THE UNIVERSITY OF MANITOBA

Remembering Without Awareness?
An Investigation of
Unattended Presentation and Punishment Effects
on Recognition and Spelling of Homophone Units

A Thesis

Submitted to the Faculty of Graduate Studies

In Partial Fulfillment of the Requirements for the Degree

MASTER OF ARTS

Department of Psychology

Winnipeg, Manitoba

September 1988

ISBN 0-315-47906-X

REMEMBERING WITHOUT AWARENESS?

AN INVESTIGATION OF UNATTENDED PRESENTATION AND PUNISHMENT EFFECTS ON RECOGNITION AND SPELLING OF HOMOPHONE UNITS

BY

KENT SOMERS

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF ARTS

Acknowledgements

I wish to express my thanks to four individuals who have shared the task of producing this thesis:

- To David Martin, for wisdom and decisiveness in providing me with direction along the way and for unwavering support;

- To Garry Hawryluk and John McIntyre, for scholarly input and moral support while serving on my committee;

- To Anne, my wife, who shared a burden equal to mine and who responded with love and patience;

Thank you.

Abstract

Right handed male subjects repeated aloud a passage of prose presented to one ear, while homophones were presented to the unattended ear. The homophones were paired with words which suggested either their less common ("easy PREY") or their more common ("minister PRAY") meaning. Half of the homophones from each of these two groups were followed by a presentation of 107 dB white noise. Subjects heard the unattended homophones in either the left or the right ear. After the dichotic presentations, recognition of homophones and spelling of homophones were tested.

It was hypothesized, first, that subjects would spell the version of the homophones previously presented. It was expected that homophones presented with the white noise would not be spelled, but that the complementary meaning would be spelled. It was predicted that these effects would be observed without subjects' recognition of the presented homophones. These effects were expected only when the unattended homophones were presented to the left ear, and not when they were presented to the right ear.

The results obtained from the procedures did not support the hypotheses forwarded. It is suggested from these results that phenomena such as implicit memory (Graf & Schacter, 1985) and memory for unattended words (Eich, 1984) may be too subtle for the present design to have produced.

Remembering without Awareness?
Unattended Presentation and Punishment Effects on Recognition and Spelling of Homophone Units

The notion of an unconscious mind, or more colloquially, "the unconscious", is popularly associated with clinical, psychodynamic psychology. Embraced by Freud, the notion of unconscious processes of the mind was a central tenet to an entire enduring school of psychology. This notion, on the other hand, has been unpalatable to behavioristic, experimentally oriented psychologists, who represent a school of thought which has come to prominence in psychology (Shevrin & Dickman, 1980). More recently, it appears that a renaissance has come about for the notion of unconscious processes, and that the current proponents of this construct are producing empirical results to support it. The realization among these experimental psychologists is that there are cognitive processes which occur outside of reportable awareness (Marcel, 1983a, 1983b; Nisbett & Wilson, 1977; Shevrin & Dickman, 1980; Zajonc, 1980).

This statement is controversial. First, it is difficult to define "consciousness" and similar terms such as "awareness" or "unconscious". Second, the suggestion that cognitive processes can, and do, occur outside of reportable awareness involves another level of controversy, which is to be the main focus of the following discussion. Empirical evidence will be reviewed which addresses the independence

of cognitive processes and reportable awareness. It is necessary to demonstrate that cognitive, and especially memory, functions may operate without conscious mediation.

An operational definion of "conscious" is needed for clarity in the current discussion. A few definitions have been provided by researchers in the area. Marcel (1983b) asserts that the primary criterion of a definition of awareness is reference to the phenomenological aspect of consciousness: our ability to observe our own behaviors, both mental and physical. Another important aspect of his definition, and perhaps a corollary of the first, is that consciousness pertains to volition, "the ability to base intentional, categorical action upon a perceptual (or imaginal) experience" (Marcel, 1983b, p. 240).

