic memory. This difference could have a simple explanation. It could reflect merely a strategy difference, a difference in the way subjects go about the task of completing the fragments. For instance, it could be that when subjects do not first study the words, they do not feel as much pressure and thus do not produce the words until the cues are of sufficient strength to render production effortless. In contrast, when subjects study the words beforehand, they may be actively thinking of those words at test and trying very hard to fit words from the list to weak cues. The resulting premature hypotheses could, as Bruner and Potter (1964) suggested for picture recognition, hinder recall in response to stronger cues. Or perhaps the presentation of a weaker cue locks the episodic group subjects into a "recall" mode that renders subsequent "recognition"—perhaps the more expedient mode for stronger cues—less efficient (cf., Section 1.5). Since there is no limited set to recall words from, the semantic group subjects would presumably always be in the "recognition" mode and thus the presentation of a weaker cue would not be a hinderance.

Any such conscious strategy explanation of the different patterns of results for episodic and semantic memory recall can easily be checked by varying the episodic-semantic condition of a
word within a test in an unpredictable fashion. Thus, if subjects study only some of the words that they are asked to produce, and at test are not given any information as to which cues are fragments of studied words and which are of nonstudied words, then whatever strategy they might adopt should be the same for both types of words, and what difference remains in the effect of prior cuing would have to be explained in some other way. The purpose of this experiment, therefore, was to see whether the finding of inhibition in episodic memory and the lack of inhibition in semantic memory still remained when the subjects could not use different strategies for the two types of memory task.

b. Method

The method was patterned very closely after that of the first two experiments. The only major difference was that only some of the to-be-discovered words were included in the study lists, so that, rather than having just a single condition at test where the words were either all episodic or all semantic, both conditions were included in the same test.

i. Materials and design. Eight new words (shown with asterisks in Table 1) were added to the 120 critical words of the first two experiments. The resulting set of 128 critical words was randomly split into four lists of 32. Of the 32 words in each list, a given subject was presented with only 16; the other 16 unpresented words formed the semantic condition at test. These 16-word subsets were interchanged between two groups of subjects so that, across the
two groups, each word served equally often in the episodic and semantic conditions. Also, half of the words in each subset of 16 were cued in the successive-cuing condition, starting with a 2-letter fragment and increasing gradually to a 5-letter fragment, and the other half were cued in the single-level cuing condition with just the 5-letter fragment being presented. The words in the two cuing conditions were of course interchanged across another two groups of subjects. One other variable that was counterbalanced in this experiment, and not in the previous three, was the testing order. The testing order within each list was reversed for half of the subjects. There were, therefore, a total of eight groups of subjects for counterbalancing purposes.

ii. Subjects and procedure. The procedure was similar to that of the first two experiments. As before, the session began with detailed instructions, followed by three practice test trials. Subjects were then given four 16-word lists to study, each of which was followed by a cued-recall test of the 16 words just presented intermixed with another 16 that had not been presented. Subjects were told that during the cuing procedure they would not know which fragments were of presented words and which were of unpresented words, and that their task was to discover the words as quickly as possible, whether or not the words had been presented.

The subjects were 16 Rice University students participating either for pay or for course credit. They were tested individually or in groups of four or fewer--although eight groups of subjects
were needed for counterbalancing measures, since the presentation of the list words was individualized, it was possible (and in fact even more desirable to prevent a possible timing bias) to test together the two groups of subjects across which the episodic and semantic words within a list were interchanged.

c. **Results and Conclusion**

The results are straightforward. When the to-be-discovered words were from episodic memory, inhibition was again clearly observed. The probability of recall in response to a 5-letter fragment was .83 when this was the only cue presented, and .73 when this cue followed the presentation of previous lower level cues. The difference was statistically reliable, $t(15)=3.99$, $p<.01$.

When the to-be-discovered words were from semantic memory, on the other hand, the probability of recall was similar regardless of whether only the 5-letter fragment was presented (.52) or whether the 5-letter fragment followed the presentation of previous weaker fragments (.51), $t(15)=0.41$, $p>.10$. As before, the recall probability at each cuing level in both episodic and semantic conditions are not relevant to present purposes and are shown in Table A3. The interaction of interest, that between type of cuing and type of memory was again reliable, $t(15)=2.64$, $p<.01$.

