

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

U·M·I

University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700 800/521-0600

Order Number 9218235

Sentence context effects in three memory tasks

Gallub, John Richard, Ph.D.

City University of New York, 1992

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

A

SENTENCE CONTEXT EFFECTS IN THREE MEMORY TASKS

by

JOHN R. GALLUB

A dissertation submitted to the Graduate Faculty
in Psychology in partial fulfillment of the
requirements for the degree of Doctor of Philosophy,
The City University of New York.

1992

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

January 9, 1992
Date

Wilma A Winnick
Chair of Examining Committee

January 14, 1992
Date

Herbert D. Saltzstein
Executive Officer

Wilma Winnick, Ph.D.
Gad Hakerem, Ph.D.
Thomas Kay, Ph.D.
Mary Hibbard, Ph.D.
Thom Verhave, Ph.D.

Supervisory Committee

Abstract

SEMANTIC CONTEXT EFFECTS IN THREE MEMORY TASKS

by

John R. Gallub

Adviser: Wilma Winnick, Ph.D.

Three experiments investigated semantic context effects in three memory tasks with special emphasis on implicit memory. Selection of the three contextual arrangements and the three memory tasks made possible comparisons and cross-comparisons of the cognitive processing at study and test phases of each memory task. Unlike previous research, Experiments 1 and 2 presented target words in concise, declarative sentences. In contrast to this, Experiment 3 substantially increased the amount of material presented at the study phase. Experiment 3 also examined the effects of context on explicit memory (free recall) in this experimental setting. Finally, effects of differential manipulation of study material were addressed by comparing nonsense target words that were either crossed out or not crossed out. Experiments were set in the framework of the component processing view. Results indicate that while all three contexts (alone, nonsense, sensible) produced significant priming, there were no differential effects among the three conditions. This was true for both a data-driven word stem completion task (Experiment 1) and a category response task (Experiment 2). These results are contrary to a component processing view which would predict significantly

less priming for the sensible condition in Experiment 1 and significantly greater priming for this condition in Experiment 2. It is proposed that the increased verbal material that accompanied the sensible condition in previous experiments was responsible for a reduction in priming for the sensible condition relative to other conditions. This was supported by a decrease in priming for the sensible condition once the amount of material to be processed at study phase was substantially increased (Experiment 3). This finding is now similar to previous experiments that also presented target words from the sensible condition within lengthy verbal material. The finding that implicit memory is not affected by semantic context is inconsistent with the processing view. However, it is consistent with other experimental manipulations such as elaboration and generation effects which are found to enhance explicit but not implicit memory. Additional results found parallel effects when comparing word-stem completion/free recall tests. Also, the act of crossing out an incongruous target word in a sentence did not increase performance on either the word-stem completion or free recall tasks.

Acknowledgements

I wish to express my sincerest gratitude to my advisor Wilma Winnick for her invaluable knowledge, constructive criticism and unwavering support. She was always available for advice and encouragement. My gratitude also to Thomas Kay who has steadfastly served on various committees over the years and always offered creative advice and an empathetic ear. I also would like to thank Gad Hakerem, Mary Hibbard and Thom Verhave for serving on my committee and giving of their valuable time so unselfishly. Graeme Senior offered the kind of friendship that neither time nor distance will diminish.

I especially thank my wife, Jeannette, who shares in this accomplishment and who has sacrificed over the years by putting her life on hold for me.

A final appreciation goes to those who volunteered to serve as subjects. I wish them the best in their college careers and life endeavors.

TABLE OF CONTENTS

I.	Title Page	i
II.	Approval Page	ii
III.	Abstract	iii
IV.	Acknowledgement	v
V.	Table of Contents	vi
VII.	Introduction	1
	Historical Background	2
	Explicit and Implicit Memory	7
	Implicit Memory	8
	Explicit-implicit Comparisons in Normals	14
	Modality and Format Effects	15
	Depth and Type of Processing	19
	Generation Effects	20
	Duration of Explicit and Implicit Memory	21
	Elaboration Effects	22
	Explicit-implicit Memory in Patient Groups	23
	Theoretical Considerations	27
	Context Effects	33
	Environmental Context	35
	Semantic Context	38
	Semantic Context Effects in Implicit Memory	40
	Semantic Context Effects in Patient Groups	42
	The Present Study	43
	Critique of Earlier Studies	44

Transfer Appropriate Processing in Implicit Memory	51
Predictions from Component Processing Theory	55
VIII. Experiment 1	60
Method	61
Subjects	61
Design	61
Material	61
Procedures	63
Results and Discussion	65
IX. Experiment 2	70
Method	70
Subjects	70
Material	70
Procedures	71
Results and Discussion	73
X. Experiment 3	78
Method	79
Design	79
Subjects	79
Material	79
Procedures	80
Results and Discussion	82
XI. General Discussion	97
XII. Appendix A	111
XIII. Appendix B	115
XIV. References	121

LIST OF FIGURES

I.	Proportion of word stems completed with target words for the context and control conditions in Experiment 1.	66
II.	Proportion of word stems completed with target words for the three kinds of contexts in Experiment 1.	68
III.	Proportion of category target responses for the context and control conditions in Experiment 2.	74
IV.	Mean weighted category responses for the three kinds of context in Experiment 2.	76
V.	Proportion of word stems completed with target words for the context and control conditions in Experiment 3.	83
VI.	Proportion of context responses for recall and word-stem completion tasks in Experiment 3.	86
VII.	Proportions of word stems completed with target words that were free recalled and with target words not free recalled.	89
VIII.	Proportion word stems completed with nonsense target words for the crossed and not crossed conditions in Experiment 3.	93
IX.	Proportion of nonsense target words recalled for the crossed and not crossed conditions in Experiment 3.	95

INTRODUCTION

The present study has examined the potential role of semantic context in implicit memory. Although the experiments to be described have studied normal human subjects, the study's interest in semantic context and implicit memory reflects an increasing awareness of these topics in the field of neuropsychology. In fact, these topics have played a critical role in recent experimental studies of memory functioning in patient groups. Pertinent to the aims of this study is that Korsakoff patients, for example, have been found to be at a serious disadvantage when background context is altered. That such a disruption occurs may have implications for both the effects of context and the functioning of the memory impaired. In addition, findings from studies of implicit memory have accorded it an important role as a memory function that is preserved in many patient groups.

In a discussion of the contextual hypothesis in relation to Korsakoff patients, Baddeley has stated: "The contextual cuing hypothesis is an attractive one that clearly deserves further exploration. Development is however limited by lack of an adequate theory of the role of context in normal memory." (Baddeley, 1982, p. 324). Hence, the present study might be considered as an investigation of processes basic to further neuropsychological research.

This section will begin by presenting a brief historical overview of the experimental study of human memory; a survey of experimental distinctions between explicit and implicit memory; and an overview of studies of influences exerted on memory by semantic context. Also included will be relevant neuropsychological studies of memory-impaired patient groups.

Historical Background

For over a century, experimental studies of human memory have employed, in spirit if not in all details, the paradigms originally set forth by Hermann Ebbinghaus in his highly influential work Uber das Gedachtnis (1885/1964). Ebbinghaus's experimentation on learning and memory represents an important advance over the speculations about the underlying mechanisms of human learning and forgetting that have been engaged in since the time of Plato and Aristotle. However, it was not until the late nineteenth century that Ebbinghaus went beyond theoretical views of memory to analyze systematically the nature of memory via experimentation. The materials and the learning method that he devised were an important feature of human experimentation for almost the entire century since the publication of Uber das Gedachtnis (1885). The method of anticipation that Ebbinghaus employed to achieve true serial learning has been at least partially preserved with the aid of the memory drum and, more recently, the computer both capable of exposing one syllable at a time for set durations and inter-item intervals.

His experimentation was of a parametric variety, and is always notable to undergraduates since he himself served both as the sole subject, and as experimenter. Some of the experimental problems examined by him were:

1. Time or trials to learn lists of syllables as a function of their length. Ebbinghaus found that doubling the number of syllables to study required more than twice the number of repetitions for the first errorless reproduction. For example, a series of 12 syllables took 16.6 repetitions, while a series of 24 syllables took 44 repetitions before an errorless trial.

2. Retention as a function of trials of repetition. Ebbinghaus would read materials from eight to 64 times to determine the effects of repetition on retention. When he retested himself on the material, the results showed that the more repetition of material, the greater the retention after a 24 hour delay.

3. Retention as a function of repeated learning. In general, on each day the average number of repetitions needed for an errorless reproduction was less than on the preceding day. Also, when learning a large number of syllables, it was better to learn them spaced over time, than all at a single time.

Ebbinghaus also observed how connections between materials facilitate memory. He stated the following:

As a result of the repetition of the syllables certain connections are established between each member and all those that follow it. These connections are revealed by the fact that the syllable-pairs so bound together are recalled to mind more easily and with the overcoming of less friction than similar pairs which have not been previously united (Ebbinghaus, 1885/1964 p.2).

Although the topics and methods employed by Ebbinghaus are of current interest, their popularity has not been strong in all the years of the intervening century. Boring, in his history of experimental psychology (1929), describes the first decade of this century as producing the culmination of Ebbinghaus's experimental work on memory, implying that there was little more to be achieved along these lines. He goes on to list new methods: method of prompting, method of memory span, method of retained members, method of identical series. Boring concluded his brief overview of verbal memory with a statement about this area of experimentation:

As regards the field of memory, the difficulty... seems to be that the experimental psychology of memory, dominated by Ebbinghaus's conceptions, has dealt principally with the formation of mechanical associations, and that the laws obtained in this way are not always applicable with precision to the

learning of meaningful material. (Boring, 1929, p. 641).

The last critical statement, one frequently echoed, was mitigated by the appearance of subsequent research of more practical application (e.g., Bartlett, 1932). Experimentation on meaningful materials, considered to have greater external validity, has continued, using meaningful words, sentences, paragraphs, drawings, photographs. At the same time, however, experiments on topics of interest to Ebbinghaus continues to appear in current journals with a surprising frequency (e.g., MacLeod, 1988; Naveh-Benjamin, 1990; Nelson, 1978).

As indication of the endurance of his methods, more than fifty years after Uber das Gedachtnis, Woodworth's (1938) classic textbook in experimental psychology devoted much attention to serial rote learning and the method of anticipation. The additional material on learning/memory that was mentioned was the method of retained members (Bolton, 1892), a precursor of free recall, paired-associate learning (Muller & Pilzecker, 1900), and the recognition method, introduced by Strong (1912, 1913). Woodworth also described in detail several parameters not mentioned by Ebbinghaus: e.g., effects of sleep, different types of material, and the occurrence of reminiscence. In the revision of Woodworth's book (Woodworth & Schlosberg, 1955), the topic of memory was moved toward the back of the book (from first to 23rd chapter), but Ebbinghaus's work was cited extensively, though

much new material (e.g., memory for stories and events, memory images) was added. A chapter on transfer and interference, not found in the original, was also included.

Most impressive of the evidence for Ebbinghaus's enduring influence are two recent publications devoted to his contributions. They are a published summary of a conference on his work and its influence (Gorfein & Hoffman, 1987) and a special issue of the Journal of Experimental Psychology: Learning, Memory, and Cognition (1985, vol. 11), marking the centennial of the publication of Uber das Gedachtnis. The conference proceedings were concerned, in the main, with present-day research interests, with due acknowledgement that Ebbinghaus's work had provided the fertilizer, if not the seeds, for much modern work. Some of the topics mentioned, overlooked by Ebbinghaus, but of considerable current importance are listed as: context and memory, semantic memory and memory dissociation (Gorfein & Hoffman, 1987, pp. 4-7).

The articles in the special issue of the Journal of Experimental Psychology: Learning, Memory, and Cognition emphasize Ebbinghaus's enduring contributions more than current and divergent research topics. Thus, there are discussions of associationism, remote association, the use of three letter words, and the savings method. Particular heed is accorded to the actual studies reported by Ebbinghaus in Uber das Gedachtnis (1885/1964).

Explicit and implicit memory

Explicit Memory. Until the 1970's, much of experimental psychology concentrated on the type of memory described by Ebbinghaus as voluntary recollection through the use of experimental techniques of free recall, cued recall and recognition memory. Common to each of these memory tasks is the subject's awareness of the connection between the initial study phase and the subsequent testing phase. In fact, the instructions during the test phase typically make specific spatiotemporal reference to the material presented during the study phase. Even more important, the instructions given for the test phase are almost the defining feature of explicit memory referring as they do to the memory test to come. Success is measured by the amount of material retrieved from the study phase. Because this process entails reference to a specific episode, Tulving (1972) has referred to this type of memory as "episodic". Others describe it as "autobiographic" (Jacoby & Dallas, 1981), "intentional" (Jacoby, 1984), "direct" (Johnson & Hasher, 1987), or declarative. "Declarative" is a word frequently used in neuropsychology and suggests the formation of new representations or data structures (Cohen, 1984). It involves information which is processed, stored and able to be retrieved consciously. Perhaps the most widely used term, "explicit", originates from the fact that explicit reference is made to a particular study experience (Graf & Schacter, 1985; Schacter, 1985).

Implicit memory. Ebbinghaus's experimentation and the strong influence that he exerted on the experimental study of human memory were both derived from the study of voluntary production of lost states, i.e, what we have just called explicit memory. At the same time, he described two additional kinds of memorial effects that in recent years have received considerable attention.

The second kind of memory (second to voluntary) entails the involuntary return to consciousness of mental states previously present in consciousness. Third is the situation in which vanished mental states give proof of their existence even though they themselves do not return to consciousness at all. About this last group, Ebbinghaus said: "Most of these experiences remain concealed from consciousness and yet produce an effect which is significant and which authenticates their previous existence" (Ebbinghaus, 1885/1964, p. 2).

Ebbinghaus clearly identified these kinds of memory, but their basis rested on observation rather than experimentation. He made no attempt to incorporate these kinds of memory into his experiments and it was his experimental work on memory, not his theoretical views on memory, that exerted the stronger influence. While recall and recognition were experimental methods used to measure voluntary recollection (explicit memory) they were unable to measure what Ebbinghaus described as memory that influenced performance without being part of the subject's consciousness.

Although most of Ebbinghaus's memory experiments can clearly be characterized as measuring explicit memory, the experimental paradigm known as savings falls outside this rubric. This paradigm, also called relearning, measures memory not by a test requiring subjects to indicate recall or recognition of material, but rather by relative performance on a second occurrence of the same learning task sometime after the first. Any facilitation in performance (i.e., decrease in number of trials) from the first to the second learning episodes was considered a savings, an indication of retention.¹ Important in the savings method is that savings may be obtained even though the subject has no memory for the original episode. By these specifications, the savings method must be considered to be an implicit memory task.

A dramatic example of the use of the savings method is Burt's (1932, 1937, 1941) experiments in which he read different sections from Sophocles' Oedipus Tyrannus in the original Greek to his son, from the time he was 15 months until he was three years old. Burt read three selections per day for three months, followed by a different set of three selections for the next three months. This procedure was

¹The exact measure of savings involves a comparison of the number of trials to learn the first time and the number the second, as in the formula:

$$\frac{\text{No. 1st} - \text{No. 2nd}}{\text{No. 1st}}$$

A value of 100% from this formula would indicate perfect retention and 0% would be complete forgetting.

repeated until the child reached age three, so that the total number of different passages read over the 21 month period was 21. At the ages of 8, 14, and 18, a different one third (seven) of the original passages along with three control passages were repeatedly read to his son until he could recite each passage verbatim. Comparison was made between the number of trials necessary to recite the previously presented passages and the control passages. Any decrease in the number of trials for the previously exposed selections compared with the control selections would be a measure of savings. Burt's results showed a 27% savings for material presented five years after exposure, an 8% savings after 10 years and no savings when the material was presented 15 years after initial exposure. These experiments dramatically demonstrate the long term effects of unaware memory over time, with the effects completely eliminated only after a 15 year interval from the initial exposure to the test condition.

Since the type of memory suggested by the savings method is not directly or explicitly gathered from the subject's consciousness, a number of terms have been suggested. Cohen (1984) used the term "procedural memory" which for him "... is available only by engaging the specific operations in which the memory is embedded." (p. 201). Another term is "indirect" (Johnson & Hasher, 1987; Richardson-Klavehn & Bjork, 1988) since the performance on tasks reflects indirectly what was learned during a prior experience. The word "incidental" used

by Jacoby (1984) has a similar rationale. However, the term "implicit" (Graf & Schacter, 1985; Schacter, 1985, 1987) is more widely used and will be the one employed in this paper. For a discussion on the direct-indirect terminology, see Richardson-Klavehn & Bjork (1988) and for arguments favoring the explicit-implicit terminology, see Roediger (1990).

The general method used to measure implicit memory presents subjects with a study task or experience followed by a test condition. The test condition typically bears no resemblance to a memory test, and no reference is made in the instructions to the original study phase. Thus subject's awareness of the relationship between study and test phases should be minimized. Here, implicit memory is measured by the amount of facilitation evident in the processing of the studied material during the testing phase. To estimate such facilitation, a baseline must be established so that performance on previously presented material may be compared to performance on similar material not seen before.

The current literature on implicit memory concentrates on a phenomenon known as "repetition priming". For Schacter (1987), repetition priming is ... "the facilitation in the processing of a stimulus as a function of a recent encounter with the same stimulus." (p.501). The major distinction between the types of testing is that in explicit memory tasks, instructions make specific reference to the study task,

whereas in implicit memory there is no mention of the previously seen material.

The following section identifies commonly used implicit memory tests where priming takes place. These include lexical decision, perceptual identification, and word completion tasks.

In a typical lexical decision test, subjects are presented with letter strings and are required to state whether the strings constitute a word or nonword. The measure of priming is a decrease in the mean latency for making the lexical decision for previously presented words or nonwords, compared with latency for newly presented words or nonwords (Forbach, Stanners & Hochhaus, 1974; Oliphant, 1983; Scarborough, Gerard & Cortese, 1979). On the perceptual or tachistoscopic identification tests, words are briefly presented to subjects who must then attempt to identify them. Priming on this test, as described by Schacter (1987), "...is indicated by an increase in the accuracy of identifying recently exposed items relative to new items or by a decrease in the amount of exposure time necessary to identify recently exposed items." (p. 507).

For the word-completion paradigms (Graf, Mandler, & Haden, 1982; Tulving, Schacter, & Stark, 1982; Warrington & Weiskrantz, 1974), subjects are initially presented with a list of words. After a brief delay, they are asked to write down the first word that comes to mind when presented with

either word-stems (e.g., tab__ for table) or fragments (_ss_ss__ for assassin). Some of the words have been previously presented, and some have not been seen before.

For all word stems, there must be at least 10 words that can complete each three letter stem. The baseline for this task is the number of target words completed by subjects who have not seen the target words before. The fragment completion task must rely on published norms or separate groups to determine the percentage of successful completions of the fragment without prior exposure of the word. The increased tendency to complete previously exposed words, relative to the baseline, is the measure of priming for both tasks.

A major difference between the two tasks is that word-stems are always the first three letters of the word, whereas fragment completions can vary both in the number and location of the letters presented as hints to the word. Thus, the word-stem completion has a more consistent control baseline than the fragment completion task. Additionally, words tend to "pop" into mind on the word-stem task, more readily than the fragment completion which is more of a problem solving task.