Martin (1980) defines awareness as "a class of brain behaviors that are operationally defined by the degree to which they are symbolically expressible" (pp. 7-8). Martin's definition differs from Marcel's in at least two respects. First, it is an operational definition anchored in human behavior, albeit behavior which is only indirectly observable through mental, vocal, or other symbolization. The second difference is that Martin describes awareness as on a continuum rather than as something that is either present or absent. This view allows that one may be partially aware of an event, object, or even one's own behavior. For example, if one grimaces at the sight of some

object (a symbolic expression of some negative affect) but vocally expresses no remembrance of doing so, it may be said that the individual was in fact aware of the object, but only partially so. Certainly it is awareness which does not require mental or vocal symbolization. Awareness in this situation is the extent to which the individual acted upon some contingency, and was not acting in a purely random manner.

A synthesis of these two seemingly incompatible definitions is made possible by referring to Martin's (1980) use of the term "reportable awareness." The definitions put forward by Martin (1980) and Marcel (1983b) agree that there are cognitive processes on which an individual is able to report. The term "reportable awareness" retains a phenomenological aspect, but operationalizes consciousness in behavioral terms. For the purpose of the present discussion, the term "consciousness" will be equated with verbally reportable awareness. It is recognized that this definition is limited in its scope, but it will be used in the present discussion for the sake of consistency.

The nature of the cognitive processes which may occur without reportable awareness is far from clear. Rather, there have been numerous perspectives in the history of the issue. For example, early theorists in the area of selective attention indicated that multiple stimuli impinging upon an individual received only peripheral

sensory analysis before one stimulus was chosen for further processing (Duncan, 1980; Shevrin & Dickman, 1980). This conservative view of pre-attentive processing was challenged by later evidence (Lewis, 1970; Marcel, 1983a). Several researchers concluded, in fact, that the meaning of stimuli may be analyzed to some extent without reportable awareness of the stimuli. Other researchers carry this conclusion beyond the scope of perceptual processes indicating that an experience with a stimulus may be recorded in memory without reportable awareness of that stimulus (e.g., Graf & Mandler, 1984; Graf & Schacter, 1985). This recording has been termed implicit memory, revealed as the facilitated performance of a task which occurs without requiring conscious recollection of a learning experience (Graf & Schacter, 1985, p. 501). Priming of a word, the facilitated performance on a task as a function of prior exposure to that word, may occur without an individual's ability to recognize or recall the prior episode; this would be evidence of implicit memory. Material which can be summoned from memory and reported by an individual is described as being in explicit memory (Graf & Schacter, 1985, p. 501). Recall and recognition tasks would access explicit memory. The current discussion will review studies which address perceptual processes which occur without reportable awareness of stimuli but which influence behavior and studies which address implicit memory for stimuli which are

studies but which are not later accessable by recall or recognition. Although the distinction drawn between implicit memory and explicit memory is somewhat artificial, it allows a conceptual framework upon which experimental hypotheses may be presented.

Semantic Analysis Without Reportable Awareness

Marcel (1983a) presented a series of visual masking experiments in an effort to dismiss what he termed the "Identity Assumption." This is the assumption, held implicitly by many perception researchers, that "the representations which constitute conscious experience are... the very same ones that are derived and used in sensory and motor processes" (p. 198). From his results, Marcel reasoned that semantic processing of visual information may occur without reportable awareness. For example, it was found that lexical decision time (the reaction time in indicating whether or not a string of letters constitutes an English word) was reduced when a target word was preceded by a masked word associated with the target word, as compared to the situation in which the target word was preceded by an unassociated masked word. That is, a subject would not be able to identify a word which was masked, or whether in fact a word had preceded the mask. However, a significant priming effect would occur if the masked word which preceded the target word (e.g., PALM) was associated to the target

word upon which lexical decision was to be made (e.g., HAND), relative to the lexical decision time when a non-associated masked word (e.g., TREE) preceded the target. Moreover, this difference in reaction time increased as the number of masked presentations was increased from 1 to 20. It is important to note that the increased frequency of masked stimulus presentations did not increase subjects' frequency of detection of the presence of the stimulus word preceding the pattern mask. Rather, when subjects were asked to indicate (with a push button response) whether or not stimulus words preceded the pattern mask presentations, the probability of correctly responding remained at or near chance levels (Marcel, 1983a, experiment 5).