The inhibition in episodic memory and the lack of it in semantic memory with this particular successive-cuing procedure are once more replicated. In addition, the present results rule out any explanation involving the subject's test strategy. Subjects were
not given any information as to which fragments were those of studied words and which not, and yet the effect of prior cuing was still limited to only those words that had been previously studied. Thus, this finding argues for a significant functional distinction between episodic and semantic memory.

4.5 Summary and Conclusion

In this chapter three experiments were reported. Experiment 2 suggested that the inhibitory effect found with the successive word-fragment cuing procedure of Experiment 1 did not extend to semantic memory. The inhibition in episodic memory was investigated in some detail in Experiment 3, and it was found that the magnitude of the effect varied systematically with the starting cue level: The weaker the initial cue, the greater the impairment in recall. Experiments 3 and 4 included both episodic and semantic memory conditions and, as in Experiment 2, showed no inhibitory effect in semantic memory. In addition, Experiment 4 ruled out a trivial explanation of the difference in the inhibitory effects between episodic and semantic memory, showing that it was not due to any strategy differences on the part of the subjects.
Chapter 5

The Temporal Course of Inhibition
5.1 Introduction

How long does an inhibitory effect last? After all, one can often remember what one had for dinner the previous night or the words of a newly learned song if one tries long enough or, under some circumstances, if one stops trying. Clinical observations, too, show that retrograde amnesia following a traumatic event usually dissipates with time. Whatever the reason for inhibition, with time, it can go away.

It would be of some interest, then, to examine the temporal course of the inhibition created under laboratory conditions. The main focus of this chapter is on the particular inhibition obtained with the successive-cuing procedure used in Experiments 1–4. First, however, it is worthwhile to mention the relevant findings for inhibition found with other paradigms.

a. Temporal Course of Retroactive Inhibition

A major development in the interference theory of forgetting was the idea of spontaneous recovery. This development was an extension of the analogy between "unlearning" (Melton & J. M. Irwin, 1940) and findings from the extinction studies in animal conditioning paradigms. B. J. Underwood (1948 a, b) reasoned that if responses to the A-B list were really "unlearned," at least to some degree, they should exhibit spontaneous recovery when a blank period is allowed after the interpolated A-D list just as, with animals, extinguished responses recovered strength with increasing delay following the extinction session. This spontaneous recovery would
be manifested in an improvement in performance on the recall of the original (A-B) list with increasing post A-D list retention interval. (Note that in this case, the term "unlearning" may be misleading: If there was any spontaneous recovery at all, it would imply that the associations were not really unlearned, but that they were temporarily repressed or blocked.) This prediction of spontaneous recovery in retroaction studies was confirmed by B. J. Underwood and, later, by Briggs (1954).

The idea of spontaneous recovery in the A-B, A-D paradigm was subsequently investigated in more detail with the use of the MMFR procedure, a procedure that probed memory for the recall of both response terms. There were many studies conducted to this end, and an excellent review can be found in L. Postman, K. Stark, and Fraser (1968). The results of most of these studies were negative, showing no evidence for spontaneous recovery. Occasionally, however, a recovery effect was reported (e.g., Silverstein, 1967), although its magnitude was usually quite small, and even the effect itself was usually obtained only under special circumstances, such as with exaggerated degrees of overlearning on the first list.