In summary, while various methods exist to explore implicit memory, there are common features which they all share. The general method used to measure implicit memory involves presenting subjects with a study task or experience

followed by a test condition. The test condition is disguised to prevent the subjects from being aware of its association with the study phase. This disguise is one of the important differences between implicit and explicit memory, which makes specific reference to the study material during the testing phase. For both forms of memory any facilitation in the processing of the study material during the testing phase is the measure of memory.

Explicit-implicit comparisons in normals

Explicit and implicit memory tasks are considered to be different and possibly suggestive of different memory systems. Yet the difference takes a subtle form, as illustrated in a simple yet convincing study by Graf and Mandler (1984). Two groups of subjects were given a set of words in the study phase, followed by word stems based on both target and control words. The only difference between the two groups was in the instructions: one group was instructed to complete the stems with words from the study list and the other to complete the stems with whatever words came to mind. Subjects given explicit instructions to use the word stems as cues to remember the word list recalled more elaborate than non-elaboratively processed words. Conversely, subjects given implicit instructions to write the first word that came to mind in response to the word stem, produced similar priming scores for both elaborate and non-elaborately study words.

The reference or lack of reference to the previously seen material appears to be basic to the difference in effect.

Explicit and implicit memory tasks are clearly different, arousing in subjects different degrees of awareness and undoubtedly calling for different kinds of cognitive processing. If this is true, it is not surprising that identical independent variables may produce different effects on the two kinds of tasks. Such an outcome has come to be called a dissociation or, in statistical parlance, an interaction. Very many such dissociations have been found, in explicit-implicit task comparisons, as will be detailed below.

Modality and format effects. The most clear cut examples of dissociations are those based on physical characteristics of the stimulus presentation, most notably sensory modality and the format in which the material is presented. When shifts of either modality or stimulus format occur between study and test phases, different effects have been found for explicit and implicit tasks. While conflicting results occur for some experimental manipulations, a clearer dissociation exists between implicit and explicit memory for modality shifts between study and test phases. For example, for new associations, Schacter and Graf (1989) presented pairs of words to be studied aurally or visually, while testing subjects on the material in the opposite modality. They found that modality shifts decreased new associations for implicit memory while having no effect on explicit memory.

Interestingly, the modality effect was eliminated by a brief preexposure of the study word in the same modality as the testing phase. This dissociation again suggests that different processing may be basic to each form of memory (see Schacter, 1987 for theoretical review).

Similar modality effects have been found for the study of 'old' (previously presented) information. For instance, Jacoby and Dallas (1981) presented a list of words aurally to subjects during a study phase, while later testing subjects on the same material within the visual modality. As was found for new associations, they discovered a clear dissociation between explicit and implicit memory, with performance on an explicit test (recognition) showing little or no effect after a modality shift. Conversely, performance on an implicit memory test (word identification) was significantly lower following changes in modality.

Modality shifts from study to test phase have also produced a drop in performance on other implicit memory tasks such as word-stem completion (Graf, Shimamura, & Squire, 1985), fragment completion (Roediger & Blaxton 1987a, 1987b); lexical decision (Kirsner, Milech, & Standen, 1983; Kirsner & Smith, 1974; Scarborough, Gerard, & Cortese 1979), and reading transformed script (Kolers, 1975). However, in all cases, explicit memory was generally unaffected by shifts in modality between study and test phases.

Format effects have to do with the way that a concept is represented, most notably as a word naming an object or as a picture of the object. In explicit memory, pictures have consistently been found to have an advantage over words on all memory tasks (e.g., Winnick, Kooper, & Sprafkin, 1974). On implicit tasks, the same comparison yields consistent results in the opposite direction. This explicit-implicit dissociation was first reported by Winnick and Daniel (1970) in an early explicit-implicit comparison. They gave subjects mixed lists of words and pictures to learn. For free recall of words and picture names, picture names yielded significantly higher scores than words, what has come to be called the picture superiority effect. When, however, tachistoscopic thresholds were obtained for the words and the names of pictures seen before, as well as control words, a reversal was found. This reversal indicates greater priming (significantly lower thresholds) for words than for picture names. Confirmation of this dissociation has come from several studies (Roediger & Weldon, 1987; Scarborough, Gerard, & Cortese, 1979; Weldon & Roediger, 1987).

The finding that explicit memory for words is unaffected by the modality in which the words are presented strongly suggests that explicit memory deals with the concepts at hand, no matter what their specific physical manifestation. In other words, the auditory presentation of a word and the visual presentation of the same word are functionally

equivalent; the shift in modality does not affect the conceptual nature of the word. That implicit memory is disadvantaged by a shift in modality (from auditory to visual and vice versa) suggests that physical or structural features are of greater importance for implicit memory. This contrast in effects has been described as involving a conceptual processing for explicit memory and a data-driven processing for implicit (Roediger, 1990; Srinivas & Roediger, 1990).

The reversal of explicit memory's picture superiority effect that occurs in implicit memory is suggestive of a somewhat different contrast between the two memory systems or processes. In free recall (for example) of words and pictures, the superior recall for pictures is usually attributed to the contribution of the imagery effects, generation effects or the dual coding that may obtain. These factors would seem to be conceptually driven and therefore of no advantage for implicit memory tasks. No picture advantage exists for word-stem completion or word identification, for example, because of the drastic change in the physical stimulus; the existence of conceptual similarity between the same item either pictured or named does not counteract the influence of the physical change.

The specifics of this interaction between the materials and the tasks seems to derive from the processing requirements at both input and retrieval. This statement will assume greater

importance when we consider theoretical aspects of the topics reviewed.

Depth and type of processing. In addition to the actual physical characteristics of the stimuli, memory is affected by the cognitive activities associated with the materials; these might include rehearsal, formation of associations, search for meaning, generation of related materials. Craik and Lockhart's (1972) notion of levels of processing asserts that as the cognitive activities engaged in during stimulus presentation deepen (i.e., delve into the semantics of each word), memory will be better, but when cognitive processing occurs only at a shallow level, memory scores will be poorer. This statement has been found to be true across a wide range of explicit learning and memory situations. For implicit memory, however, the levels of processing variable appears to be irrelevant.

Jacoby and Dallas (1981) required subjects either to answer questions about the meaning of a word (elaborate processing), or to say whether or not a word contained a certain letter (non-elaborate processing). Following this study stage, two memory tasks were administered. Consistent with the literature (Bradshaw & Anderson 1982), explicit memory (recognition) was greater for elaborative study than for non-elaborative. However, memory, as measured by an implicit word identification task, was unaffected by level of processing.

Generation Effects. In addition to demonstrating the reversal of the picture superiority effect, the effects of generation were also shown in the Winnick and Daniel's influential study (1970). Along with the words and pictures mentioned, they presented definitions for which subjects had to provide the words, a generation condition. The words generated from definitions, as well as the picture names (also a generation condition), showed better free recall and higher thresholds (i.e., poorer implicit memory) than did words presented as words. This finding is suggestive of a dissociation in the effects of generation on explicit and implicit memory tasks.

Along the same line as Winnick and Daniel, Jacoby (1983a) examined the generation effect by presenting a word from which the subject was required to produce its opposite. During the study phase, subjects were presented with 3 conditions: reading a word alone (XXX-COLD); reading a word within a meaningful context (hot-COLD); or generating the antonym from a contextual cue (hot-???). During the test phase, subjects were given either a recognition or perceptual identification task. The perceptual task required the subjects to respond to a very brief (35 ms) presentation of words. Priming occurred when previously presented words were identified more often than words not previously seen.

Consistent with previous studies of explicit memory (e.g. McDaniel, Woddill & Einstein, 1988; Slamecka & Graf, 1978),

words generated by subjects were better recognized than words read in context, which in turn, were recognized better than words read alone. The direct opposite result occurred for the perceptual identification task. On this task, the probability of identifying target words in the no-context condition was higher than that for the context condition, with lowest priming occurring for the generate condition (see also Smith & Branscombe, 1988).

Duration of explicit and implicit memory. In a unique priming test Kolars (1975) presented transformed script to subjects and asked them to decipher the material and read it aloud. One year later, he presented both new and previously read text to the same subjects. A significant priming effect was demonstrated when paragraphs that had been presented one year earlier were read faster than newly presented paragraphs. This occurred even though subjects were unable to distinguish the 'old' from the 'new' text. The results questioned information processing theories that require repeated neuronal firing for reverberating circuits or changes in membrane protein to form long term memory. The brief exposure to the material, together with the year interval, suggest that implicit, and perhaps all forms of memory are far more robust than once hypothesized.

While Koler's experiment illustrates the extremes of implicit memory, the duration of the priming effect varies significantly according to the types of priming tests and

clinical populations. For instance, the duration of the priming effect in amnesic persons differs dramatically according to the study material involved. For instance, McAndrews, Glisky, & Schacter (1987), found significant priming after one week when amnesic patients had to rearrange verbal material into a meaningful sentence, while Graf, Squire, & Mandler (1984), demonstrated that priming for word-stem completion tasks lasts only a few hours (see also, Diamond & Rozin, 1984; Rozin, 1976; Squire, 1986; Squire, Shimamura, & Graf, 1987).

Elaboration effects. Since most studies have examined implicit and explicit memory using different tasks, it could be argued that the dissociation between the two types of memory is an artifact of the testing procedures. It should be pointed out that although implicit/explicit dissociations occur for a large number of variables, there are instances where they are by no means the general rule. Often, it is the combination of differences and similarities which provide support or its absence for various theories. Additionally, studies with similar methodology and stimuli can obtain conflicting results, serving to confuse the issues they were originally designed to clarify.

An illustration of this comes from studies that have examined new associations between words. As previously mentioned (Graf et al., 1982), in order for implicit memory to take place, words have to be processed elaborately. One

method was to have subjects rate how much they liked a word on a seven-point scale. This method ensured sufficient semantic processing for priming of single target words. However, this same semantic processing proved insufficient for implicit memory to occur for new associations between unrelated word pairs such as Mother-Calendar (Graf & Schacter, 1985; Schacter & Graf, 1986a). In this case both implicit and explicit memory for new associations required subjects to formulate high level semantic connection between the word-pairs (e.g. The angry MOTHER returned the CALENDAR).

This outcome presents a theoretical paradox since elaboration during study phase did not affect implicit memory for a single word, but was necessary for implicit memory to occur for new associations. This is contrary to many theories since it suggests that similar processes underlie both implicit and explicit memory. In other experiments, however, there were clear dissociations between implicit and explicit memory for new associations. Graf & Schacter (1987) for instance, found implicit memory for new associations to be unaffected by proactive and retroactive interference which significantly attenuated explicit memory. This finding would now support the view that different processes or mechanisms affect the two forms of remembering.

Explicit-implicit memory in patient groups. In the years since Ebbinghaus, most research involving memory has concentrated on explicit memory in the form of cued recall,

free recall and recognition memory. However, it was the study of patients with serious memory impairments (amnesia) that stimulated the recent surge of interest in implicit memory. Amnesic patients demonstrate impaired recall and recognition of a learning episode even after a delay of a few minutes.

Several studies suggest that the explicit memory loss results from damage to the diencephalic midline or medial temporal region (Moskovitch, 1982; Rozin, 1976; Squire, 1986; Weiskrantz, 1985). However, while severe loss of new information occurs (anterograde amnesia), preserved memory has been noted for perceptual and cognitive tasks such as mirror tracing (Milner, Corkin, & Teuber, 1968), reading mirror-inverted script (Cohen & Squire, 1980), puzzle solving (Brooks & Baddeley, 1976) and learning of new lexical rules (Kinsbourne & Wood 1975). Interestingly, while amnesic patients have no explicit recollection of such tasks, previous presentations nonetheless facilitate performance on subsequent implicit memory tests. In other words, although performance on these tasks may be normal or near-normal, amnesics will not remember seeing the previously presented material.

Originally, researchers attributed the failure to retain verbal information as an inability to consolidate short-term verbal memory into long-term storage (Milner et al., 1968). However, the work of Warrington and Weiskrantz (1968, 1970, 1974, 1978) challenged traditional theories by demonstrating that long-term verbal information can be retained in amnesics.

They demonstrated this phenomenon by use of implicit memory tasks.

The typical paradigm used by Warrington and Weiskrantz presented amnesics and normal controls with a word list followed by a free recall test. This is an explicit memory task and, as would be expected, the amnesics were significantly impaired when compared with normal controls. However, along with the explicit task, both experimental and control groups were tested with words that were represented only by their first three letters (e.g. tab for table). These word stems were taken from the previously seen word list, but subjects were instructed simply to complete them with the first word that came to mind. It is important to note that the subjects were unaware of the connection between the initial word list and subsequent word-stem completion task, thus making it an implicit memory task. In stark contrast to the explicit memory task, where amnesics demonstrated poor retention of verbal material, both normal controls and amnesics showed similar performance on the implicit memory task of completing word-stems. These results indicate that amnesics do process verbal information into long-term storage, but have difficulty with proper encoding or retrieval of the information into consciousness.

The findings of Warrington and Weiskrantz have been replicated on a variety of tasks and in several patient groups. Other examples of preserved memory functions using

implicit memory tasks are fragmented picture completion (Warrington & Wieskrantz, 1968), lexical decision (Moskovitch, 1982; Glass & Butters, 1985), perceptual identification (Feustel, Shiffrin, & Salasso, 1983; Cermak, Talbot, Chandler, & Wolbarst, 1985), spelling of homophones (Jacoby & Witherspoon, 1982), reading of transformed script (Kolers, 1975; Masson, 1984) and free association of related information (Gardner, Boller, Moreines, & Butters, 1973; Shimamura & Squire, 1984; Schacter, 1985). For extensive reviews, see Schacter and Graf (1986a); Schacter, (1987); Shimamura, (1986); and Richardson-Klavehn and Bjork (1988).

One feature common to all implicit memory tasks is that the subject's instructions during the testing phase do not make reference to the study phase, but rather the subjects are told to complete the task as if it were a guessing game. In fact, it appears that in order for amnesics to demonstrate preserved memory, they have to respond to a task on an automatic or unaware level. For example, Shimamura and Squire (1984) presented highly related word pairs (e.g. table-chair) for study to two groups of amnesic subjects. The only difference between the groups was the instructions used to elicit the correct response to the first word of the pair. Normal retention of the word pairs occurred when subjects were instructed to respond with the first word that came to mind (implicit instructions). By contrast, recall was impaired when amnesics were instructed to use the first word as a cue

to remember the matched pair (explicit instructions). Similar results were demonstrated by Graf, et al. (1984) using word stems; Schacter (1985) using common idioms; and Gardner, et al. (1973) using uncommon exemplars to categories.

Graf, et al. (1982) found a dissociation between explicit and implicit memory in normals that is similar to the dissociation found in amnesics. They simulated the difficulty that amnesics have in processing information by preventing elaborate study of material by normals. They accomplished this by having subjects rapidly search a word to find any vowel that also appeared in a preceding word. The process emphasized the components of the word rather than its semantic meaning. A second group of normal subjects was given the task of rating how much they liked a word on a seven-point scale. This ensured elaborate processing of the word on a semantic level. The test phase required completion of word stems from the study list followed by a recall test. Findings were similar to what has been found in amnesics, with both groups producing a similar proportion of the study words for the word completion task, and recall being higher following elaborative study compared with non-elaborative study.

Theoretical considerations. Confronted by the array of puzzling findings from comparisons of explicit and implicit memory performance, a few theoretical formulations of possible bases for the differences have been put forth. The three theories to be described differ both in the nature of their

explanations and in the range of their applications. Most important, all of the theories are in need of experimental evaluation.

Two of the three main theories formulate basic distinctions between implicit and explicit memory, with one (activation) focusing on implicit memory only. While each of these theories can accommodate some of the experimental results from the implicit memory literature, there are also data questioning their basic premises (for reviews see Masson, 1989; Schacter, 1987)

The first of these, the "activation" theory, examines only implicit memory and contends that the priming effect is due to the temporary activation of an existing representation in memory (Graf & Mandler, 1984; Mandler, 1980; Morton, 1979; Rozin, 1976). Activation does not entail a modification of the studied material, but suggests a facilitation in performance over trials (e.g. word-stem completion). At the same time, this theory has difficulty explaining repetition priming effects for nonwords, which were obviously not stored prior to "activation" (Feustel, et al., 1983; Johnston, Dark & Jacoby, 1985; Salasso, Shiffrin & Fuestel, 1985). Similarly, the activation view is inconsistent with data showing that amnesic patients acquire new associations on implicit memory tests of paired associations (Cohen & Squire, 1980; Graf & Schacter, 1985, 1987; McKoon & Ratcliff, 1979, 1986; Moscovitch, Winocur & McLachlan, 1986; Schacter & Graf,

1986a, 1986b). Finally, repetition priming effects have been documented as lasting over days, weeks and months which cannot be explained by activation which typically lasts over a relatively short time frame (Crovitz, Harvey & McClanahan, 1979; Jacoby, 1983b; Jacoby & Dallas, 1981; McAndrews, et al. 1987; Schacter & Graf, 1986a; Sloman, Hayman, Ohta, Law & Tulving, 1988).

The activation theory, concerned as it is with only implicit memory and making predictions that are difficult to test directly, will be dismissed as largely irrelevant to the present study. The remaining two theories, one emphasizing differences in systems and the other differences in the processing involved in explicit/implicit memory, will be viewed as two opposed, yet testable views.

The second theory, "multiple memory systems", proposes that implicit and explicit memory operate under different subsystems of memory. The theory postulates that the differences found between implicit and explicit memory are due to the different properties and operations of two memory systems (Cohen & Squire, 1980; Squire, 1986, 1987; Tulving, 1983, 1985). According to Squire (1986, 1987) the procedural memory system underlies performance on implicit memory tests, while the declarative memory system is responsible for explicit or aware memory. The declarative-procedural distinction is one that is easily defined but does not readily produce operational distinctions. Without operational

distinctions, experimental scrutiny of the theory is rendered difficult, if not impossible.

The most compelling evidence for this theory comes from studies of amnesics whose declarative memory, as measured by explicit tests, is impaired, while procedural memory, measured by implicit tests, is left relatively intact. The theory states that dissociations would be expected if the forms of memory were governed by separate systems. Alternative explanations of the significant number of dissociations found between implicit and explicit memory in both normal and patient groups, lends credence to such a viewpoint. However, alternative explanations of these findings can be formulated easily enough from other theories.

This theory cannot explain all of the dissociative effects that have been reported. Dissociative effects between explicit and implicit forms of remembering have been found in amnesic patients (e.g. Warrington & Weiskrantz, 1968, 1970, 1974), and normal subjects (e.g. Graf, et al. 1982; Jacoby & Dallas, 1981; Tulving, et al. 1982), and are easily explained. On the other hand, this theory has difficulty in explaining dissociative effects between tasks such as free and cued recall both operating under the same declarative system (Roediger & Blaxton, 1987b; Schacter & Graf, 1986b, 1987b) and among different tests of implicit memory (e.g., Schwartz, 1989). Also, many dissociations originally used as evidence

for separate systems can also be explained by a single memory system (Dunn & Kirsner, 1988).

The form of memory systems theory put forth by Tulving (1972) has adopted two more familiar, more easily defined systems, those called episodic and semantic. Episodic is the term applied to memory for specific occurrences, information that includes a representation of the context in which the events occurred. These events may be either life experiences or artificial laboratory situations. Semantic memory provides the basis for remembering characteristics of objects and people, as well as concepts, relations, events, and assorted facts. Semantic memory exists without reference to the context of condition of acquisition.

The third theory, the "component processing view" suggests that the basis for explicit-implicit dissociations is not separate memory systems but rather differences in processing as it occurs on study and/or memory tests. This view holds that performance on a test will be enhanced to the extent that operations are similar during the study and test phases (Jacoby, 1983a; Kolers & Roediger, 1984; Roediger, Weldon & Challis, 1989). This theory is an extension of transfer appropriate processing advanced by Morris, Bransford, & Franks (1977), which in turn derives from the encoding specificity view of Tulving and Thomson (1973). The basic premise is that memory will improve with increases in the congruity of the processing requirements at study and test phases.

Jacoby's (1983a) experiment will be used to illustrate the way this theory explains the dissociation between explicit and implicit memory. This experiment had subjects remember the word "cold" in three different conditions. In the first condition, the target word was presented alone (XXX-COLD). In this no-context condition, the word was simply read aloud by the subject. There were no semantic cues available to the subject and therefore was processed more on a perceptual basis. This type of processing is referred to as "data-driven" since the processing is based on the data at hand and analysis of its physical features without semantic connections. By contrast, a second condition required subjects to generate the target word from an antonym cue (e.g. hot-???). Since the target word "cold" was not present, the subject could not process it by its physical features and therefore, it was not data-driven. Jacoby argues that the target word in this condition was generated by processing the related word on a semantic, conceptual level and hence was "conceptually-driven". The third condition was a context condition where subjects read the words with the semantic clue (e.g. HOT-COLD). It was proposed that this condition involved both data-driven and conceptually driven processing.

When examining the test phase, Jacoby (1983a) suggests that most implicit memory tests are data driven since they are concerned with perceptual identification of the word, and analysis of its physical feature. By contrast, explicit

memory tests, such as recognition and recall are conceptually driven since subjects must rely on semantic processes and analysis of the meaning of the target words for memory to occur. Applying the theory to Jacoby's study, the words in the no-context condition should have greater priming than the context condition since the implicit test favored analysis of the physical features of the target words. Furthermore, the analysis at the test matched the initial study of the word. Conversely, words that were generated at the study phase would require semantic processing and would do better where the test task requires similar semantic or conceptual processing. The results of the experiment followed the prediction and are frequently cited as evidence for the component processing theory.

Context effects

The omnipresence of contextual effects in learning, paired with the absence of a cohesive theoretical framework, has been acknowledged frequently ever since this topic began to take on importance in human learning. "No single concept is so widely used in theories of memory functioning as the concept of context.... never in the history of choice of theoretical mechanisms has one been chosen that has so little support in direct evidence." (Underwood, 1977, p. 43).

Although studies of context in learning and memory have by no means been a prominent area of experimentation, the topic of context has appeared with surprising consistency since the

early 1900's, and with increasing frequency in the last decade or so.

One of the earliest descriptions of an experimental design to test contextual effects is by Carr (1925, p. 251). Further indication of the pervasiveness of this concept comes from the following statement from an early introductory textbook:

Everything which the human being learns has, during practice, a complex context which is a part of the total stimulus situation. We may call it the stimulatory context, and it may be subdivided into three parts. One kind of context consists of the stimulation from the external environment, such as the furniture of the room, the experimenter and the apparatus. A second kind is the stimulation from the interoceptors which make up the feelings of the body, and the third is the ideational context which constitutes the unessential content of consciousness. (Boring, Langfeld, & Weld, 1939, p. 347).

In current statements about context, stimulation from the interoceptors, which might now be called state-dependency, is not viewed as a contextual influence. Thus, Wickens (1987, p. 135) cites two "definitions" (not two types) of context from Webster's Third International Dictionary (no date given). These are: (a) external context or the interrelated conditions in which something exists and (b) semantic context or the

parts of a written or spoken passage preceding or following a word or group of words and so intimately associated with them as to throw light on their meaning. These two types of context appear to be quite different from this definition, although the difference has frequently been obscured.

Wickens's acceptance that context has two different meanings or two different definitions is modified when he examines the different types of experimental manipulations. He selects the terms context alpha for environmental and context beta for the semantic context, because these terms carry no excess meaning. These two types of context might be considered to be two different forms of environmental influence, with the possibility of different theoretical bases. Nonetheless, the nature of the experimental operations characteristic of each type needs identification in order to distinguish between the psychological processes involved in each.

Environmental context. Though the present study's concern with context has to do only with human memory, mention should be made, if only in passing, that animal tasks have not escaped scrutiny for contextual influences. Studies of contextual effects have been especially prominent in Pavlovian conditioning, where the experimental stimuli are clearly specified and available for pairing with irrelevant context stimuli. A popular design is the "switching" maneuver, and a good example is the study by Rescorla, Durlach and Grau (1985)

in which pigeons received training in two different chambers, with two different CSs (conditioned stimulus) present in both. In each chamber (the context), only one CS was followed by reinforcement, and the pigeons were found to respond to the appropriate CS in each context. With the same conditioned stimuli present in both contexts, the pigeons used context as the cue for responding to the respective CSs. Other studies have shown that the contextual stimulus can become a CS (e.g., Balaz, Capra, Hartl, & Miller, 1981) or may serve as a cue to a specific CS-UCS relationship (Miller & Schachtman, 1985).

The Rescorla et al. (1985) experiment just described is almost human-like in its conception and implementation; i.e., it seems easy enough to transpose, mutatis mutandi, the elements of such experiments into an experimental paradigm appropriate for humans. In a more or less comparable design, the switching would take place from the learning stage to the retention stage. The study by Godden and Baddeley (1975) is one that employed a quite dramatic "switch". They used as subjects members of a divers club, and examined environmental contexts by having subjects learn a list of 36 unrelated words on dry land and underwater. After a short delay, they were asked to recall these words either in the same environment in which the words were learned, or in a different one. Results demonstrated significantly more words recalled in the same environment as compared with words recalled in a different environment.

In a more conventional experiment on environmental context, Weiss and Margolius (1954) gave subjects a first-stage task that required learning of word-CVC pairs, each placed for all trials on differently colored cards. Retention was measured 24 hours after learning and imposed different stimulus conditions for each of three groups. The conditions were: unchanged, substitution of homogeneous gray for colors and presentation of colored cards without the verbal material. Recall scores were highest for the unchanged condition, next highest for colors alone, and poorest in the presence of the homogeneous gray background for the materials. These findings suggest that the environmental context supplied by the colors, provided cues (even when alone) to facilitate memory for these paired-associates (see also Peterson & Peterson, 1959).

Smith (1979) has described the results or to-be-expected results from the impact of environmental context. "The environmental reinstatement effect is that subjects remember more when tested in their original learning context relative to those tested in a new environmental context." (Smith, 1979, p. 460). Such a statement points up the almost atheoretical nature of environmental context studies. However, a few theoretical viewpoints have been expressed, one mentioning the possibility that the change in environment might produce a disruption of learning, a nonspecific, nonenvironmental effect, having little application to the area of animal learning. As of now, the disruption explanation does not

appear to yield insights into environmental context. Such a formulation has little application to the area of animal learning and even less to semantic context effects. This last deficiency is of importance here, since the interest of the present study is not in environmental context, but rather exclusively in semantic context.

Semantic context. In semantic context, specific manipulation of the verbal material places such material (the context) in spatial or temporal juxtaposition with target items. To take an early and simple example, a meaningful sentence context may precede either a (target) word that completes the meaning of the sentence or one that does not. That recognition (or other measure) for related, but not for unrelated words, is facilitated by the previously seen sentence is taken to indicate the operation of a semantic context effect. This was originally shown by Tulving and Gold (1963), measuring tachistoscopic thresholds for words that were either congruous or incongruous with pre-exposure sentences. Sentence context was viewed as providing part of the information needed for tachistoscopic identification. More specifically, the sentence was claimed to yield information content and degree of conformity with the target word.

In a quite different paradigm, and one more frequently used, a target word, for instance, may be paired with a word that provides a semantic context or cue for the to-be-

remembered (target) word. If presentation of the paired word facilitates memory of the target word, then the context may be said to have an effect. Typically, a target word is produced more often in the same context as it was studied than in a different context.

Another paradigm for the study of semantic context places the target word in a meaningful sentence, rather than paired with another word. Embedded as they are in a semantic framework, such target words may well be affected in a manner different from the effects experienced by target words paired with context words.

The structure of a sentence would seem to be a more fully realized context for a word, providing not merely associative linkage but in addition a framework of meanings, references and connotations, to say nothing of active imagery and personal involvement. In contrast, paired words, though related, engender only a unilateral context. It seems most surprising that these two paradigms should be incorporated into the same category of semantic context. However, it will take subsequent research to determine whether these are similar or different contextual situations.

The analysis just provided suggests that target words embedded in sentences and enhanced by the meanings and references therein might be at a disadvantage in tests of priming. Because of the weaker linkage allegedly in existence for a target word paired with another word, word-pair context

can be viewed as a somewhat stronger basis for priming. With the sentence providing a cohesive whole, a word embedded in its midst is likely to resist separation and therefore to be a weaker case for priming.

Semantic context effects in implicit memory. As previously discussed, Jacoby (1983a) examined the effects of generating a target vs. viewing the word alone. However, this same study also addressed the question of context in which material was presented. Specifically, whether a word presented alone (XXX-COLD) primes more than one presented in a meaningful context (hot-COLD). Jacoby's finding that explicit memory is enhanced by a target word in context over one presented alone, is reversed for implicit memory. This idea of context as a variable which dissociates the two memory forms has only recently begun to be studied.

Blaxton (1989) has recently investigated context effects by replicating Jacoby's study using semantically similar word pairs during the study phase (hawk-EAGLE) contrasted with words presented alone (XXX-EAGLE). Using a fragment completion task as a measure of implicit memory, she also found enhanced priming for the no-context condition, with explicit memory benefiting more from words presented in context. Also, in a series of experiments, Graf and Schacter used word pairs to examine the effects of context on a word-stem completion task (Graf & Schacter 1985, 1987; Schacter & Graf, 1986b). They presented unrelated word pairs to subjects

(e.g. window-REASON) for study, and tested them either within the same context (window-REA____) or different context (officer-REA____). Words in the same-context condition showed greater priming than words in the different condition, even though words in the different condition primed more than unprimed control words. These studies suggest that the context in which words are presented for study has significant influence on subsequent testing, and this effect seems analogous to the workings of environmental context.

However, other experiments concerned with the effects of context on implicit memory have generated conflicting results depending on the methods employed. As mentioned, previous investigators have found enhanced priming for words in a No-context condition when compared with words presented as word-pairs (Jacoby, 1983a; Blaxton, 1989). However, when words in a no-context condition were compared with words within text (e.g. sensible or nonsensical sentences), results were less consistent. It should be made clear that different kinds of processing may be involved when words are presented in pairs or in sentences. A target word presented in a word-pair, such as window-DOOR, stands in a more straightforward relation to its mate, almost like a word against a colored background (in a typical environmental context manipulation). This pairing effect, it is maintained, is quite different from the role of the word in a semantically based sentence such as "The children opened the **door** noisily when they came home from

school." In this comparison, the sentence has far more connotations, meanings, references and images than the unitized word pair. These differences suggest that context effects from words embedded in sentences may not parallel those found for word pairs. Other variables to be considered are length of sentence, position of word, and competing imagery from other words in the sentence. Indeed, experiments investigating semantically based context vary greatly in their materials and paradigms.

Semantic context effects in patient groups. Recent patient-normal comparisons (e.g., Winocur & Kinsbourne, 1978) have found different effects of context and suggest the need for clarification of the role of context as a means of furthering neuropsychological research on memory dysfunction in patient groups. As Baddeley notes, "A number of investigators have suggested that amnesic patients may suffer from an inability to use contextual information in recall" (1982, p. 323). According to Winocur, "...the amnesic syndrome involves a basic deficiency in context retrieval. amnesics fail to reconstruct adequately the original context in which the material was presented and thus lose the facilitatory cue that context can provide" (Winocur, 1982, p. 146). And again, Jacoby (1982) states:

When processing is adapted to a novel task, context is involved to a larger extent so that an item is specified in terms of context and a relatively

distinctive encoding is produced. I suggest that the memory deficit suffered by the Korsakoff patient is partially due to the patient's failure to specify presented items in terms of their context and, thereby, produce a distinctive encoding that will support later retention performance. This failure to specify an item in terms of its context is related to one form of deficit in attention (p.98).

The Winocur and Kinsbourne (1978) study may be taken as an example of the inclusion of context in studies of normal-patient memory.

The present study

Rationale. The purpose of this dissertation is to examine and analyze semantic context effects in implicit memory from the viewpoint of the component processing view. This theory explores the effects of context on explicit and implicit memory by calling on the distinction between conceptually-driven processes and data-driven processes. Data-driven processes engage in the analyze of the sensory and perceptual components of the stimulus material. Conceptually-driven processes are invoked when study materials require analysis on a conceptual basis and involve organization, reconstruction and elaboration. It is argued that implicit memory tasks such as word-stem completion, perceptual identification and word fragment completion are data-driven since they are concerned

with the initial identification of the stimulus and its components. On the other hand, explicit memory tests such as recognition and recall involve conceptually driven processes since the original stimulus material must be reconstructed. The dissociations found between performance on implicit and explicit memory tasks are thus explained in terms of data-driven and conceptually-driven processes. Tasks that incorporate data-driven processes produce enhanced performance on implicit memory tests, while those tasks that are more conceptually-driven enhance performance on explicit tests (Jacoby, 1983a; Roediger & Blaxton, 1987a).

How results from these experiments may be taken as support for the component process view is explained by Masson:

As further evidence of the importance of conceptually-driven processes in repetition effects, consider the results that reveal the weakening or absence of repetition effects when a word initially appears as part of a sentence but then is tested in isolation (Levy & Kirsner, 1989; MacLeod, 1989; Oliphant, 1983). Presentation of a word in isolation versus the context of a sentence may induce very different interpretations so that changing context across repetitions reduces or eliminates the repetition effect. (Masson, 1989, p. 130)

Critique of earlier studies. The studies quoted by Masson are important since they have been cited as supportive

evidence for component processing view and to add to the implicit-explicit dichotomy. This section will examine the methods and the results of these studies, followed by an introduction to the current study which offers a different hypothesis for the role that semantic context plays in implicit memory.

Oliphant (1983) for example, using lexical decision as a measure of priming, failed to find a priming effect when target words were inserted into a context provided by pre-experimental questionnaires and instructions. By contrast, words presented in list form demonstrated significant priming. Similar results were found by Levy and Kirsner (1989) who found priming for words in list form, but not for the same words presented in a meaningful text. These results were consistent with the processing view since words embedded in text would be conceptually-driven and therefore not expected to influence data-driven implicit memory. Words presented alone are data-driven and expected to show significant priming on implicit memory tests.

In considering the effects of context on priming, MacLeod (1989) presented target words under two conditions and found that words which fit sensibly into the paragraph showed less priming than words that were incongruous to the text. Additionally, in Experiment 3 he found that equating the frequency of target words affected the amount of priming. MacLeod's experiments are important to the present study in

that they demonstrated discrepant priming results by changing the material within the experiment, while keeping the conditions constant. Since the present study questions whether context influences implicit memory, a detailed examination of MacLeod's experiment is important.

MacLeod (1989) varied sentence context during initial exposure to determine the degree of influence of context on priming in a word fragment completion task. This study has been cited frequently as support for contextual influence on implicit memory.

In Experiment 1, subjects were given several paragraph-length stories to read. They were told that these stories were being developed as part of a reading comprehension test. Each paragraph contained two words used as priming stimuli. One word made semantic sense within the story (sensible condition), while the other made the sentence nonsensical (nonsense condition). Subjects were instructed to cross out the word that did not fit into the story. Following the presentation of the stories, subjects were given word fragments and asked to complete them with the first word that came to mind. Priming was measured by taking a previously established baseline and subtracting it from the word fragments completed with target words.

The results showed significant priming for the incongruous words, but not for words that fit semantically into the sentence. This led him to conclude that context might prove

to be an important factor in implicit memory. The critical finding was that implicit memory was greater for words presented out of context than for words within a semantic context.

Since the frequency of occurrence for words used in the nonsensical condition was much less than that for the words that fit semantically, MacLeod presented all words in list form to see if there was differential priming for the words that occurred under each condition (Experiment 2). The results indicated that while priming occurred for both high and low frequency words, there was nine percent greater priming for the lower frequency words. This questioned whether it was the context that caused the priming discrepancy or the difference in frequency. To address this question, MacLeod took only the words used in the sensible condition and separated them into two groups (Experiment 3). As with the first experiment, one set of words made sense within the story and one set made the sentence nonsensical. Therefore, unlike the first experiment, the same words were used in both conditions. Since words in the sensible and nonsense conditions were now of equivalent frequency, MacLeod reasoned that any differences in priming would be due to the context in which they appeared. In this experiment, priming now occurred for words in the sensible condition, but significantly more priming occurred for the nonsense condition. He therefore,

concluded that the context in which a word appeared influenced performance on implicit memory tests.

In examining the design however, several questions emerged as to whether words presented in sensible and nonsense conditions had similar exposure during the study phase. Since the conclusions were based upon a comparison between the two conditions, it is essential that all target words have an equivalent level of attention paid to them. The following examination of MacLeod's design raises the question of equivalent attention and offers an alternative method to investigate the influence of context on priming experiments during both study and test phases.

While MacLeod's Experiments 1 and 2 found significantly greater priming for words in the nonsense condition than for words semantically related to the story, these results are contrary to much of the priming literature that has found level of processing and type of study to have minor influence on the magnitude of priming (Craik & Tulving, 1975; Graf & Mandler, 1984; Graf, et al., 1982; Jacoby & Dallas, 1981; Schacter & McGlynn, 1989). A possible explanation for the discrepancy is the differential attention paid to words in the sensible vs. nonsense conditions. In the first experiment, subjects were instructed to read over the paragraph and cross out the incongruous word in the sentence. Since the paragraph was read silently, there was no way to be assured that the targeted sensible word was processed at all. In fact,

subjects may not have read the semantically related word at all, or quickly scanned over it in order to satisfy the instructions to cross out the incongruous word. Additionally, since the nonsensical words in Experiment 1 (e.g. aardvark, rutabaga, toboggan) had much lower frequency of use than the words that fit the story semantically, the nonsensical words were likely to stand out in the story. This may have caused subjects to direct their attention to the nonsensical words while skipping over the sensible ones. If the sensible word was not processed, it would explain the greater priming for nonsensical words without requiring an explanation such as a component processing theory. MacLeod indicated that the frequency discrepancy between the target words in the two conditions was significant; 82.43 occurrences per million for the sensible set compared with only 15.18 per million for the nonsensical set. In fact only 17 of the 28 nonsense target words appeared in the norms. This could explain why MacLeod found priming for words in the sensible condition of Experiment 3, where words of equivalent frequencies for both conditions were used. Since there was no word that stood out in the paragraph, subjects were as likely to read words that made sense to the story as those out of context.

In summary, equating the frequency of the target words for both conditions produced priming for the sensible condition, with the nonsense condition still showing greater priming. Since the methodology used to test the context remained the

same in both experiments 1 and 3, it must be assumed that the word frequency, was instrumental in causing a differential priming effect between sensible and nonsensical words. This begs for an alternate explanation other than the context in which the words were presented.