In addition to reviewing the literature on spontaneous recovery, L. Postman et al. (1968) demonstrated the effect under special conditions in their own laboratory. To rescue the idea of spontaneous recovery, they proposed a response-set suppression hypothesis (see also Newton & Wickens, 1956). According to this hypothesis, when a subject is asked to learn a second list, he or she develops a
strategy for avoiding the first list (i.e., the A-B associations) as a whole. With passage of time after the acquisition of the second list, however, the tendency to suppress the first list dissipates, leading to a recovery from inhibition. A test of this hypothesis was by means of the MMMFR procedure, in which, along with the stimulus term (A), the interfering response term (D) was also provided. The intention was to further remind the subject of his or her suppression strategy, which would in turn provide even more inhibition for the first list responses. Thus, since with the D term provided the initial inhibition would be greater, with the passage of time more recovery should be observed in a later test of the A-B list in the MMMFR condition than in a conventional MMFR condition (where, initially, both responses are asked for). As predicted, a later test of only the A-B list did indeed demonstrate more recovery after the MMMFR than the MMFR procedure. In a nutshell, then, the experiments pursuing the temporal course of retroactive inhibition seem to indicate that although such inhibition probably does not disappear totally, it can, with the passage of time and under certain conditions, be significantly attenuated.

b. Temporal Course of the Inhibitory Effect of Recall on Subsequent Recognition

The inhibitory effect of an interpolated recall test on subsequent recognition performance was discussed in Section 1.5. Despite an occasional counterfinding, it has been demonstrated that if subjects are asked to recall a set of items before receiving a
recognition test, their performance on the recognition test is depressed. Belbin (1950) observed that the inhibition resulting from an interpolated recall test was very much present even when the recognition test was delayed by three hours; this finding was later replicated, with a slightly different procedure, by Kay and Skemp (1956). Thus, allowing substantial time between the two tests does not seem to eliminate the inhibitory effect of the initial recall test.

c. Temporal Course of Inhibition in the John Brown Effect

Although an inhibitory effect in semantic memory was not observed with the present word-fragment cuing manipulation, it is worth mentioning what happens to inhibition over time in a semantic memory paradigm in which inhibition is observed. One criticism of John Brown's finding (where studying some of the to-be-recalled items inhibited the recall of the remaining items from semantic memory) was that he did not give subjects enough time to recall. Since subjects who had studied some of the items tended to recall these items first, the recall period might not have provided as much time for these subjects to try to recall the other items as it did for the control subjects. As was mentioned in Section 3.3b, Roediger and Payne (1982; cited in Roediger & Neely, 1982) gave their subjects a full 10 minutes for recall, measuring performance cumulatively. Although the John Brown effect was small in magnitude, it was still statistically reliable at the end of the
10-minute period, at which time the recall functions of both groups were measured to be very close to the asymptote.

d. Hypermnesia

Hypermnesia is a finding that has precious little to do with inhibition per se, but has a lot to do with the temporal course of inhibition. It refers to the finding of continued improvement in recall of a set of items across repeated recall tests or with increased time on any given test. Although observed with considerable enthusiasm in the early days of memory research (Ballard, 1913; W. Brown, 1923; Nicolai, 1922), the results from such studies were not always replicable (Ammons & Irion, 1954; Buxton, 1943), and the enthusiasm gradually waned.

Interest in this topic was rekindled primarily through the efforts of Erdelyi and his associates. Although hypermnesia is a counterintuitive finding and seems to go against the normal forgetting functions, it has proven, with recent procedures to be quite robust. For example, Erdelyi and Becker (1974) found that, at least with pictures, performance improved across the three successive 7-minute recall tests. More dramatically, with repeated recall efforts over a week, Erdelyi and Kleinbard (1978) found over 50% improvement compared to initial recall levels. Elaborating on the same theme, Roediger and Thorpe (1978) reported that the number of actual tests did not matter; as long as the total recall time was long enough, performance continued to improve. The same effect has also been found with words (Belmore, 1981; Erdelyi, Buschke, &
Finkelstein, 1977; Roediger & Thorpe, 1978; Roediger, Payne, Gillespie, & Lean, 1982). The finding of hypermnnesia has been replicated many times (e.g., Erdelyi, Finkelstein, Herrell, B. Miller, & Thomas, 1976; Madigan, 1976; Yarmey, 1976), and is no longer an issue; recall increases over time.