An additional issue that must be addressed is MacLeod's finding that nonsensical words primed more than sensible words even when the same words were used for both conditions (Experiment 3). Hence, it can still be argued that the reason for the priming discrepancy was because nonsensical words were data-driven and, therefore, more influenced by implicit memory tasks.

However, there are differences between the two conditions other than contextual which can account for the superiority of nonsense over sensible words. For instance, in both Experiments 1 and 3, the position of the target words within the sentences were not counterbalanced, so that sensible words were placed in the beginning of the paragraph much more frequently than nonsensical words. Another factor is that nonsensical, but not sensible, words were crossed out. This may have caused additional attention paid to the processing of the nonsense words which could account for the greater priming. Finally, in three of the 28 passages, the sensible word is positioned after the nonsense word. Since the instructions were for the subjects to cross out the nonsense word, there would be no reason for them to read the passages

to the end. Therefore, the sensible words may not even have been read for 3 of the 28 passages.

Transfer appropriate processing in implicit memory. In addition to the problems in methodology in the study phase of the experiment, MacLeod used a fragment completion task to measure the effect of priming. Since this is a perceptual task, it seems reasonable that it will favor words studied in isolation or crossed out over those studied within a semantic context such as sentences or phrases. As stated by Roediger (1990), "... this general approach to understanding dissociations between tests has been called transfer-appropriate processing (Morris et al., 1977; Roediger, et al., 1989) because performance on a test is assumed to benefit as a direct function of similarity in operations between learning and testing activities." (p.1049). This effect is presently undergoing intense scrutiny, and may explain many inconsistencies so prevalent in implicit memory literature.

Applying this processing view to MacLeod's study, his finding that words which are incongruous to the paragraph, or presented alone prime more than words that fit semantically, is not surprising. Presentation of a perceptually based fragment completion task is more consistent with priming of lists of words, and words incongruous to paragraphs. Also, the added manipulation of having subjects cross out the nonsensical word, may have increased the processing of such words on a perceptual level.

Since use of these data-driven tests selectively favor words in the alone and nonsense conditions, perhaps a conceptually driven implicit memory task, favoring words in the sensible condition, would enhance performance for such words. One such task which is conceptually based is the category association task. Since this task requires subjects to process target words as exemplars to specific categories, examination of words go beyond their mere physical features to become conceptually driven (Roediger et al. 1989; Srinivas & Roediger, 1990). It would be predicted that relatively greater priming would occur for the sensible condition now that congruity exists between study and test phases.

In examining the implicit memory literature for semantic context, the more a word was embedded, either in unrelated word pairs or paragraphs, the less priming occurs. Conversely, as the amount of attention to the target words (under different context conditions) became similar, there was less distinction between the amount of priming for various contextual conditions. Therefore, there seems to be a hierarchy of priming effect for context depending on the extent to which the target word is attended to, or "stands out" for enhanced processing. This leads to question whether it is the context that affects priming, or the concentration and attention paid to the target word. Hence, the explanation can be viewed in terms of attention paid to the material, rather than a conceptually-driven/data-driven dichotomy.

Using the above studies as illustrations, the greater the attention paid to the word, the more priming is likely to occur. Conversely, as words became embedded in extraneous material and therefore less attended to, the priming effect lessened. Support for this view comes from Srinivas and Roediger's (1990) finding that target words in sentences failed to demonstrate the typical enhanced performance on a free recall test (Jacoby, 1983a; Blaxton, 1989). Their explanation was that target words embedded in verbal material will resist separation from the context. It seems logical that this same argument could explain why previous context experiments on implicit memory found significantly less priming for words within context; namely, that target words were too embedded in verbal material for processing, and therefore, priming to take place.

Their explanation was:

This anomalous finding is probably due to the nature of the generation materials used in this study. The target words in the Context condition were embedded in sentences, and thus may have been less salient than words in the No Context condition. Alternatively, items studied in the Context condition may suffer input interference from the study of more material. Because other studies using sentences to evoke generation of items did not include a No Context condition (e.g. Kane &

Anderson, 1978), comparison of findings across studies is hazardous (Srinivas & Roediger, 1990, p. 395).

The present study carried out three experiments to pursue semantic context effects beyond the experiments cited and to examine evidence for the component processing view. In all three, context is formed by a sentence containing a target word; in two conditions the target word either makes sense or does not, and in the third condition, the target word is presented alone. Experiments 1 and 2 used a word-completion task and a category responding task, respectively. Experiment 3 studied context effects for both explicit free recall and word stem completion. Thus procedures in Experiment 1 were partially replicated except that the response requirements were altered so that half of the subjects had to make a specific response to nonsense words (crossing them out) and half did not.

These three memory tasks differ in the extent to which processing is either stimulus bound or involves some degree of conceptualization. The word-stem completion task seems to be dependent on analysis of the stem and a match of the stem to available words. Much less stimulus bound is category naming for which a memory search must be undertaken for words that are conceptually related. In the explicit task of free recall, the subject uses conceptual means (organization, clustering, association) to recover the set of words.

An important feature of these experiments is that target words are embedded in brief, declarative sentences. Several earlier studies have presented target words within rather wordy paragraphs, creating interference from the extraneous material in such paragraphs.

Predictions from component processing theory. The contextual conditions for the target words and the memory tasks used to detect the contextual effects have been chosen as appropriate to the component processing theory. Outcome predictions from this theory will be provided for various combinations of input-output conditions.

To aid in the delineation of these predictions, the tabular display in Table 1 shows the three context conditions and the three memory tasks used in the three experiments. The various combinations of input and retrieval conditions will, in general, yield congruity or incongruity in processing operations as reflected in performance scores. Since the experiments reported will provide findings that fit in each of the cells, specific predictions can be put forward.

The sequence of predictions presented below considers each contextual condition in turn, starting with the word alone condition.

(1) Presentation of target words alone constitutes an instance of almost pure perceptual processing. The inclusion of a response requirement was for the purpose of equating conditions across all contexts. The response requirements

Table 1. Levels of the context variable (at top) and memory tasks (at left) used in the present study the resultant cells yield combinations of input and retrieval conditions whose effects are predicted from the components processing theory.

Tasks \ Contexts	Alone	Sense	Nonsense
Word Stem			
Category			
Free Recall			

(rate how frequently the word is used) did not seem to be conceptual in that the target words are presented alone.

Word stem completion is a task that draws on analysis of physical features of words. With such a match to the processing conditions at input, the clear prediction is that for this task the alone condition will show strong priming.

When the target word alone condition is followed by the (implicit) category responding task, the cognitive activity called for in this task will be at variance with the data-driven materials at input. This leads to a prediction of lower scores for word alone condition than obtained in word stem completion.

Free recall is another conceptually based task, but one considered to be explicit. For target words in the word alone condition, free recall is predicted to be poor.

(2) The target word set in a sensible sentence would seem almost to define semantic context and to set the stage for conceptual processing. The word's meaning is bound to the other words in the sentence and reading the sentence will surely instigate cognitive activity.

The divergence of such conceptual processing from the response requirements in the word-stem completion task leads to the prediction of little priming. For the two conceptually based memory tasks, free recall and category responding, the congruence at encoding and retrieval is predictive of more priming than for other context conditions.

(3) When words, including target words, are arranged in a sentence whose meaning excludes the target word, the processing of the target words will have both perceptual and conceptual aspects. They will be attended to because they stand out as discrepant with the rest of the sentence. This feature resembles the perceptual input of the word alone condition. At the same time, the decision that the sentence is nonsense involves conceptual processing and this instance of such processing may exert a stronger effect than for sensible sentences. Both of these forms of processing are likely to be strong and may affect all memory tasks in the same way but for different reasons.

For the word stem completion task, the perceptual features at input predict high scores. For category responding and free recall, both conceptually based, the prediction is of higher scores. It should be noted that such higher scores may be brought on by the perceptual features as well.

(4) The control condition measured, in the three tasks, the response strengths of responses to target words not seen before. These baseline scores should be equally low for all context conditions across the three tasks.

(5) An additional prediction, tangential to the component processing theory, has to do with response options in the nonsense condition. MacLeod's (1989) requirement that subjects cross out the nonsense word in each of his sentences raises a question of the effect of that response. The

comparison of that condition with a no response condition in the present study is predicted to yield higher scores when response is required. In other words, both the search for the nonsense word and the additional attention caused by the response are predicted to produce better priming.

The above predictive structure will now be applied to each contextual condition of the three experiments of this study.

For Experiment 1, the three conditions (alone, nonsense, sensible) are presented during the study phase, with implicit memory measured by a data-driven word stem completion task. According to the component processing view, enhanced performance occurs when there is a processing match between material presented at input and the task used to measure memory. Since both the alone condition and word stem completion task involve data driven processing, the prediction would be for greatest priming in the alone condition. Words from the nonsense condition, having both data and conceptual processing would be predicted to have less priming than the alone condition, with words from the conceptually based sensible condition priming least.

Experiment 2 presented words in the same three contextual conditions as Experiment 1, but used a conceptually driven category response task to measure implicit memory. Since the cognitive processing requirements between this task and the sensible condition are similar (conceptually driven), the prediction of greatest priming for target words in the

sensible condition would be expected. Again, the nonsense condition, combining both processing forms, would have less priming, with the data-driven alone condition now priming least.

The third experiment had a similar design as Experiment 1, except that the number of sentences and words in the alone condition were substantially increased. Since this third experiment used a data-driven task to measure priming, it would be expected that words from the alone condition, which is also data-driven, would have greatest priming. Words from the nonsense condition involving both data and conceptual processing would be expected to have less priming than the alone condition with words from the sensible condition priming least.

The various components of this conceptual framework will be tested in the following experiments, with implications of the results addressed in the General Discussion section.

Experiment 1

The purpose of this experiment was to test the predictions from the component processing theory, as they apply to the word-stem completion task.

Presentation of target words in the three conditions described was followed, in this experiment, by a word-stem completion task. In contrast to previous studies using similar tasks to examine semantic context, an attempt was made to present all target words under as similar conditions as

possible. In this way, context could be examined without concern that target words from any one condition were more readily accessible than others.

It should be noted that the study phase that preceded the two different memory tasks in Experiments 1 and 2 was exactly the same, and given simultaneously. Half of the study material was used for each of two implicit memory tasks. This was done to keep conditions for the study phase as constant as possible for the two tasks. However, since the tasks and measurement scales were so different, they were presented and described as two different experiments (Experiments 1 and 2).

Method

Subjects. Forty-eight college undergraduates, with English as their primary language, volunteered to participate in the experiment.

Design. The mixed design included two (independent groups studying parallel lists) X two (second stage priming tasks) X three (contexts) mixed design ANOVA.

Materials. The 36 words used (e.g. corporal, salmon, spider, cousin and purple), were selected from each of 36 categories (e.g. a military title, a fish, an insect, a relative, a color). Additionally, six buffer words were selected for use at the beginning and end of the experimental test phase.

The materials were selected from category norms for verbal items compiled by Battig and Montague (1969) and Shapiro and

Palermo (1970). The exemplars were ranked according to how frequently they were given as belonging to a category. The words were chosen so that a) they were ranked at least fourth in order of frequency, b) they contained at least five letters, c) they did not have more than one meaning, d) they were logical responses to a category, e) they were in the singular word form, f) the first three letters did not form a word, and g) their three-letter stem could be completed by at least 10 words from the Webster's New International Dictionary: Second Edition Unabridged, (no date given).

An easily comprehensible six to eight word declarative sentence was constructed for each of the 36 words. No word in the sentence fit any of the categories except those 36 chosen as exemplars. Additionally, no word that was used to describe a category was used in the sentence. For instance, if the category was FRUIT, the sentence would contain an exemplar from that category such as, 'cherry', but not the category name, FRUIT. The 36 words from the sensible sentences were then interchanged to make an additional 36 sentences that were nonsensical.

Materials were presented in booklets containing 18 of the target words. Six of the words were incorporated into meaningful sentences; six were used to make nonsense sentences; and six were presented alone. All of the 36 words were counterbalanced across subjects so that the words appeared equally often in each condition. The 36 words along

with the three conditions in which they were used appear in Appendix A.

Procedure. The subjects were tested individually. They were instructed as follows:

You are being asked to give responses to material in order to gather baseline data for use in future studies of language processing. You will first receive a booklet containing several pages. On each page, there will be either a sentence that makes reasonable or logical sense, a nonsensical sentence making a ridiculous statement, or a singly presented word. If the page contains a sentence, you are to read the entire sentence aloud and say whether you feel that it is 'sensible' or 'nonsensical'. Should the page contain a single word, you are to read the word aloud and judge how frequently you think the word appears in the English language. The rating for the single word will be done on a 5-point scale, with 1 representing a word you feel rarely occurs in the English language, and 5 representing a word you feel occurs quite often. There will be a 5-point scale continuously displayed in front of you with the rating system labeled. The task is not timed, and you can turn each page after you answer the question. Do you have any questions before we begin?

Upon completion of the study phase subjects were instructed:

You will now be presented with another booklet whose material will be used to provide baseline data for a different experiment. When the page contains 3 letters, you are to complete it with the first English word that comes to mind. You can say any English word, but please say the first word that comes to mind. The only restriction is that it must be at least 5 letters in total length. An example of a partial word and its completion would be: poe___ / poetry. In this illustration poetry completes the stem correctly and is at least 5 letters in length. The word poet completes the word stem, but would not be accepted since it only contains 4 letters.

The measure of implicit memory was the proportion of target words from the three conditions of the study phase that were used to complete the word stems. The proportion of target words used from each of the three conditions of the study phase (sensible, nonsensical and alone) measured the effects of context on implicit memory. The proportion of word stems that were completed with target words, even when the target words were not presented, provided the control or baseline measurement.

Results and Discussion

As Figure 1 shows, previously seen target words for sensible, nonsense and alone conditions grouped together were used more frequently for completion of word-stems (40.9%) than words that served as controls (7.8%). This difference was found to be significant, $t(47) = 10.03$, $p = .0001$, and suggests that priming occurred for the three context conditions when compared with controls.

Comparison of the extent of the priming effect among the three conditions is possible from an examination of Figure 2. The quite evident lack of significance is confirmed from an analysis of variance (ANOVA): $F(2,88) = 1.44$, $p = .243$.

Such a finding is at variance with the component processing view which would predict for word stem completion greater priming for data-driven (perceptual) processing (e.g. alone and nonsense) over more semantically processed material (e.g. sensible condition). This view purports that memory is enhanced when there is a match between the operations at study and test phases (transfer appropriate processing). Since this match occurred for the alone and nonsense conditions, but not the sensible condition, the present finding of equivalent priming for all conditions is of interest. It is suggested that the present experiment, by preventing target words of the sensible condition from being too embedded in verbal material, enhanced the saliency of such words. This increased the

Figure Captions

Figure 1. Proportion of word stems completed with target words for the context and control conditions in Experiment 1.

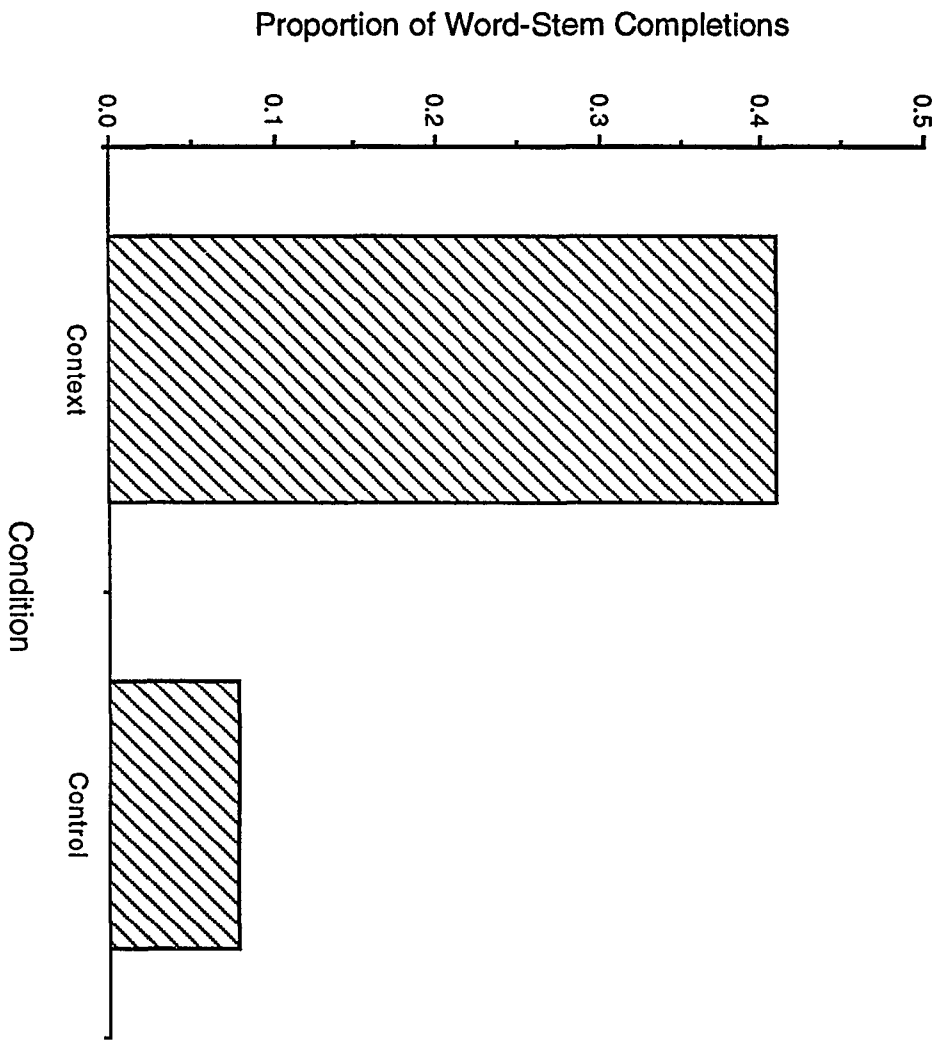
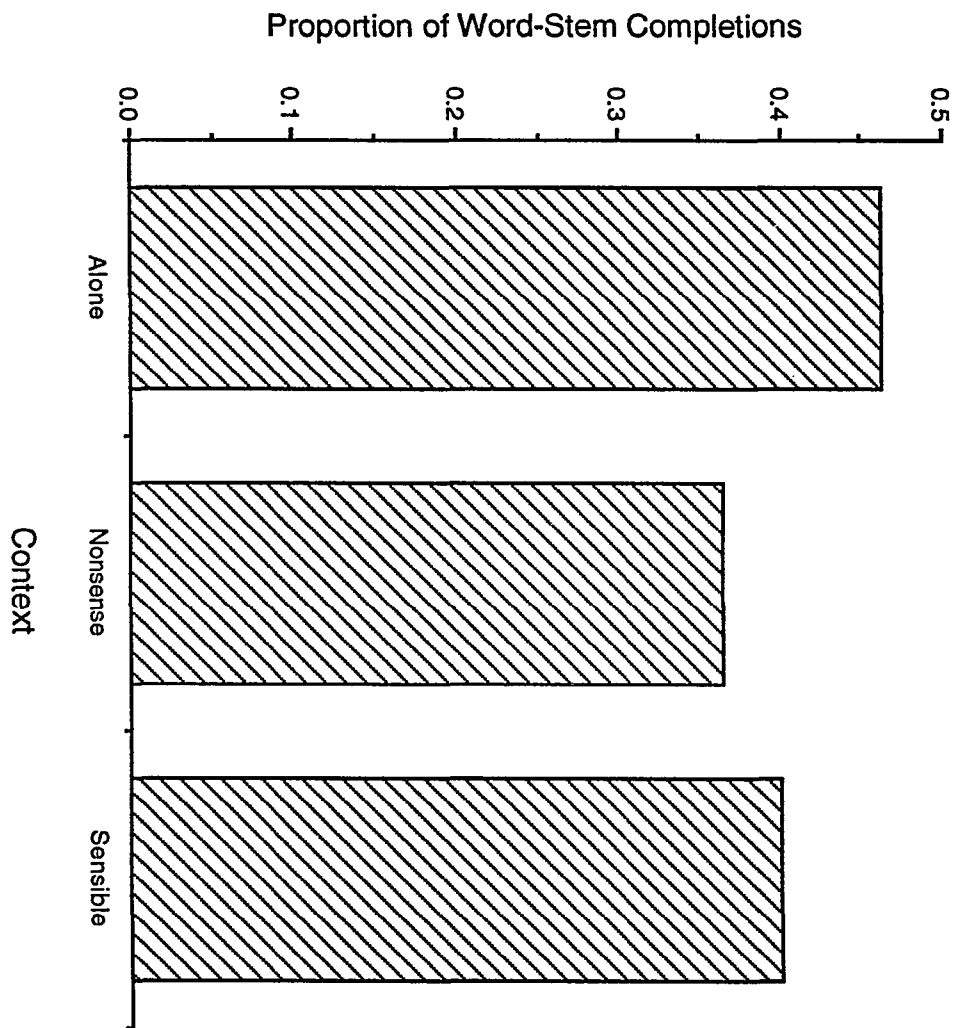


Figure Captions

Figure 2. Proportion of word stems completed with target words for the three kinds of contexts in Experiment 1.



likelihood of greater attention paid to these target words and therefore, greater priming.

Experiment 2

The second experiment examined context effects using the implicit memory task of category responding, considered to entail more conceptual processing. The task is more semantically based than the word-stem completion task used in the other experiments because the subject must process the target word as an exemplar that fits a designated category. Since words in the sensible condition have been processed in a manner similar to the test condition, they should have enhanced priming relative to the other two conditions (see transfer-appropriate processing; Roediger, et al., 1989). It is predicted that this congruity of presentation and test conditions will cause a relative increase in priming for the sensible condition over the other two conditions. This would suggest a dissociation between these two memory tasks.

Method

Subjects. The subjects for Experiment 2 were those used for Experiment 1.

Material. The materials used in Experiment 2 were the same as used in Experiment 1. As previously mentioned, subjects were presented with the same study phase that was used for what is called Experiments 1 and 2. The two testing measures were counterbalanced so that half of the target words were tested with a word stem completion task and half with a

category responding task. In addition, the two tasks were counterbalanced for order, so that half of the subjects received the word stem completion task followed by the category responding task and half had the tasks presented in reversed order.

Procedure. The subjects were tested individually. Since subjects from both experimental conditions received the same study phase, there was only one set of study phase instructions for the two experiments.

Upon completion of the study phase, subjects were instructed in the test phase as follows:

You will now be presented with another booklet whose material will be used to provide baseline data for a different experiment. On the pages of this booklet you will find names of categories and you are to say the first three English words that come to mind belonging to that category. Give three, and only three, words per category. For example, if the category is 'A type of fuel', three appropriate responses could be oil, gas, and coal.

For the test phase, subjects were presented with 18 categories and asked to say the first three category-appropriate responses that came to mind. Three exemplars were requested to ensure against categories whose common responses were very robust. Half of the categories were related to the exemplars that appeared in the various conditions of stage 1.

This was considered to be set A. The other half of the categories (set B), served as controls. This was reversed across subjects so that half of the subjects received set A as target words and set B as control words, while the other subjects received set B as target words and set A as control words.

The target words used in Stage 1 were chosen from the list of possible responses to the categories found in Stage 2. Therefore, the category labels in Stage 2 served as cues for the priming test. Since the words selected were uncommon responses to the categories, any use of them as exemplars would be considered the effect of previous exposure in Stage 1 and a measure of priming. The probability of responding with a "target word" that was not presented during the study phase, provided the measure of baseline.

The proportion of target words used from each of the three conditions of the study phase (sensible, nonsense and alone), measured the effects of context on implicit memory in this task.

Across all subjects, the 36 target words were counterbalanced to occur equally often in each of the three conditions of Stage 1. Counterbalancing also took place for the testing phase, so that words from the three conditions in Stage 1 (sensible, nonsense, alone), occurred as often in the two priming conditions of Experiments 1 and 2 (word-stem completion and category response).

Results and Discussion

The three target responses, as well as the responses to each category from the control list that had not been seen before, were weighted according to the response order (first, second or third). The first, second and third positions were given relative weights of 3, 2 and 1 respectively. Each subject's weighted responses for the three contexts were then added to yield a single score for each context condition. The rationale for the weighting procedure was that the first position represents greatest response availability while second and third responses suggest lesser availability. The increase in response availability is another way of describing priming effects.

As Figure 3 shows, all target words in the context conditions were produced more frequently as exemplars (30.6%) than all words in the control condition (12.3%). A within subjects t -test confirmed these observations, with a significant difference between conditions $t(47) = 7.86, p = .001$, two-tailed. An analysis of variance for a three factor mixed design, (list, order, context) examined the proportions of target words correctly produced as a function of three study conditions (alone, nonsense, sensible).

Figure 4 shows the amount of priming that occurred in the category task for target words in the three conditions (alone, nonsense and sensible). The main effect for condition was non-significant $F(2,88) = 2.47, p = .09, n.s.$

Figure Captions

Figure 3. Proportion of category target responses for the context and control conditions in Experiment 2.

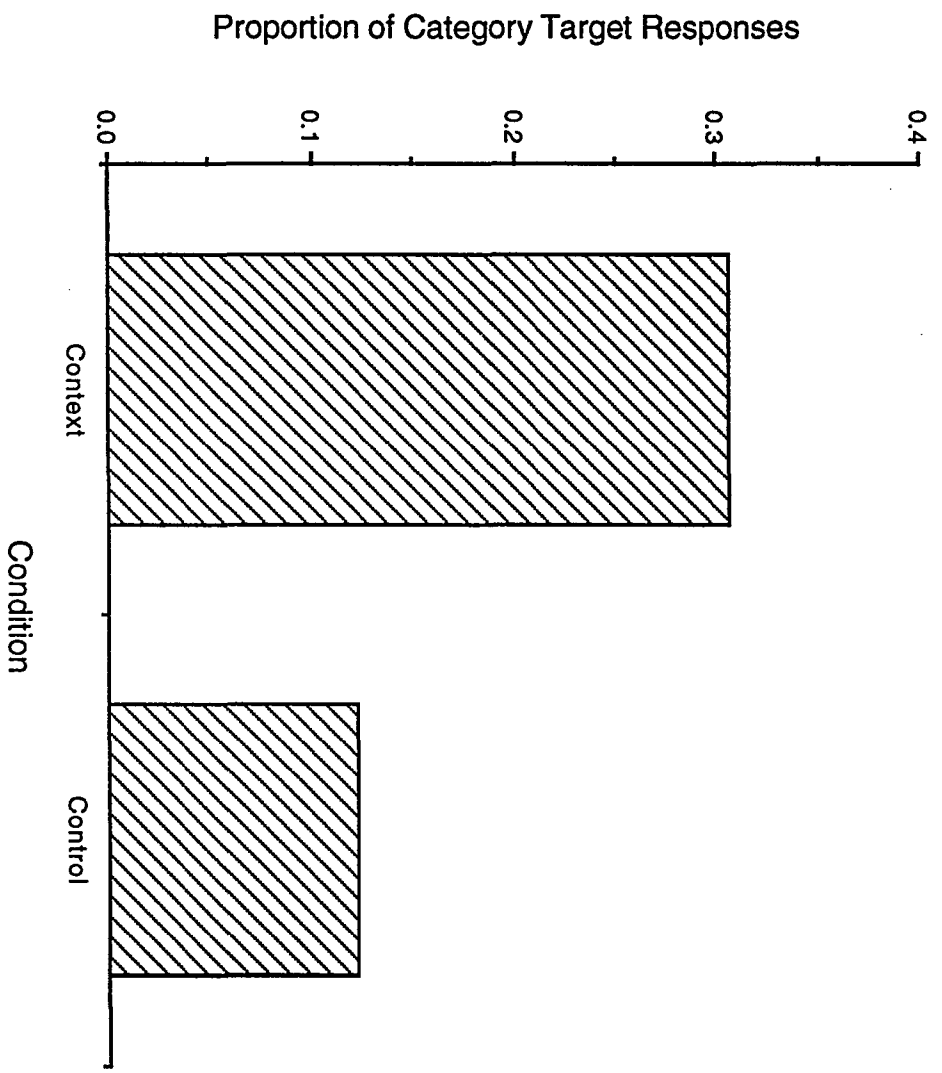
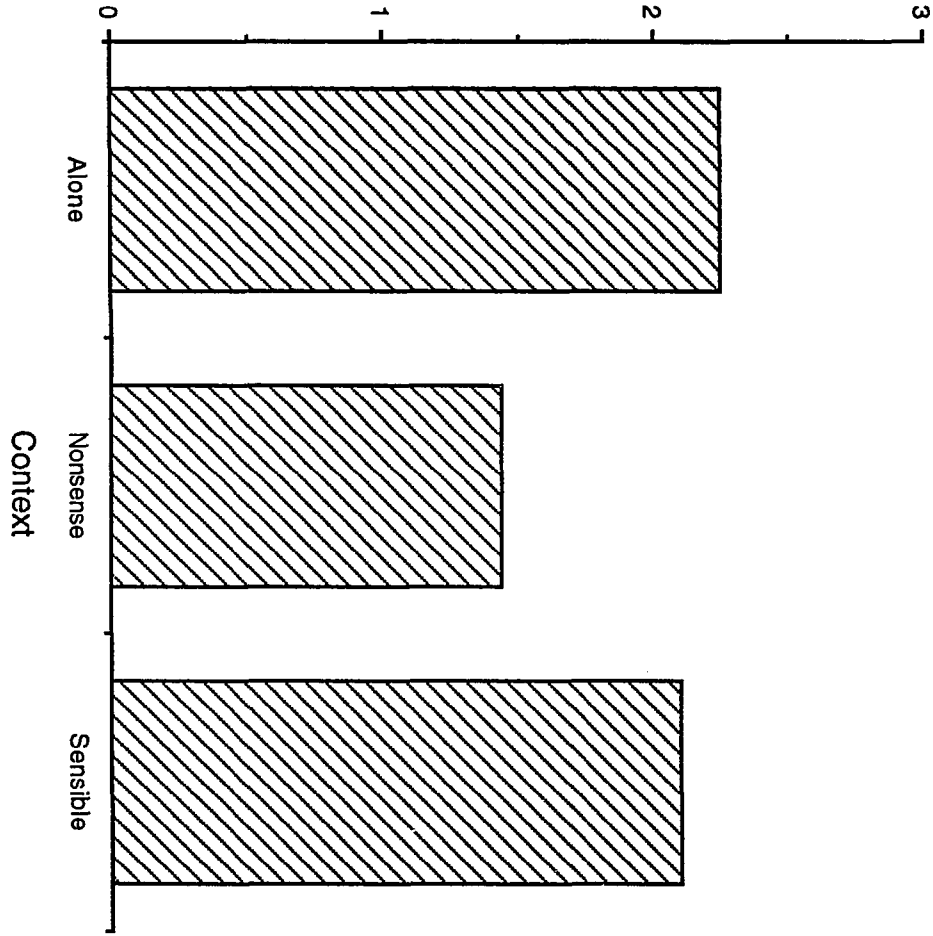


Figure Captions

Figure 4. Mean weighted category responses for the three kinds of context in Experiment 2.

Mean Number of
Category Target Responses



The main effect results indicate that the sensible condition had priming equivalent to the alone and nonsense conditions. These results are contrary to previous literature which has found significantly less priming for target words from the sensible condition which had target words embedded in lengthy paragraphs. As with the first experiment, these findings suggest that presenting words in simple, declarative sentences caused the semantic condition to produce equivalent priming in the alone and nonsense conditions.

Experiment 3

The third experiment pursued the study of semantic context by examining possible effects on explicit as well as implicit memory; of particular interest was the possibility of a dissociation between implicit and explicit memory in this experimental setting. Previous literature has documented many experimental variables which have produced dissociations for explicit and implicit memory. They include shifts in modality (Graf et al., 1985; Kirsner, et al., 1983; Scarborough et al., 1979; Roediger & Blaxton, 1987a), generation effects (Jacoby, 1983a; Winnick & Daniel, 1970), variations in level in processing (Craik & Tulving, 1975; Graf et al., 1982; Graf & Mandler, 1984; Jacoby & Dallas, 1981; Winnick & Daniel, 1970), and manipulation of retention intervals (Jacoby & Dallas, 1981; Tulving et al., 1982). Since so many other experimental manipulations have produced dissociations, it was of interest whether semantic context would have similar effects.

A second interest of this experiment was in the effect of crossing out nonsense words as was done by subjects in MacLeod's (1989) study. It was reasoned that instructions to cross out the nonsense words in a paragraph might call attention or give added saliency to such words, at the expense of the others. To evaluate such a possibility, two groups of subjects differed, with one group instructed to cross out nonsense words, and the other not.

An important difference between this experiment and Experiment 1 was the amount of material to be processed by subjects during the study phase. While the sentence format (simple, declarative) and memory task (word-stem completion) were the same, the present experiment increased the number of target words from nine to 33. The question raised was whether this increase might make for a difference from results of Experiments 1.

Method

Subjects. Thirty-six college undergraduates, with English as their primary language, volunteered to participate in the experiment.

Design. A 2 (independent groups given parallel lists at the first stage) X 2 (crossed vs. not crossed task at the second stage) X 3 (contexts presented in stage 1) mixed ANOVA.

Materials. The 66 words to be used were selected according to the following criteria: a) they contained at least five letters, b) they did not have more than one meaning; c) they

were in the singular word form; and d) their 3-letter stems could be completed by at least 10 words from the Webster's New International Dictionary : Second Edition, Unabridged (no date given). An easily comprehended 6-8 word declarative sentence was constructed for each of the 66 words. For each word, a sensible and nonsensical sentence was created. Lists were counterbalanced so that each word appeared equally as often in the three conditions (alone, nonsense, sensible).

Materials were presented in booklets containing 33 of the target words, distributed among the three conditions. Additionally, three primacy and three recency buffer words were selected for both the study and test phases of the experiment.

Procedure. The subjects were tested individually. One half of the subjects were instructed as follows:

You are being asked to give responses to material in order to gather baseline data for use in future studies of language processing. You will first receive a booklet containing several pages. On each page, there will be either a sentence that makes reasonable or logical sense, a nonsensical sentence making a ridiculous statement, or a singly presented word. If the page contains a sentence, you are to read the entire sentence aloud and say whether you feel that it is 'sensible' or 'nonsensical'. Should the page contain a single word, you

are to read the word aloud and judge how frequently you think the word appears in the English language. The rating for the single word will be done on a 5-point scale, with 1 representing a word you feel rarely occurs in the English language, and 5 representing a word you feel occurs quite often. The task is not timed, and you can turn each page after you answer the question. Do you have any questions before we begin?

The other half of the subjects had the same instructions as above, but rather than just stating the sentence was nonsensical, they were instructed to cross out the word that made a sentence nonsensical. Upon completion of the study phase, all subjects were instructed:

I would now like you to recall as many nouns as you can from the previously presented material. That includes words from all the conditions that were presented: alone, nonsensical and sensible.

After the free recall, which was recorded by the examiner, subjects were instructed as follows:

You will now be ask to provide baseline data for future experiments. You will be presented with 66 word-stems to be completed with the first English word that comes to mind. You can say any English word that completes the word-stem, but please say the first word that comes to mind.

Context effects were assessed in two memory tasks, explicit free recall and word stem completion.

The measures of priming for Experiment 3 were the proportions of target words from the study phase that were used to complete the word stems compared with the control words. The proportion of target words from each of the three conditions of the study phase (alone, nonsense, sensible), measured the effects of the different context conditions on implicit memory.

Additionally, the possible effect of increasing attention to the target word was examined by comparing free recall and priming of nonsense words within two conditions; one where the subject stated that the sentence was nonsensical and one where the nonsense word was crossed out as well.

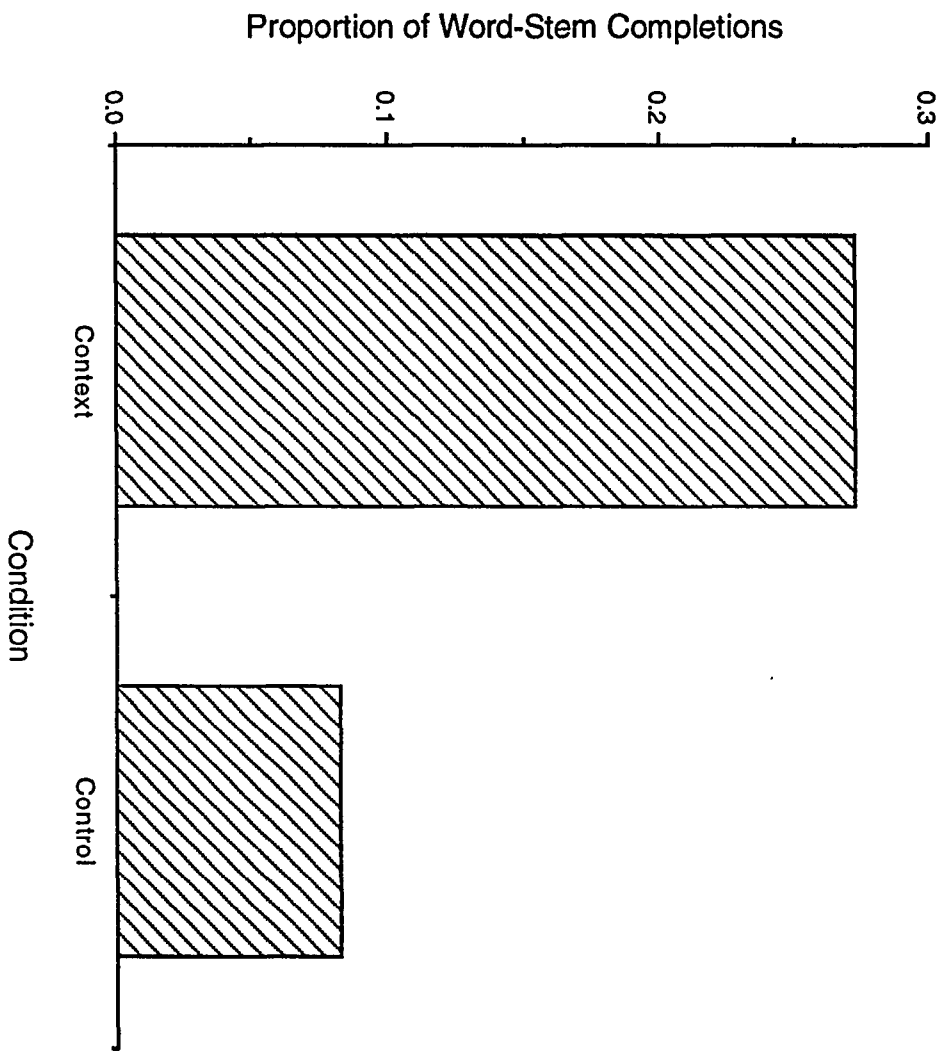
Results and Discussion

As Figure 5 indicates, priming occurred for the word-stem task, with word stems completed more frequently with target words (27.3%) than control words (8.2%). A within-subjects t -test confirmed this observation, finding a significant difference between conditions: $t(35) = 14.55$, $p = .001$, two-tailed.