One way of accounting for hypermnnesia is to assume that some sort of an initial inhibition dissipates as time spent on recalling a set of items increases. It is of some interest to note that this initial inhibition is probably specific to recall, since when the test format is recognition, more time spent on making a decision does not affect response accuracy, whereas more time spent on a cued-recall test—at least for episodic words—does indeed improve performance (Peynircioğlu & Watkins, Note 2). If one thinks of hypermnnesia in recall as the dissipation of some sort of an initial inhibition, the observed improvement in recall very much resembles the idea of spontaneous recovery in classical interference theory—although of course in hypermnnesia research nothing is experimentally induced to cause "unlearning." Recall appears to be a self-inhibiting process. Whatever the interpretation of hypermnnesia, for present purposes the point of interest is that one kind of inhibition, albeit one that is not artificially created or even observed as such, does go away with time.

5.2 The Present Paradigm

Interest now turns to the temporal course of inhibition obtained in the present study. The successive word-fragment cuing
procedure used in Experiments 1, 3, and 4 led to a lower level of episodic recall than did the single-level cuing procedure. Is this inhibition just a temporary development, one that dissipates within seconds, or is it a more permanent effect, controlled strictly by the episodic nature of the recall task? If the inhibition is indeed temporary and dissipates in a short time, the effect could not be said to be controlled solely by the episodic nature of the task.

The suggestion would be that the episodic nature of the recall task is only the initial basis for the inhibitory effect, but that episodicness is not what regulates or directs the effect. That is, the episodic nature of a recall task may be necessary to promote the inhibitory effect initially, but not sufficient enough to make it persist.

The purpose of the next experiment was to explore the possibility that this inhibition might be temporary. It was conceivable that even a beneficial effect of prior cuing could occur if subjects were given more time to complete the last-level, critical cue. Thus, the question posed was whether the inhibitory effect would still occur if, for both the successive and single-level cuing conditions, subjects were given plenty of time with the critical word-fragment cue.

5.3 Experiment 5

a. Method

The method was identical to that of Experiment 4 with the exceptions that (a) subjects gave their responses orally, (b) the
time allowed at each cue level in the successive-cuing condition was decreased to 3 seconds, and, most importantly, (c) if subjects were unable to discover a word after the regular 3 seconds with the strongest level cue, they were allowed to continue trying for an additional 60 seconds. The time it took for them to make a correct response during this additional interval was recorded using a stop-watch. The subjects were 16 Rice University students participating for pay or course credit. They were tested individually.

b. Results and Conclusion

Before turning to the results of main concern, it should be noted that before the extra time was allowed, there was again a reliable inhibitory effect of prior cuing in episodic memory. The proportion of words discovered after 3 seconds of cuing with the 5-letter fragment was .65 in the successive cuing condition and .77 in the single-level cuing condition, t(15)=5.17, p < .001. As before, no such inhibition was observed in semantic memory: The proportion of words discovered at the end of the regular period in the successive cuing condition (.49) was in fact slightly greater than that in the single-level cuing condition (.45), though not reliably so, t(15)=1.45, p > .10. Once again the interaction between type of memory and type of cuing was reliable, t(15)=5.18, p < .001.

Having obtained the expected inhibition in episodic memory, interest now focuses on what happened during the course of the
additional recall time. Cumulative levels of recall for the successive and single-level cuing conditions during the additional minute are shown for both episodic and semantic memory conditions in Figure 1. Although response times of the subjects were recorded to within a second, for ease of exposition and analysis, they were collapsed into 6-second segments. As can be seen, the inhibition in episodic memory did not dissipate over the 60 seconds. Although performance was at a high level at the end of the minute (.97 in the single-level and .89 in the successive-cuing condition), the inhibitory effect remained as strong as it was in the beginning; certainly it was still statistically reliable, $t(15) = 5.09$, $p < .001$. It was also reliable at every point in between.

As expected, in the semantic condition, performance in the two cuing conditions remained similar throughout the 60 seconds, and at no point was there any hint of inhibition. At the end of the 60 seconds, the proportion of words produced was .81 in both the single-level and the successive-cuing conditions; the type of memory by type of cuing interaction was still reliable, $t(15) = 3.14$, $p < .01$. 
Figure 1. The time course of inhibition in episodic memory. Experiment 5. 
●—● single-level cuing, episodic recall, □—□ successive-cuing, episodic recall, ×—× single-level cuing, semantic recall, △—△ successive cuing, semantic recall.
It seems, then, that after a full minute during which level of performance reaches a very high level, the inhibitory effect of prior cuing remains undiminished. It should be noted that the time allowed for inhibition to dissipate was in fact 20 times (3 seconds versus 60 seconds) as great as was the time allowed initially. Such a result suggests that the inhibition observed within episodic memory with the present test manipulation is not just a temporary effect but an enduring one, probably tied to the episodic nature of the recall task.