An analysis of variance examined two memory tasks (word-stem completion/free recall) and three kinds of context (alone, nonsense, sensible). The main effect for task was significant ($F(1,35) = 38.98$, $p = .001$) and indicates more

Figure Captions

Figure 5. Proportion of word stems completed with target words for the context and control conditions in Experiment 3.



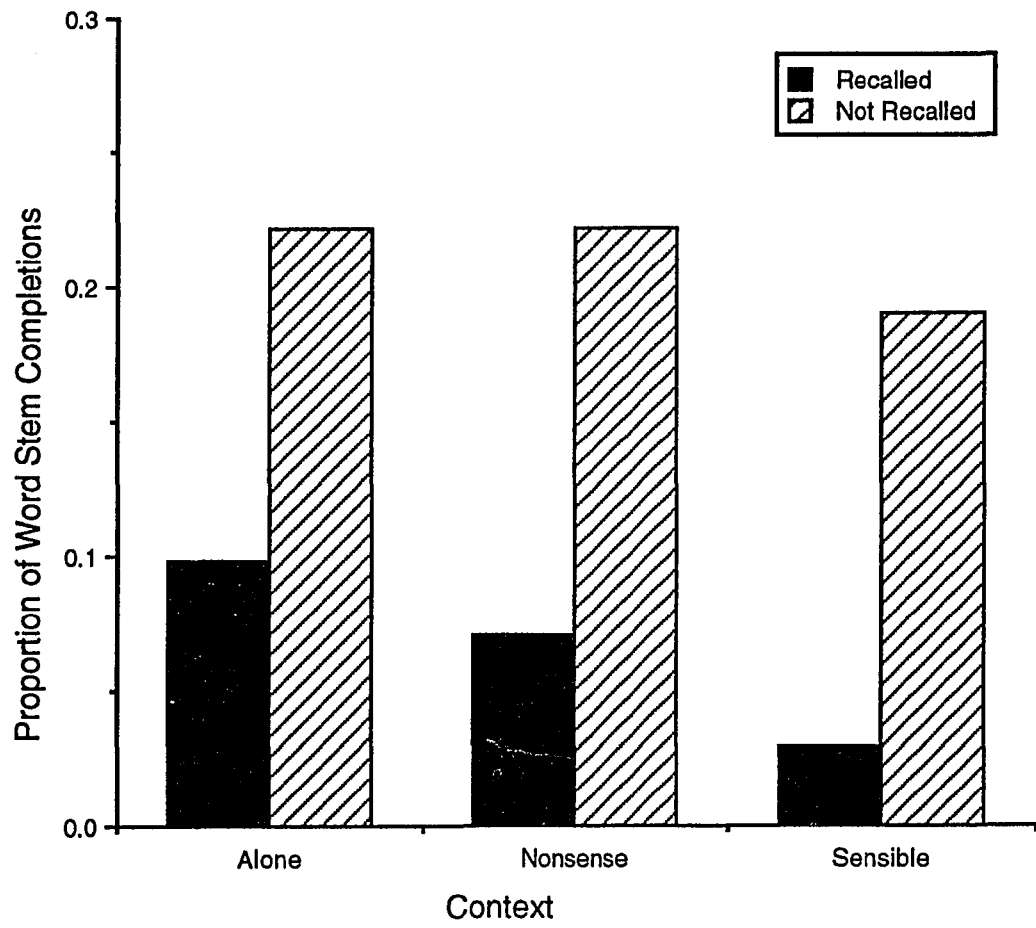
word stems were completed (with target words), than target words were recalled (Figure 6). These results are not surprising since a word stem provides a cue for accessing the target word, whereas free recall has no such aid to facilitate memory.

The interaction between tasks and contexts was non-significant and suggests parallel effects of the context variable for the two types of memory tasks. For both tasks, Figure 6 indicates an overall tendency for the alone condition to have greater priming than the nonsense condition, with the sensible condition priming least ($F(2,70) = 8.95, p = .001$). A series of planned comparisons confirmed that words in the alone condition showed greater priming than words in the sensible condition for both the word-stem completion task ($t(35) = 2.69, p = .02$), and free recall ($t(35) = 4.49, p = .002$). However, the alone/nonsense, and nonsense/sensible comparisons failed to yield significance for either the word-stem completion or free recall tasks.

This comparison of word-stem completion and free recall scores, it is important to note, is confounded. The free recall test was administered first and was followed by word-stem completion. Hence, the target words recalled at the first stage have received additional practice trials that might benefit the corresponding word-stem completions. An additional scoring procedure counted only word stem

Figure Captions

Figure 6. Proportion of context responses for recall and word-stem completion tasks in Experiment 3.

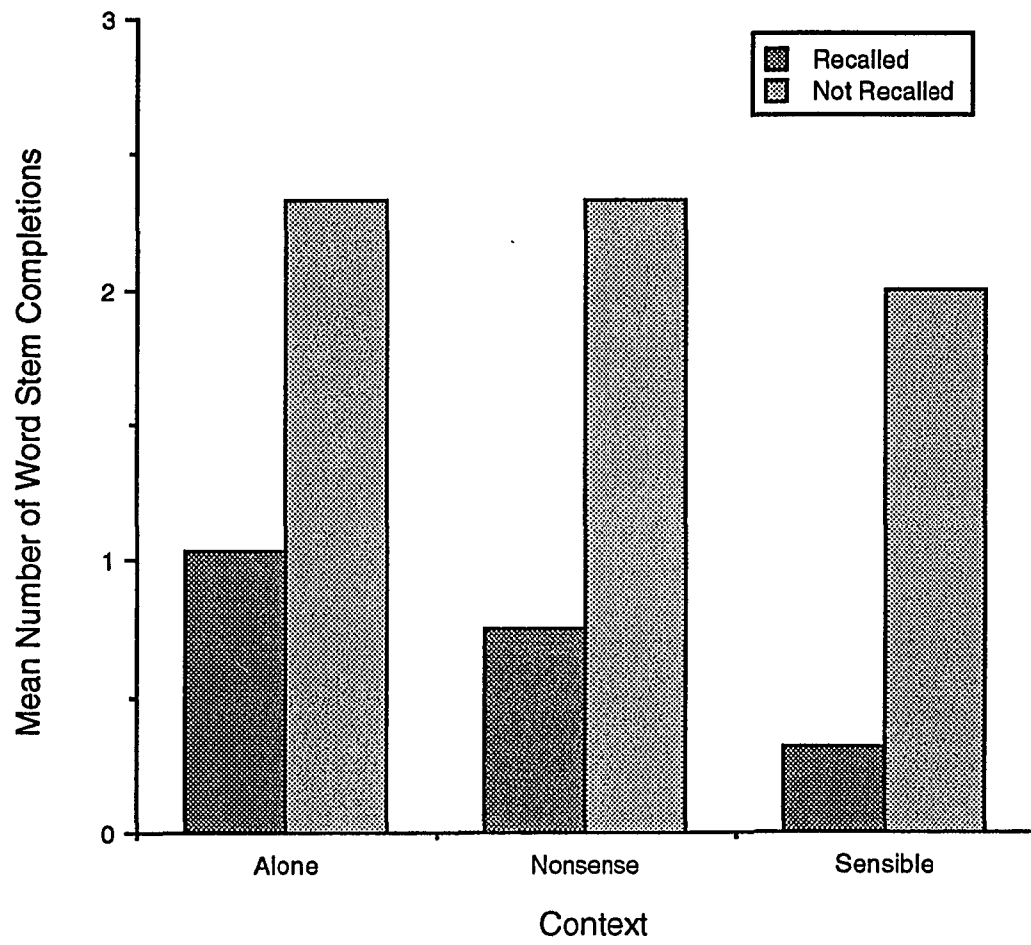


completions for words not free recalled for each condition. These conditional word stem scores were compared with completions for words free recalled.

Figure 7 suggests parallel effects for context conditions with both target words recalled and not recalled. The analysis of variance failed to find an interaction between the two kinds of word-stem completions (words not free recalled and words free recalled) and context (alone, nonsense, sensible). Parallel effects occurred for context conditions whether or not target words were also free recalled. Since there were many more stems completed with words not recalled compared with words recalled ($F(1,35) = 72.97, p = .001$), analysis of these two conditions using proportions was undertaken. A related t test, collapse across conditions, ($t(35) = 3.12, p = .004$) showed that word stems were completed with proportionately more words that were free recalled (47.2%) than words not free recalled (32.1%). Therefore, the additional act of free recalling a target word significantly increased the probability of also completing a word stem. With this in mind, an examination of context effects was performed for target words that completed the word stems, but were not recalled. An analysis of variance failed to find a significant difference for the three context conditions (alone, nonsense, sensible). Therefore, the additional act of free recalling a word contributed significantly to the context effect found in Experiment 3.

Figure Captions

Figure 7. Proportions of word stems completed with target words that were free recalled and with target words not free recalled.



That is, once free recalled words were eliminated from the analysis, results for context were the same as found in Experiments 1 and 2; i.e. no significant difference for context condition.

What follows is an examination of the context variables on the word-stem completion task. As mentioned, the present experiment found significantly less priming for the sensible condition compared with the alone condition. These results are contrary to those of Experiment 1 which found equivalent priming for the alone and sensible conditions. The increased number of sentences in Experiment 3 provides the basis for postulating increased interference at the study phase, thereby making the target words less salient or accessible for implicit memory. It is important to reiterate that Experiment 3 incorporated the same design as Experiment 2, except that the verbal material to be processed during the study phase was substantially increased. As the amount of verbal material increased, possibilities for interference increased, affecting the implicit memory task. It might also be said that the saliency of the target words decreased, thus causing less priming of words in the sensible condition. It is interesting that these results are now similar to previous research which also embedded target words from the sensible condition in extraneous verbal material.

This experiment also analyzed the effects of crossing out incongruous words within paragraphs. The question posed was

whether factors other than context might account for previous finding of superior priming of the incongruous words relative to sensible words. The present results indicate that the additional act of crossing out a word was not a contributory factor in the increased priming. In fact, the additional act of crossing out the incongruous word in the sentence did not enhance subject performance on either the word-stem completion task (see Figure 8), or the recall test (see Figure 9). An analysis of variance confirmed these observations in failing to find a significant difference for the word-stem condition $F(1,34) = .120, p = .731, n.s.$, or free-recall condition $F(1,34) = .018, p = .895, n.s.$

These findings were surprising, as it seemed logical that the act of crossing out a word, in addition to reading it, would increase the attention paid relative to words just read aloud. Perhaps the act of reading the incongruous word aloud in this experiment, rather than silently as in MacLeod's (1989), enhanced the processing of the word to such an extent, that the additional task of crossing the word out had relatively little effect. Similarly, the relatively short length of the sentences, by allowing greater processing of all words, lessened the effect of highlighting any one word over another. It would be interesting to repeat the experiment with the subjects reading the nonsense sentences silently rather than aloud.

Figure Captions

Figure 8. Proportion word stems completed with nonsense target words for the crossed and not crossed conditions in Experiment 3.

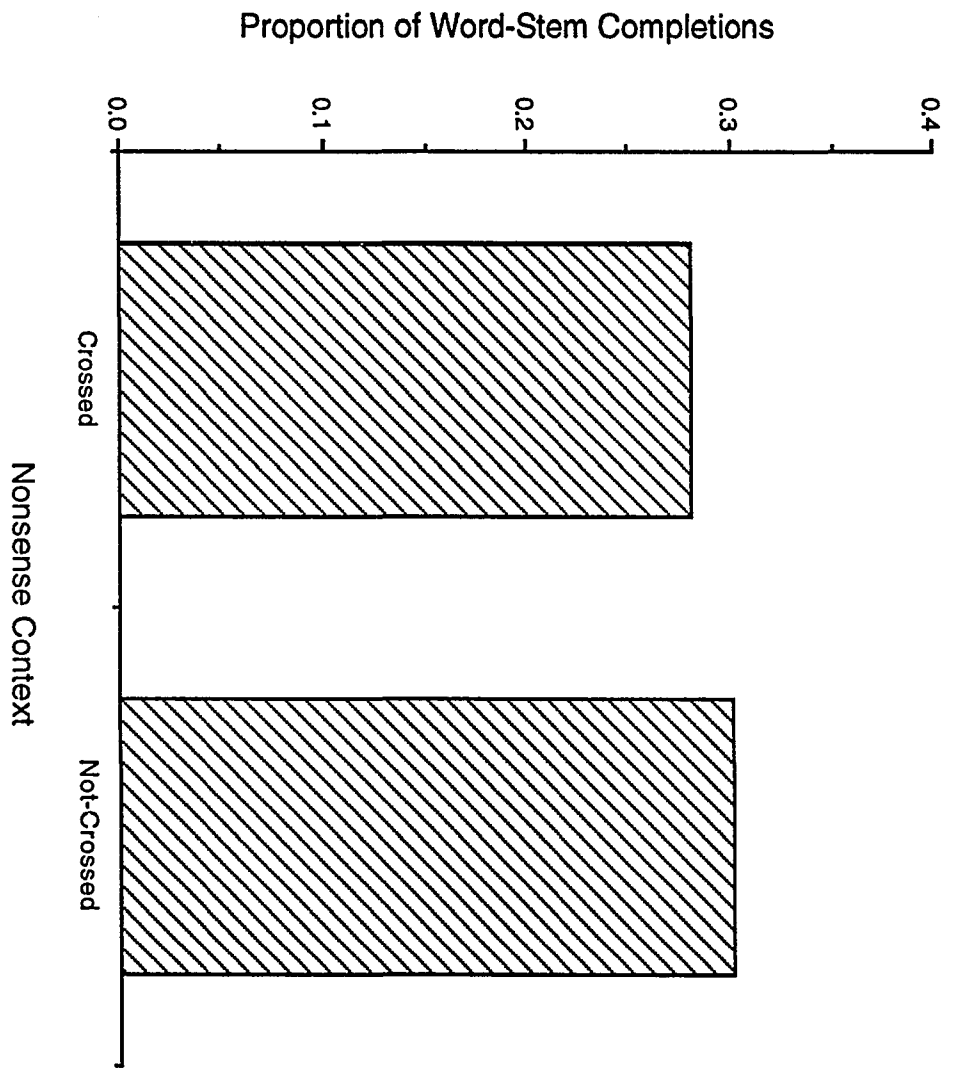
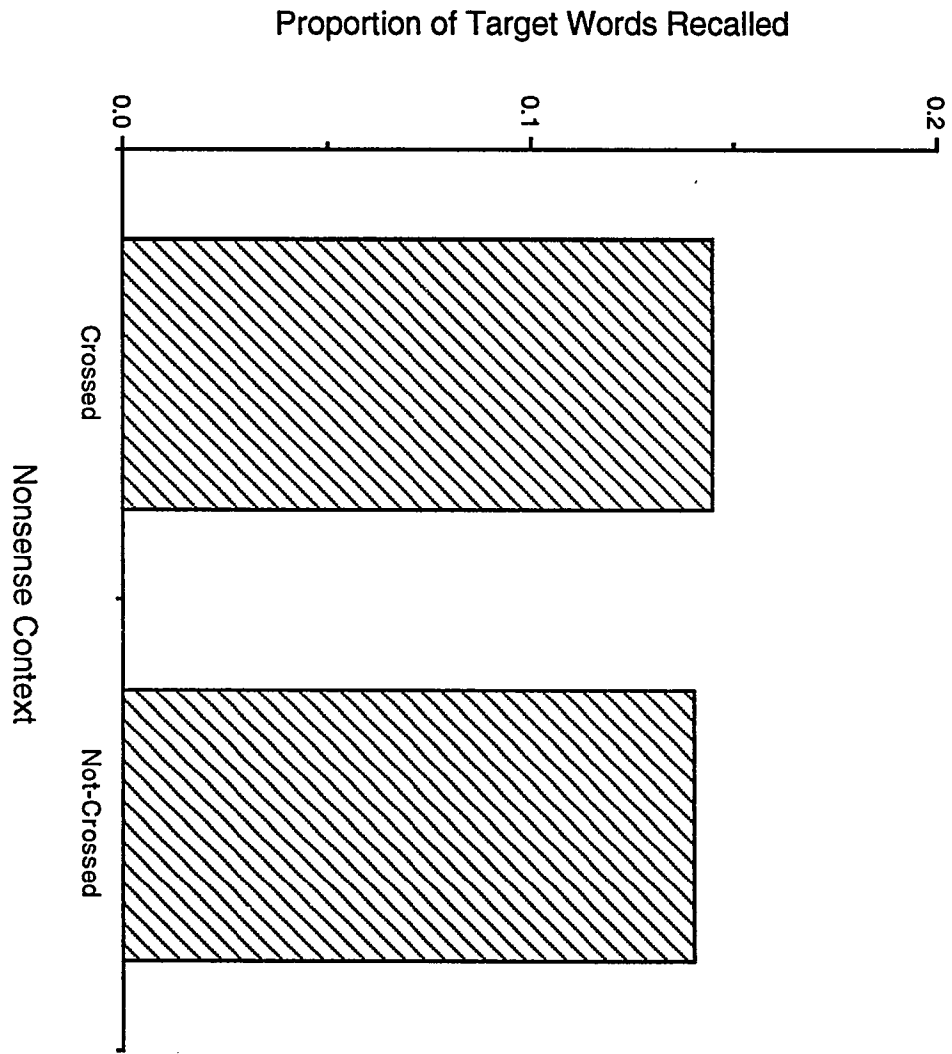


Figure Captions

Figure 9. Proportion of nonsense target words recalled for the crossed and not crossed conditions in Experiment 3.



General Discussion

The three experiments comprising this study were set in the framework of the transfer appropriate processing view. Selection of the three contextual arrangements and the three memory tasks made possible comparisons and cross-comparisons of the cognitive processing at the two stages of each memory task. In advance of actual experimentation, the processing view seemed eminently appropriate to the analysis of the study's stimulus input, the tasks, and their interrelations. The three experiments reported in this study provided additional clarification of the component processing view.

The main findings of this study showed that words within the sensible condition produced equivalent priming for the alone and nonsense conditions (Experiment 1); that there was also no effect of context for the category responding task (Experiment 2); and embedding target words in additional verbal material decreased priming for the sensible condition relative to the other conditions (Experiment 3). Results from Experiment 3 for the three types of context were parallel for free recall and word stem completion tasks. However, target words that were free recalled were more likely to be used to complete word stems than words that were not free recalled.

Aside from examining the component processing theory, Experiment 3 found that the motor act of crossing out an incongruous word in a sentence did not enhance performance on subsequent tests of implicit and explicit memory.

The major findings originated from the initial question of concern to this research. Does the context in which target words appear influence performance on subsequent implicit memory tasks? The answer, which this discussion will address, is that it depends upon how context is defined and which tasks are used to measure it.