5.4 Conclusion

In previous chapters a curious finding of an inhibitory effect with the successive word-fragment cuing procedure in episodic memory was demonstrated. Such evidence as is available suggests that inhibitory effects found in other paradigms often tend to dissipate, at least to some degree, over time, and the experiment reported in this chapter was designed to investigate the temporal course of the inhibition found with the present cuing procedure. More specifically, the question was whether the inhibitory effect of cuing would diminish as more time was allowed on the critical cue. Thus, in Experiment 5, both in the single-level and the successive-cuing conditions, subjects were given an additional minute to recall a word if they had not succeeded in the initial allowed time, and their response times were recorded. The results showed as large an inhibitory effect of successive cuing at the end of the minute as at the end of the initial 3 seconds. Clearly, the inhibition observed with
the present cuing procedure is not a transitory phenomenon, which is consistent with the idea that it is a product of episodic memory.
Chapter 6

Summary, Conclusions, and Speculations
Memory inhibition, or blocking, may be defined as a memory failure due to an interfering agent occurring after the memory is formed. It is an everyday feature of human memory, and as a topic of research it is as old as memory experimentation itself. The classical interference era, an era dedicated almost exclusively to this issue, produced countless demonstrations of memory inhibition. Other approaches have, between them, yielded an equally prolific literature. The results of all this research have been influential in shaping current theories of memory, from simple heuristic principles to intricate mathematical formulations. Although there is still no entirely satisfactory explanation of why inhibition occurs, the results obtained in the laboratory clearly show that it can be simulated, manipulated, and predicted with a certain amount of confidence.

The present series of experiments also demonstrates inhibition in memory. But unlike previous demonstrations, the inhibition is brought about in a way that does not deliberately mismatch the test environment with the study environment, nor does it involve introducing more items of the sort being tested. Subjects studied a list of words, and were then cued for recall with fragments of these words. In the successive-cuing condition, cuing for each word began with a weak level cue (a 2-letter fragment), which increased progressively until it included 5 or 6 letters of an 8-letter word. In the single-level cuing condition, only the strongest level cue was used. Performance was found to be impaired in the successive-cuing
condition relative to that in the single-level cuing condition. This basic finding was replicated several times. In addition, the magnitude of this inhibitory effect varied systematically with the number of letters included in the initial cue. When cuing began with a 2-letter fragment recall was inhibited to a greater extent than when it began with a 3-letter fragment, which in turn was inhibited to a greater extent than when cuing began with a 4-letter fragment, and so on. Further, the inhibitory effect was found to be by no means a momentary phenomenon. It still occurred when subjects were allowed a full minute on the final-level cue.

The significance of these results can perhaps be best appreciated from the perspective of Mandler's (1979) distinction between item elaboration and item integration. Briefly, elaboration during a study period refers to a relating of the to-be-remembered item to other items or to extra-list concepts—a process that could result in many different avenues for accessing the items in a subsequent memory test. For instance, given the word cat, the subject might think back to one of the previous words such as ball, and form an image that combines the two words; or he or she might quickly think of such concepts as animal, fur, love, and link them with the target word cat. Integration, on the other hand, refers to thinking about the specific features of a given word in isolation. Although it is not quite clear from Mandler's exposition whether integration could also refer to thinking about the specific features of the concept that a word denotes, the process at least encompasses
all perceptual organization that could take place within a given word. Thus, for instance, when given the word *cat*, integration would involve directing attention to the sound of the word, its shortness, its particular letters and so on.

Previous demonstrations of memory inhibition can be readily interpreted as interference with the effects of the elaboration process (cf., Warrington & Weiskrantz, 1974). The present demonstration, on the other hand, is more readily thought of as due to interference with the integration process. A finding of major interest in this research was that the inhibitory effect of prior cuing did not occur when the to-be-discovered words had not been studied beforehand, and hence when performance was based entirely on semantic memory. Although context-dependent inhibition—and in one case (Bruner & Potter, 1964) what could perhaps be called context-free inhibition—had been previously demonstrated in semantic memory, with the present procedure there was none. Perhaps this lack of inhibition should not be terribly surprising. If, as has been suggested here, context-free inhibition is due to disruption of the outcome of some integration process, there should be no inhibition in the semantic memory condition, for the to-be-discovered words had not just been presented and so had not just been integrated. Words in the abstract—i.e., words in semantic memory—are generally conceptualized as existing in relation to other words and to their respective concepts. Thus, unless first its concept is isolated and activated, a given word's physical representation does
not play much of a role in one's recollection of that word. An explanation of this sort can thus accommodate the lack of inhibition in semantic memory.

Bruner and Potter's (1964) demonstration of inhibition in semantic memory when, in a progressive focusing task, identification of pictures was impaired without manipulation of context, the finding may have been specific to the type of material used. Pictures, or graphic representations of objects, are more likely to be inherently "integrated" in semantic memory. In thinking about an apple, one may tend to visualize it, and so activate its pictorial features, whereas its symbolic graphemic representation may be less likely to be activated. This difference between the two types of material (pictorial and verbal) could very well underlie the discrepancy between the present findings and those of Bruner and Potter, despite the formal similarity in the cuing procedures. Of course, an obvious prediction from such a hypothesis is that using a gradual focusing procedure should not inhibit identification of printed words. Conversely, a successive fragment-cuing procedure should inhibit identification of pictures when successive picture fragments are presented.

Bruner and Potter's (1964) findings notwithstanding, the present results certainly show an impressive interaction between type of cuing procedure and type of memory. Although the distinction between episodic and semantic memory has been accepted well enough for it to find its way into introductory text books, its
usefulness beyond that of satisfying intuition has often been questioned for lack of a definitive functional difference. The present results would appear to demonstrate such a difference. It is of interest to speculate that as the episodioness of the to-be-discovered items wanes, the inhibitory effect would dissipate. An obvious way of checking this implication would be to give the single-level and successive cuing tests at various times after list presentation. One would expect that eventually, as the words gradually lost their special status of having been recently experienced as unique events, the observed inhibition would diminish.

There is research on the Stroop Effect—the finding that naming the color in which a word is printed is slower if the word is the name of another color—that is of some relevance here. Dyer (1971) separated the color and word components of a single stimulus, and desynchronized their presentation, such that the words were initially presented in black and after a variable interval were colored in with an interfering color. In this way, Dyer was able to investigate the inhibitory effect as a function of the interval between the presentation of the two components of the stimulus. Color-naming latencies turned out to be much shorter when the initial incongruent word in black was exposed for more than 50 milliseconds, indicating that interference was being reduced at this delay. There was, however, still some inhibition in color naming even after 500 milliseconds (the longest delay interval); it still took subjects longer to name the color in which a word was written if the word was
the name of another color. In a study extending this line of research, Glaser and Glaser (1982) also found that inhibition was present but very much reduced after a delay of about 200 milliseconds.

Could an analogous reduction in inhibition be obtained in the present paradigm? Would the inhibitory effect of weaker cues on the effectiveness of the stronger cues ever dissipate of the two were temporally separated? More particularly, if a subject failed to discover a word with, say, a 2-letter fragment, would giving a stronger cue after interpolating other test trials—and thus, presumably, directing the subject's attention away from the undiscovered word—still be less effective in eliciting that word compared to when the subject is not given the initial 2-letter fragment trial? If not, it would be interesting to systematically chart the dissipation of the inhibition.