This section will begin by examining the predictions presented earlier (based on the component processing view) in light of the findings obtained in the three experiments of this study.

First, it should be noted that context effects for the two implicit memory tasks and for the explicit free recall task were relatively small. This was particularly evident for the category responding task in Experiment 2. The small effect produced is explained by the choice of target words that were uncommon responses to a category. Since the responses were uncommon, the priming had to overcome many easily accessed responses. The choice of uncommon exemplars was to help prevent false positive responses when the same categories were presented in the control condition. In fact, while the overall effect was small, it was highly significant when compared with unprimed responses to categories.

In the material that follows, the findings will be evaluated in terms of the predictions from the component processing theory.

Experiment 1. The response requirement for Experiment 1 (word-stem completion) offered congruence for the target words within the alone and nonsense conditions while being at variance with words within a semantic context. According to the component processing view, with its emphasis on transfer appropriate processing, the predicted outcome would find priming for the alone and nonsense conditions significantly greater than for the sensible condition. Such findings have previously surfaced in the literature and have been used to promote the view that semantic context, while enhancing conceptually-driven explicit memory, has little effect on data-driven implicit memory.

The present research, which employed a data-driven word stem completion task, is at odds with the above view. While all three contexts (alone, nonsense, sensible) produced significant priming, there were no differential effects among the three conditions. The present study, by presenting words from the three contexts under similar conditions, decreased the likelihood that any one context would have a processing advantage over another. The saliency of words within conditions is especially important given Srinivas and Roediger's (1990) finding that semantic effects for explicit memory can be eliminated when words are too deeply embedded in accompanying verbal material. This explanation is also applicable to results of previous studies on implicit memory. Basically, the failure of the semantic condition to show

significant priming in prior studies might have been due to the limited access or attention paid to embedded target words relative to target words of other conditions. The present study, by allowing greater saliency for words in the semantic condition, created a situation where enhanced attention, processing and priming could take place.

Results from Experiment 1 suggest that the component processing view may not be an appropriate explanation for the semantic context effects. Rather, the previous findings of relatively reduced priming for the semantic condition can be explained by the amount of attention paid to target words during the study phase.

Experiment 2. The category responding task used in this experiment entails more conceptual processing than the word-stem completion task since the subject is required to produce a word that is an exemplar of the category. By the nature of that retrieval operation, a match between encoding and retrieval conditions will be effected when the exemplar had previously been seen in a sensible position in the sentence. Therefore, the prediction was that this condition would have relatively greater priming compared with the more data-driven alone and nonsense conditions. The evidence that the category association task is conceptually-driven comes from recent research by Srinivas and Roediger (1990), who found the category association task to have similar results as a free recall test. Since other purportedly data-driven tasks (e.g.

word-fragment completion) demonstrated opposite effects from free recall, they concluded that the category association task was conceptually-driven.

Results from Experiment 2 found equivalent priming for the three context conditions (alone, nonsense, sensible). This outcome, consistent with the first experiment, suggests that presentation of words in concise, simple, declarative sentences, rather than embedding them in additional verbal material, facilitates priming for words in the sensible condition. These results are inconsistent with the transfer appropriate processing view which would predict enhanced performance for the sensible condition now that congruence exists between study and test phases (i.e., both conceptually driven).

Experiment 3. In examining the third experiment, there was a two-fold purpose. First, by increasing the number of sentences to be processed, it sought to replicate the results of previous experiments on semantic context in implicit memory. This was accomplished by presenting target words in the same simple, declarative sentences as Experiment 2, except that the number of sentences to be processed was increased. In this way, any differences between Experiments 1 and 3 would be attributed to the increased verbal material and not the context in which the words were presented.

The results of Experiment 3 were similar to other experiments on context since the words in the sensible

condition now demonstrated limited priming. In fact, contrary to both Experiments 1 and 2, the sensible condition now demonstrated significantly less priming than the alone condition. These results are similar to other experiments on semantic context that also presented target words along with extraneous verbal material. Therefore, it is suggested that this extraneous material, by reducing the saliency and amount of attention paid to the target words, caused decreased priming for words in the sensible condition of Experiment 3 compared with Experiment 1.

This experiment also included free recall as an explicit memory task. The free recall test is a task considered to be highly conceptual since subjects have to try to generate words and then select those seen before. This process is aided by associations, imagery and elaboration. The prediction that free recall scores would be highest for targets seen in the sensible context, was not borne out in Experiment 3. In fact, recall scores were lowest for the sensible condition, which were, in fact, significantly poorer than the alone condition.

One explanation for this is that compared to the alone condition, target words in sentences, whether sensible or nonsense, had competition for attention from other words in the sentence (See Srinivas and Roediger (1990) for similar results for explicit memory). Words presented alone, however, were free from such competing verbal material.

To investigate the effects of increased attention of one condition relative to others, Experiment 3 examined the act of crossing out a target word that was incongruous to the sentence. The specific question asked was whether the additional manipulation of crossing out a word at all responsible for the increased priming for nonsense over sensible conditions in MacLeod's (1989) experiment.

Surprisingly, the results of the present experiment did not find a difference in priming between crossed and not crossed out target words for either the word-stem completion task or the free recall test.

A number of explanations exist for failure to find increased performance for nonsense words that were crossed out relative to those that were only read aloud. Firstly, it could simply be that the motor act of crossing out a word was insufficient to cause a measurable effect. Secondly, the act of reading target words aloud in this experiment, as opposed to silently in MacLeod's (1989), may have enhanced the target words to such a degree that crossing them out added little to the processing. Finally, since the sentence length for each target word was shorter in this experiment than in MacLeod's, the act of highlighting any one word over another may have had relatively little effect.

In any event, given present results, the crossing out of nonsense words can not be considered as an influential factor in the relatively increased priming for nonsense over sensible

words in MacLeod's experiment. The explanation remains one of the extent to which target words are embedded in verbal material, and whether there is a match between study and test phases.

Perhaps future testing could better address this issue by controlling for the effect of sentence length and the manner in which target words are presented.

The following material examines theoretical considerations in light of various experimental paradigms in semantic priming.

Examinations of semantic context in implicit memory were carried out using diverse experimental paradigms. For instance, paradigms examining the effects of semantic context on implicit memory vary from word-pairs (Jacoby, 1983a); and paragraphs (MacLeod, 1989); to meaningful text (Levy & Kirsner, 1989; Srinivas & Roediger, 1990) and lengthy questionnaires (Oliphant, 1983).

First, for words presented in pairs, the extent to which they can be considered to provide semantic context is questionable. By not forming a sentence, they do not form the cohesive semantic unit needed for conceptual processing to take place. At the other extreme, words embedded in lengthy questionnaires or paragraphs obscure the target word in extraneous verbal material, thus giving relative advantage to other conditions used for comparison (e.g. alone and nonsense). This was demonstrated in Experiments 1 and 3 where

the increase in material accompanying target words in Experiment 3 significantly decreased priming for the sensible condition relative to Experiment 1. The above concerns were addressed by Schacter (1990) where he stated:

Thus, when target words are presented for study in unusual formats or subjects are required by a study task to attend to the physical features of the words, priming may be based largely on novel word form representations; when words are not presented in unusual formats and study tasks do not require processing of a word's physical features, activation of pre-existing representations may play a more prominent role (p. 552).

It has become clear that applying one theory or process to all types of priming is insufficient. The tendency for investigators to draw conclusions from experiments using very different study and test materials is no longer productive or justifiable. This seems especially true when considering semantic context. When target words are presented in sentences, subjects may apply their own unique associations and imagery to the study material. This is very different from single word or word pair presentation and may not be appropriately accounted for by component processing, or any present, theory.

Tulving and Schacter (1990), for instance, make clear that their theory, based on a perceptual representation system,

addresses perceptual and not conceptual priming. Perceptual priming for them is concerned with physical features of the target word, while conceptual priming involves semantic processing. They do not attempt to explain all priming phenomena by a single theoretical construct. While their theory concerns perceptual priming, they believe that "... conceptually driven priming reflects a process of semantic learning: the modification of, or adding of new information to, semantic memory (p. 304)." Clearly, while sentences seem to fit this criterion, word pairs do not. Therefore, bridging results from various experimental designs for the purpose of validating theories must be done cautiously.

Along with the study phase, caution must also be taken when interpreting results from different implicit memory tasks. In addressing this issue, Tulving and Schacter (1990) assert that:

... access to the information that supports priming is very inflexible, or hyperspecific. Success or failure of gaining access to a representation through one cue has no implications for success or failure of access to the same representation through a different cue... (p.303)".

It is interesting that this statement could also be used to support the data-driven/conceptually-driven dichotomy of the component processing theory. At present, the two supposedly

diametrically opposed theoretical camps of multiple memory systems and component processing view may be gravitating toward similar interpretations. Proponents of the component processing view endorse the transfer-appropriate processing view to explain dissociations between implicit and explicit memory. Roediger (1990), for instance, explains dissociations between memory tests by the degree to which there is a match in processing between the study and test phases. Tulving and Schacter, who promote multiple memory systems, have recently expressed views that appear very much like the transfer appropriate processing view so crucial to the component processing theory. For instance, Schacter (1990) states:

It is possible that within a word form system, both activation of pre-existing, abstract representations and creation of novel, specific representations contribute to priming; the importance of each process may be determined by the nature of the target material and the encoding operations required by a particular study task.

(p. 552)."

With the many inconsistencies surrounding priming, a hypothesis recently proposed by Blaxton (1989) may be worth considering. When Blaxton was unable to account for all of her results using the component processing view, she proposed that her findings suggested a continuum for the conceptually-driven/data-driven processes. "That is, although there may be

tasks that strictly involve either conceptually or data driven processes, others may involve a mixture of the two (p. 667)."

This concept provides new avenues for research. For instance, what manipulation of data-driven tasks produce results predictive of conceptually-driven processing.

Results of the present research have found priming in both word stem completion and category response tasks to be equivalent across context conditions (alone, nonsense, sensible). These results do not support the component processing theory, which is concerned with whether there is a match in processing requirements between material presented at study and the task used to measure it.

The component processing theory would predict increased priming for the semantic context when a processing match between the study and test phases occurred and a decrease when the processing requirements were discordant. In fact, previous literature has found either a lack of semantic priming or significantly less priming if a non-match occurred between study and test phases. These previous studies are in fact at odds with other experimental manipulations such as elaboration and generation effects that were not found to influence (increase or decrease) the amount of priming effect for target words. This discrepancy was clarified by the present study which explained the previous decreases in semantic context as an artifact of embedding target words in lengthy verbal material. In fact, once target words were

placed in shorter sentences, all three conditions had an equivalent amount of priming. The implications of such a finding is that higher order manipulations such as elaboration, generation and now semantic context effects, which increase explicit memory, do not affect implicit memory. Therefore, a more general assumption can now be made that implicit memory may be relatively independent of such higher level processing.

One possible theoretical hypothesis generated from this assumption is that implicit memory may be the phylogenetically oldest form of memory. Perhaps it is an "instinctual", more primitive form of memory that lower order animals relied on to remember dangerous terrain, food cache and location of a home base. As the animal cortex developed, survival would be enhanced for those species who could integrate language, reasoning, decision making and primed memory into a more conscious higher order memory system. Storage and integration of such memory would logically involve areas such as the hippocampus and frontal cortex which are concerned with higher order processes. Support for such a theory comes from Tulving's (1989) cerebral blood flow studies that found conscious memory to involve more anterior structures. A recent, as yet unpublished, finding by Raichle and Squire also support this theory. They have shown that unaware memory produced greater activity within the region of the brain which was initially stimulated (in this case visual cortex). By

contrast, conscious recall of the same material showed greater stimulation in the hippocampus and frontal cortex. Therefore, priming with its basic, instinctual, unaware attributes may in fact have its roots in the evolution of the species.

This discussion bears on the question of whether implicit and explicit memory are separate memory systems or components of one older more basic system. If the aforementioned evolutionary hypothesis is applied to this discussion, it would appear that a stronger case can be made for one memory system where the higher order explicit memory evolved from more basic implicit memory.

While the techniques described above need verification from more exacting techniques such as Brain Topography, they offer a logical hypothesis on which to base future experimentation.

APPENDIX A

The categories and sentences used in Experiments 1 and 2. Target words used for the sensible condition are underlined, while words used for the nonsense condition are in parentheses.

A unit of time

A month can go by very quickly.
(stapler)

A relative

The cousin and other family came to visit.
(sable)

A Military title

The corporal received the medal for bravery.
(Detroit)

A four-footed animal

The elephant led the parade into the city.
(malaria)

An article of furniture

The dresser was large enough for the clothes.
(cheek)

A color

Purple is associate with royal robes.
(plumber)

A part of the human body

The heart pumps blood through the arteries.
(slippers)

A fruit

A strawberry tastes best when eaten ripe.
(ballet)

An alcoholic beverage

Brandy tastes best when sipped slowly.
(oriole)

A country

Germany has many beautiful castles and rivers.
(broccoli)

A crime

Burglary occurs mainly in big cities.
(heart)

A substance for flavoring food.

Garlic is a pungent addition to cooking.
(corporal)

A name applied to a person to indicate his occupation
or profession

The plumber spent hours fixing the leak.
(salmon)

A natural earth formation.

The volcano spewed its lava over the town.
(trapeze)

A sport

Soccer must be played without use of hands.
(storm)

A part of a building

The basement became flooded after the pipe burst.
(spider)

A weather phenomenon

The storm interrupted the hiking trip.
(anchor)

A musical instrument

The trombone gave off a loud sound.
(garlic)

A type of music

The opera was sung before a large audience.
(turtle)

A bird

The oriole makes its nest in trees
(brandy)

A dance

The ballet flowed with elegance and grace.
(Germany)

A vegetable

Broccoli is rich in vitamins and minerals.
(cousin)

A type of footgear

Slippers are comfortable around the house.
(volcano)

An insect

The spider wove an elaborate web.
(tripod)

A disease

Malaria still occurs in very hot climates.
(basement)

A fish

The salmon fought its way upstream.
(trombone)

A city

Detroit is famous as an automobile center.
(cockpit)

A kind of fur

The sable looked luxurious on the women.
(burglary)

A reptile

The turtle walked slowly toward the pond.
(dresser)

A part of a boat

The anchor was thrown overboard.
(month)

A part of a circus

The trapeze requires balance and agility
(purple)

A part of an airplane

The cockpit contained computerized instruments.
(elephant)

A part of the face

The cheek swelled after she slapped it.
(opera)

An item of office supplies

The stapler jammed while fastening the report.
(pulpit)

A piece of photographic equipment

The tripod can be helpful for a clear picture.
(soccer)

A part of the church.

The pulpit stood high above the congregation.
(strawberry)

APPENDIX B

Target words along with each context condition (alone, nonsense and sensible) used in Experiment 3.

ALLEY	The alley was dimly illuminated. An alley accompanied the apology note.
BACON	Bacon can be served very crisp. Bacon had an imposing appearance.
BLOOD	Blood gushed from the open wound. Blood led the parade into the city.
BRAIN	The brain is the main part of the nervous system. The brain is the resting place for many unfortunates.
BUNGALOW	The bungalow was across the sandy beach. The bungalow was unconscious after the attack.
CHAPLAIN	The chaplain reassured the widow. The chaplain escaped from the fisherman's net.
CIRCUIT	The circuit of the race was dangerous. The circuit released toxic waste.
CLOTHING	The clothing is neatly arranged in the dresser. The clothing staked out his claim.
COMRADE	A comrade addressed the socialist meeting. A comrade is often served with baked potato.
CONTRACT	The contract included the terms of the agreement. The contract was dimly illuminated.
CRADLE	The cradle rocked softly. The cradle accepted a medal for courage.

DISEASE	The disease was diagnosed too late for any help. The disease was across the sandy beach.
EDIFICE	The edifice had an imposing appearance. An edifice was given to the well behaved pupils.
ELEPHANT	The elephant led the parade into the city. The elephant is the main part of the nervous system.
FACTORY	The factory released toxic waste. The factory was served to the gods.
FILAMENT	The filament in the light bulb became incandescent. A filament is cozy around the house.
FLASK	The flask held unused chemicals. The flask adorned the entrance to the city.
FLOWER	A flower accompanied the apology note. A flower can be served very crisp.
FOREST	A forest shelters many animals. A forest required a permit.
GARRET	The garret was cluttered with junk. The garret survived the dry season.
GRASS	The grass covered the front yard. Grass is often worn for work.
HERMIT	A hermit lives an isolated existence. The hermit adjoining the park was abandoned.
INFANT	The infant babbled his first word. The infant was unsafe during the rising tide.

LEADER	The leader took the group to several attractions. The leader gushed from the open wound.
MACARONI	Macaroni takes only seven minutes to cook. Macaroni was cold and snowy.
MAGAZINE	A magazine is often full of advertizement. The magazine felt unwanted in the meeting.
MALARIA	Malaria still occurs in very hot climates. Malaria was made of pink silk.
MARSH	A marsh is a bare piece of land without trees. A marsh may expose a watch or jewelry.
MATERIAL	The material for the curtains is on the table. The material moved slowly toward the pond.
METAL	The metal was polished to a fine luster. The metal took the group to several attractions.
MISSILE	The missile reached the target. Missile still occurs in very hot climates.
MONARCH	The monarch opposed the new venture. The monarch was cluttered with junk.
MORGUE	The morgue is the resting place for many unfortunates. The morgue is neatly arranged in the dresser.
MUSTACHE	A mustache may add interest to a man's features. The mustache addressed the socialist meeting.
NECTAR	Nectar was served to the gods. Nectar was designated for smoking.

OFFICER The officer accepted a medal for courage.
 The officer is a kind of instrument.

OUTSIDER The outsider felt unwanted in the meeting.
 The outsider was polished to a fine luster.

OVERALLS Overalls are often worn for work.
 Overalls covered the front yard.

PEACH A peach tastes best when eaten ripe.
 A peach lives an isolated existence.

PHANTOM The phantom of the opera has been a celebrated
 play.
 The phantom was diagnosed too late for any help.

POPLAR The poplar survived the dry season.
 The poplar reassured the widow.

PORTAL The portal adorned the entrance to the city.
 A portal tastes best when eaten ripe.

PRISONER The prisoner exhibited no remorse.
 The prisoner in the light bulb became
 incandescent.

PROPERTY The property adjoining the park was abandoned.
 The property rocked softly.

RECITAL The recital featured a classical symphony.
 The recital held unused chemicals.

REPTILE The reptile moved slowly toward the pond.
 The reptile included the terms of agreement.

REVOLVER A revolver required a permit.
 A revolver shelters many animals.

SALOON The saloon was designated for smoking.
 The saloon of the race was dangerous.

SETTLER The settler staked out his claim.
 A settler is rich in vitamins and minerals.

SHAWL The shawl was made of pink silk.
 The shawl reached the target.

SHORE The shore was unsafe during the rising tide.
 The shore takes only seven minutes to cook.

SLIPPERS Slippers are cozy around the house.
 Slippers bored the entire audience.

SPEAKER The speaker bored the entire audience.
 The speaker for the curtains is on the table.

SPINACH Spinach is rich in vitamins and minerals.
 Spinach is useful for photography.

STEAK Steak is often served with baked potato.
 The steak featured a classical symphony.

STORM The storm interrupted the picnic.
 The storm was of classic design.