It would also be of interest to see how far the inhibitory effect reported here would generalize to other test procedures, such as the gradual focusing procedure of Bruner and Potter (1964) and the tachistoscopic perceptual recognition procedure of Jacoby and Dallas (1981). Another direction worth pursuing would be to change modalities, and to see if, when words are presented auditorily, giving auditory cues of successively better quality would give rise to a similar inhibitory effect. Further, it would be of interest to see if the integration process is modality-specific or modality-independent. For instance, would weak word fragments inhibit strong
fragments if the words had been presented auditorily? Inhibition arises in the successive-cuing procedure when weaker cues are gradually replaced by stronger cues. It may be of interest to see whether such inhibition would still arise when the stronger cues did not subsume the weaker cues, but were qualitatively different. For instance, would preceding the strong word-fragment cue by a weak tachistoscopic cue impair fragment completion relative to presenting the strong word-fragment cue alone?

Finally, it would be worth seeing whether an inhibitory effect comparable to that obtained in this study would arise if semantic rather than physical cues were used. In the terminology of Mandler's (1979) distinction, would a successive-cuing procedure that tapped the effectiveness of elaboration processes be also detrimental to recall? Thus, for example, would a strong semantic cue, such as "a small, oval-shaped, transparent particle associated with a weather phenomenon" for the target word RAINDROP be less effective if it followed a weak cue, such as "a small, oval-shaped particle?"

In brief, this study has demonstrated a new form of memory inhibition. Giving a weak word-fragment cue prior to a strong word-fragment cue has been shown to impair memory performance compared to giving just the strong fragment. This inhibitory effect was found to be robust and to persist undiminished when subjects were given extended time with the strong cue. Moreover, no such inhibitory effect occurred when the words were to be recalled on the basis of
semantic memory. This pattern of results argues for a functional
difference between episodic and semantic memory.
Reference Notes


3. Tulving, E. Personal communication, 1981.


References


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Appendix
Table A1

Words used in the experiments. The underlined letter, along with the first letter of the word defines a unique cue.

| acquaint | eyesight | kerchief | observer | * unawares |
| aircraft | festival | keyboard | obstacle | unjustly   |
| amethyst | fiftieth | kilogram | opulence | unkindly   |
| anywhere | frequent | knapsack | oratorio  | unlawful   |
| antelope | genocide | knockout | orthodox | unlikely   |
| approval | gigantic | laziness | overflow | unvoiced   |
| atomizer | gullible | lifeboat | * overkill | upheaval   |
| beverage | halfback | localize | pastrami | vagabond   |
| bequeath | handcuff | logician | * quaintly | vehement   |
| boutique | hangover | loiterer | quantity  | vermouth   |
| bungalow | identify | lollipop | quotient  | vexation   |
| caffeine | imbecile | loophole | raindrop  | vineyard   |
| confetti | implausibly | magazine | receptor  | volcanic   |
| conquest | imprison | mischief | rehearse  | wardrobe   |
| dejected | inkstand | mobilize | reviewer  | wickedly   |
| delivery | innovate | mosquito | * rightful | windmill   |
| disjoint | inquirer | motivate | sequence  | wreckage   |
| downfall | * inscribe | mystique | sideways  | yachting   |
| downtown | inwardly | namesake | smallpox  | yearbook   |
| driveway | jaundice | navigate | theorize  | yearning   |
| dwelling | jealousy | needless | * township | yielding   |
| eighteen | jeopardy | negative | tranquil  | yourself   |
| embezzle | * jettison | nightcap | tricycle  | zeppelin   |
| envelope | joyfully | November | tweezers  | twilight   |
| ethereal | jubilant | nowadays | twilight  | twilight   |
| euphoria | judicial | numbness | ugliness  | ugliness   |
| eventful | kangaroo | oblivion | umbrella  | umbrella   |

* Words that were added in Experiments 4 and 5.
Table A2

Mean cumulative recall probability at each cue level in the successive cuing condition (Experiment 1).

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<td>.36</td>
<td>.56</td>
<td>.78</td>
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<td>4</td>
<td>5</td>
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Table A4

Mean cumulative recall probability at each cue level in the successive cuing condition (Experiment 4).

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<tr>
<td>Semantic Condition</td>
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Table A5

The moment weights assigned to the differences of scores recalled cumulatively at each level of cuing as a function of starting level (Experiment 3).

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