TEMPLE The temple was of classic design.
 The temple interrupted the picnic.

TRIPOD A tripod is useful for photography.
 A tripod may add interest to a man's features.

TROUT The trout escaped from the fisherman's net.
 The trout opposed the new venture.

TRUMPET The trumpet is one kind of instrument.
 A trumpet is a bare piece of land without trees.

References

- Baddeley, A.D. (1982). Amnesia: A minimal model and an interpretation. In L.S. Cermak (Ed.), Human memory and amnesia (pp. 305-333). Hillsdale, N.J.: Erlbaum.
- Bartlett, F.C. (1932). Remembering: An experimental and social study. London: Cambridge University Press.
- Battig, W.F., & Montague, W.E. (1969). Category norms of verbal items in 56 categories: A replication and extension of the Connecticut category norms. Journal of Experimental Psychology Monographs, 80, (3, Pt. 2).
- Blaxton, T.A. (1989). Investigating dissociations among memory measures: Support for a transfer appropriate processing framework. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 657-658.
- Bolton, T.L. (1892). The growth of memory in school children. American Journal of Psychology, 4, 362-381.
- Boring, E.G. (1929/1950). A history of experimental psychology. New York: Appleton-Century-Crofts.
- Boring, E.G., Langfeld, H.S., & Weld, H.P. (1939). Introduction to psychology. New York: Wiley.
- Bradshaw, G.L., & Anderson, J.R. (1982). Elaborative encoding as an explanation of levels of processing. Journal of Verbal Learning and Verbal Behavior, 21, 165-174.
- Brooks, D.N., & Baddeley, A.D. (1976). What can amnesic patients learn? Neuropsychologia, 14, 111-122.
- Burt, H.E. (1932). An experimental study of early childhood memory. Journal of Genetic Psychology, 40, 287-295.
- Burt, H.E. (1937). A further study of early childhood memory. Journal of Genetic Psychology, 50, 187-192.
- Burt, H.E. (1941). An experimental study of early childhood memory: Final report. Journal of Genetic Psychology, 58, 435-439.
- Carr, H.A. (1925). Psychology: A study of mental activity. New York: Longmans Green.
- Cermak, L.S., Talbot, N., Chandler, K., & Wolbarst, L.R. (1985). The perceptual priming phenomenon in amnesia. Neuropsychologia, 23, 615-622.

- Cohen, N.J. (1984). Preserved learning capacity in amnesia: Evidence for multiple memory systems. In L.R. Squire, & N. Butters (Eds.), Neuropsychology of Memory (pp. 83-103). New York: Guilford Press.
- Cohen, N.J., & Squire, L.R. (1980). Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of "knowing how" and "knowing that." Science, 210, 207-209.
- Craik, F.I.M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General, 104, 268-294.
- Craik, F.I.M., & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.
- Crovitz, H.F., Harvey, M.T., & McClanahan, S. (1979). Hidden memory: A rapid method for the study of amnesia using perceptual learning. Cortex, 17, 273-278.
- Diamond, R., & Rozin, P. (1984). Activation of existing memories in the amnesic syndrome. Journal of Abnormal Psychology, 93, 98-105.
- Dunn, J.C., & Kirsner, K. (1988). Discovering functionally independent mental processes: The principle of reversed association. Psychological Review, 95, 91-101.
- Ebbinghaus, H. (1964). Memory: A contribution to experimental psychology. New York: Dover. (Original work published 1985; translated 1913).
- Feustel, T.C., Shiffrin, R.M., & Salasso, M.A. (1983). Episodic and lexical contributions to the repetition effect in word identification. Journal of Experimental Psychology: General, 112, 309-346.
- Forbach, G.B., Stanners, R.F., & Hochhaus, L. (1974). Repetition and practice effects in a lexical decision task. Memory & Cognition, 2, 337-339.
- Gardner, H., Boller, F., Moreines, J., & Butters, N. (1973). Retrieving information from Korsakoff patients: Effects of categorical cues and reference to the task. Cortex, 9, 165-175.
- Glass, A.L., & Butters, N. (1985). The effects of association and expectations on lexical decision making in normals, alcoholics, and alcoholic Korsakoff patients. Brain and Cognition, 4, 465-476.

- Godden, D.R., & Baddeley, A.D. (1975). Context-dependent memory in two natural environments: On land and underwater. British Journal of Psychology, 66, 325-331.
- Gorfein, D.S., & Hoffman, R.R. (1987). Memory and learning: The Ebbinghaus conference. Hillsdale, N.J.: Erlbaum.
- Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. Journal of Verbal Learning and Verbal Behavior, 23, 553-568.
- Graf, P., Mandler, G., & Haden, P. (1982). Simulating amnesic symptoms in normal subjects. Science, 218, 1243-1244.
- Graf, P., & Schacter, D. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11, 501-518.
- Graf, P., & Schacter, D. (1987). Selective effects of interference on implicit and explicit memory for new associations. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 45-53.
- Graf, P., Shimamura, A.P., & Squire, L.R. (1985). Priming across modalities and priming across category levels: Extending the domain of preserved function in amnesia. Journal of Experimental Psychology: Learning, Memory and Cognition, 11, 385-395.
- Graf, P., Squire, L.R., & Mandler, G. (1984). The information that amnesic patients do not forget. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10, 164-178.
- Jacoby, L.L. (1982). Knowing and remembering: Some parallels in the behavior of Korsakoff patients and normals. In L.S. Cermak (Ed.), Human memory and amnesia (pp. 97-122). Hillsdale, N.J.: Erlbaum.
- Jacoby, L.L. (1983a). Remembering the data: Analyzing interactive processes in reading. Journal of Verbal Learning and Verbal Behavior, 22, 485-508.
- Jacoby, L.L. (1983b). Perceptual enhancement: Persistent effects of an experience. Journal of Experimental Psychology: Learning, Memory, and Cognition, 9, 21-38.
- Jacoby, L.L. (1984). Incidental versus intentional retrieval: Remembering and awareness as separate issues. In L.R. Squire, & N. Butters (Eds.), Neuropsychology of memory (pp. 145-156). New York: Guilford Press.

- Jacoby, L.L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. Journal of Experimental Psychology: General, 11, 306-340.
- Jacoby, L.L., & Witherspoon, D. (1982). Remembering without awareness. Canadian Journal of Psychology, 36, 300-324.
- Johnson, M.K. & Hasher, L. (1987). Human learning and memory. Annual Review of Psychology, 38, 631-668.
- Johnston, W.A., Dark, V.J., & Jacoby, L.L. (1985). Perceptual fluency and recognition judgments. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11, 3-11.
- Kane, J.H., & Anderson, R.C. (1978). Depth of processing and interference effects in the learning and remembering of sentences. Journal of Educational Psychology, 70, 626-635.
- Kinsbourne, M., & Wood, F. (1975). Short-term memory processes and the amnesic syndrome. In D. Deutsch, & J.A. Deutsch (Eds.), Short-term memory (pp. 257-291). New York: Academic Press.
- Kirsner, K., & Smith, M.C. (1974). Modality effects in word identification. Memory & Cognition, 2, 637-640.
- Kirsner, K., Milech, D., & Standen, P. (1983). Common and modality-specific processes in the mental lexicon. Memory & Cognition, 11, 621-630.
- Kolers, P.A. (1975). Memorial consequences of automatized encoding. Journal of Experimental Psychology: Human Learning and Memory, 1, 689-701.
- Kolers, P.A., & Roediger, H.L. (1984). Procedures of mind. Journal of Verbal Learning and Verbal Behavior, 23, 425-449.
- Levy, B.A., & Kirsner, K. (1989). Reprocessing text: Indirect measures of word and message level processes. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 407-417.
- Mandler, G. (1980). Recognizing: The judgment of previous occurrence. Psychological Review, 87, 252-271.
- Masson, M.E.J. (1984). Memory of the surface structure of sentences: Remembering with and without awareness. Journal of Verbal Learning and Verbal Behavior, 23, 579-592.

- Masson, M.E.J. (1989). Fluent reprocessing as an implicit expression of memory for experience. In S. Lewandowsky, J.C. Dunn, & D. Kirsner (Eds.), Implicit memory: Theoretical issues (pp 123-138). Hillsdale, N.J.: Erlbaum.
- MacLeod, C.M. (1988). Forgotten but not gone: Savings for pictures and words in long-term memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 14, 195-212.
- MacLeod, C.M. (1989). Directed forgetting affects both direct and indirect tests of memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 13-21.
- McAndrews, M.P., Glisky, E.L., & Schacter, D.L. (1987). When priming persists: Long-lasting implicit memory for a single episode in amnesic patients. Neuropsychologia, 25, 497-506.
- McDaniel, M.A., Wodtill, P.J., & Einstein, G.O. (1988). A contextual account of the generation effect: A three factor theory. Journal of Memory and Language, 27, 521-636.
- McKoon, G., & Ratcliff, R. (1979). Priming in episodic and semantic memory. Journal of Verbal Learning and Verbal Behavior, 18, 463-480.
- McKoon, G., & Ratcliff, R. (1986). Automatic activation of episodic information in a semantic memory task. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 108-115.
- Mueller, G.E., & Pilzecker, A. (1900). Experimentelle Beitrage zur Lehre vom Gedachtnis [Experimental contributions to the study of memory]. Zeitschrift fur Psychologie der Sinnesorgane, Ergänzungsband #1.
- Milner, B., Corkin, S., & Teuber, H.L. (1968). Further analysis of the hippocampal amnesic syndrome: 14 year follow-up study of H.M. Neuropsychologia, 6, 215-234.
- Morris, C.D., Bransford, J.D., & Franks, J.J. (1977). Levels of processing versus transfer appropriate processing. Journal of Verbal Learning and Verbal Behavior, 16, 519-533.
- Morton, J. (1979). Facilitation in word recognition: Experiments causing change in the logogen models. In P.A. Kolers, M.E. Wrolstad, & H. Bouma (Eds.), Processing of visible language (Vol. 1, pp. 259-268). New York: Plenum.
- Moscovitch, M. (1982). Multiple dissociations of function in amnesia. In L.S. Cermak (Ed.), Human memory and amnesia (pp. 337-370). Hillsdale, N.J.: Erlbaum.

- Moscovitch, M., Winocur, g., & McLachlan, D. (1986). Memory as assessed by recognition and reading time in normal and memory-impaired people with Alzheimer's disease and other neurological disorders. Journal of Experimental Psychology: General, 115, 331-347.
- Naveh-Benjamin, M. (1990). Coding of temporal order information: An automatic process? Journal of Experimental Psychology: Learning, Memory, and Cognition, 16, 117-126.
- Nelson, T.O. (1978). Detecting small amounts of information in memory: Savings for nonrecognized items. Journal of Experimental Psychology: Human Learning, and Memory, 4, 453-468.
- Oliphant, G.W. (1983). Repetition and recency effects in word recognition. Australian Journal of Psychology, 35, 393-403.
- Peterson, L.R., & Peterson, M.J. (1959). Short term retention of individual verbal items. Journal of Experimental Psychology, 58, 193-198.
- Rescorla, R.A., Durlach, P.J., & Grau, J.W. (1985). Contextual learning in Pavlovian conditioning. In P.D. Balsam, & A. Tomie (Eds.), Context and learning. Hillsdale, N.J.: Erlbaum.
- Richardson-Klavehn, A., & Bjork, R.A. (1988). Measures of memory. Annual Review of Psychology, 39, 475-543.
- Roediger, H.L. III (1990). Implicit memory: A commentary. Bulletin of the Psychonomic Society, 28, 373-380.
- Roediger, H.L. III, & Blaxton, T.A (1987a). Effects of varying modality, surface features, and retention interval on priming in word fragment completion. Memory & Cognition, 15, 379-388.
- Roediger, H.L. III, & Blaxton, T.A (1987b). Retrieval modes produce dissociations in memory for surface information. In D. Gorfein, & R.R. Hoffman (Eds.), Memory and cognitive processes: The Ebbinghaus centennial conference (pp. 349-377). Hillsdale, N.J.: Erlbaum.
- Roediger, H.L. III, & Weldon, M.S. (1987). Reversing the picture superiority effect. In M.A. McDaniel, & M. Pressley (Eds.), Imagery and related mnemonic processes: Theories, individual differences, and applications (pp. 151-174). New York: Springer Verlag.

- Roediger, H.L. III, Weldon, M.S., & Challis, B.A. (1989). Explaining dissociations between implicit and explicit measures of retention: A processing account. In H.L. Roediger III, & F.I.M. Craik (Eds.), Varieties of memory and consciousness: Essays in honor of Endel Tulving (pp. 3-41). Hillsdale, N.J.: Erlbaum.
- Rozin, P. (1976). A psychobiological approach to human memory. In M.R. Rosensweig, & E.L. Bennett (Eds.), Neural mechanisms of memory and learning (pp. 3-48). Cambridge, Mass: M.I.T. Press.
- Salasso, A., Shiffrin, R.M., & Feustel, T.C. (1985). Building permanent memory codes: Codification and repetition effects in word identification. Journal of Experimental Psychology: General, 114, 50-77.
- Scarborough, D.E., Gerard, L., & Cortese, C. (1979). Accessing lexical memory: The transfer of word repetition effects across task and modality. Memory & Cognition, 7, 3-12.
- Schacter, D.L. (1985). Priming of old and new knowledge in amnesic patients and normal subjects. Annals of the New York Academy of Sciences, 444, 41-53.
- Schacter, D.L. (1987). Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 501-518.
- Schacter, D.L. (1990). Perceptual representation systems and implicit memory: Toward a resolution of the multiple memory systems debate. In A. Diamond (Ed.), The development and neural bases of higher cognitive functions. Annals of New York Academy of Sciences, 608, 543-571.
- Schacter, D.L., & Graf, P. (1986a). Preserved learning in amnesic patients: Perspectives from research on direct priming. Journal of Clinical and Experimental Neuropsychology, 8, 727-743.
- Schacter, D.L., & Graf, P. (1986b). Effects of elaborative processing on implicit and explicit memory for new associations. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 432-444.
- Schacter, D.L., & Graf, P. (1989). Modality specificity of implicit memory for new associations. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 3-12.
- Schacter, D.L., & McGlynn, S.M. (1989). Implicit memory: Effects of elaboration depend on unitization. American Journal of Psychology, 102, 151-181.

- Schwartz, B.L. (1989). Effects of generation on indirect measures of memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 1119-1128.
- Shapiro, S.I., & Palermo, D.S. (1970). Conceptual organization and class membership: Normative data for representative of 100 categories. Psychonomic Monograph Supplements, 3, 108-127.
- Shimamura, A.P. (1986). Priming effects in amnesia: Evidence for a dissociable memory function. Quarterly Journal of Experimental Psychology, 38A, 619-644.
- Shimamura, A.P., & Squire, L.R. (1984). Paired-associate learning and priming effects in amnesia: A neuropsychological approach. Journal of Experimental Psychology: General, 113, 556-570.
- Slamecka, N.J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. Journal of Experimental Psychology: Human Learning and Memory, 4, 592-604.
- Sloman, S.A., Hayman, C.A.G., Ohta, N., Law, J., & Tulving, E. (1988). Forgetting in primed fragment completion. Journal of Experimental Psychology: Learning, Memory, and Cognition, 14, 223-239.
- Smith, S.M. (1979). Remembering in and out of context. Journal of Experimental Psychology: Human Learning and Memory, 5, 460-471.
- Smith, E.R., & Branscombe, N.R. (1988). Category accessibility as implicit memory. Journal of Experimental Social Psychology, 24, 490-504.
- Squire, L.R. (1986). Mechanisms of memory. Science, 232, 1612-1619.
- Squire, L.R. (1987). Memory and brain. New York: Oxford University Press.
- Squire, L.R., Shimamura, A.P., & Graf, P. (1987). Strength and duration of priming effects in normal subjects and amnesic patients. Neuropsychologia, 25, 195-210.
- Srinivas, K., & Roediger, H.L. (1990). Testing the nature of two implicit tests: Dissociations between conceptually-driven and data-driven processes. Journal of Memory and Language, 29, 389-412.
- Strong, E.K. (1912). The effects of length of series upon recognition memory. Psychology Review, 19, 447-462.

- Strong, E.K. (1913). The effects of time-interval upon recognition memory. Psychology Review, 20, 339-372.
- Tulving, E. (1972). Episodic and semantic memory. In E. Tulving, & W. Donaldson (Eds.), Organization of memory (pp. 381-403). New York: Academic Press.
- Tulving, E. (1983). Elements of episodic memory. Oxford: Oxford University Press.
- Tulving, E. (1985). How many memory systems are there? American Psychologist, 40, 385-398.
- Tulving, E., & Gold, C. (1963). Stimulus information and contextual information as determinants of tachistoscopic recognition of words. Journal of Experimental Psychology, 66, 319-327.
- Tulving, E., Schacter, D.L., & Stark, H.A. (1982). Priming effects in word-fragment completion are independent of recognition memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 8, 336-342.
- Tulving, E., & Thomson, D.M. (1973). Encoding specificity and retrieval processes in episodic memory. Psychological Review, 80, 352-372.
- Underwood, B.J. (1977). Temporal codes for memories: Issues and problems. Hillsdale, N.J.: Erlbaum.
- Warrington, E.K., & Weiskrantz, L. (1968). New method for testing long-term retention with special reference to amnesic patients. Nature, 217, 972-974.
- Warrington, E.K., & Weiskrantz, L. (1970). Amnesic syndrome: Consolidation or retrieval. Nature, 228, 628-630.
- Warrington, E.K., & Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. Neuropsychologia, 12, 419-428.
- Warrington, E.K., & Weiskrantz, L. (1978). Further analysis of the prior learning effect in amnesic patients. Neuropsychologia, 16, 169-177.
- Weiskrantz, L. (1985). On issues and theories of the human amnesic syndrome. In N.M. Weinberger, J.L. McGaugh, & G. Lynch (Eds.), Memory systems of the brain (pp. 380-415). New York: Guilford Press.

- Weiss, W., & Margolius, G. (1954). The effect of context stimuli on learning and retention. Journal of Experimental Psychology, 48, 318-322.
- Weldon, M.S., & Roediger, H.L. (1987). Altering retrieval demands reverses the picture superiority effect. Memory & Cognition, 15, 269-280.
- Wickens, D.D. (1987). The dual meanings of context: Implications for research, theory, and applications. In D.S. Gorfein and R.R. Hoffman (Eds.), Memory and learning: The Ebbinghaus centennial conference (pp. 135-152). Hillsdale, N.J.: Erlbaum.
- Winnick, W.A., & Daniel, S.A. (1970). Two kinds of response priming in tachistoscopic word recognition. Journal of Experimental Psychology, 84, 74-81.
- Winnick, W.A., Kooper, F., & Sprafkin, J. (1974). Free recall as a function of type of evoking stimulus. Journal of Experimental Psychology, 103, 269-273.
- Winocur, G. (1982). The amnesic syndrome: A deficit in cue utilization. In L.S. Cermak (Ed.). Human memory and amnesia. Hillsdale, N.J.: Erlbaum.
- Winocur, G., & Kinsbourne, M. (1978). contextual cueing as an aid to Korsakoff amnesics. Neuropsychologia, 16, 671-682.
- Woodworth, R.S. (1938). Experimental psychology. New York: Holt.
- Woodworth, R.S., & Schlosberg, H. (1955). Experimental psychology review. New York: Holt.