Marcel concluded that pattern masking does not interfere with the semantic processing of visual information per se, but that it interferes with the ability to report on the product of visual processing. That is, reportable awareness is not necessary for the processing of the meaning of visual stimuli. As well, reportable awareness is not a necessary consequence of perceptual processing; repeated presentations of a stimulus facilitated a priming effect without increasing subjects' awareness of that stimulus. It appears that consciousness is, to some extent, functionally independent of antecedent perceptual processes. This conclusion is supported by Fowler, Wolford, Slade, and Tassinary (1981), who used Marcel's (1983a) procedure and

reported similar findings.

Lewis (1970) presented to the right ear of each of his subjects a series of words which were to be repeated aloud and verbatim without error. This procedure is termed shadowing. In the other ear, synchronized with the shadowed stimuli, were other words which were to be unattended. Some of these words were synonymous with their shadowed mate. Lewis found that the reaction time for these shadowed words was longer as compared to the words not paired with synonyms. He concluded that the meanings of the unattended words were being processed. This processing occurred in addition to the processing demands already placed on the individual to shadow the attended list. The delay in reaction time, he reasoned, was an effect of momentary overtaxing of the individual's overall processing capacity.

Lewis' (1970) conclusions are theoretically significant in at least two respects. First, they support Marcel's (1983a) conclusion that reportable awareness of stimuli may be

independent of semantic perceptual processing. Lewis' subjects were not able to identify any of the unattended stimuli although they were influenced by them. Second, these findings suggest that Marcel's observation of a division between perceptual processes and reportable awareness generalizes beyond visual perception and is evident in auditory perception as well.

Other procedures have dramatically illustrated that the meaning of the stimuli to which an individual attends can be influenced by unattended information. Lackner and Garrett (1972) had subjects listen to ambiguous target sentences (e.g., "the spy put out the torch...") in a dichotic listening procedure. In the unattended ear, other sentences were presented which either biased the meaning of the target sentence ("the spy extinguished the torch...") or were unrelated to the target sentence. In these paired presentations, the target sentence preceded the other sentence by approximately half a second, and was 5 to 10 dB louder than the other sentence. Ear of presentation was counter-balanced, and no effect of ear of presentation was found. It was each subject's task to paraphrase the attended ambiguous sentence and to begin that paraphrase before the sentence was completed. Subjects were able to comply with these procedures. It was found that subjects could not identify the content of the unattended channel and that they were not aware that the attended sentences were ambiguous. However, they tended to resolve the ambiguities in line with the meaning of the biasing sentences, as compared to a baseline of typical, unbiased interpretations of the ambiguous sentences. This finding is consistent with Lewis' (1970) and Marcel's (1983a) conclusions that automatic semantic processing may occur without reportable awareness of stimuli. Lackner and Garrett's study seems to

build on this conclusion, illustrating that the information which becomes expressed as reportable knowledge does not have to be available for reportable awareness. Their study, among others (Motley & Baars, 1976; Nisbett & Wilson, 1977), therefore supports and extends Lewis' (1970) findings.

Implicit and Explicit Memory in Amnesics

The most obvious quality of an organic amnesic disorder such as Korsakoff's syndrome is a dissociation apparent in memory. That is, only a part of memory is compromised. Speech remains intact, and short term memory remains functional (Baddely, 1982). The nature of the deficit which exists with this amnesia is less obvious. A distinction applied to the amnesic syndrome which appears to have some utility in describing the memory deficit (Schacter & Tulving, 1982) is Tulving's (1972) psychological model of episodic memory and semantic memory (Kinsbourne & Wood, 1975; Kinsbourne & Wood, 1982). Tulving's categories are intended to label long term memory systems which store information about time related events and temporal-spatial relations (episodic memory), or which store the "cognitive referents" of perceptual processes, especially those required for use of language (semantic memory; Tulving, 1972). The distinction seems to have become firmly entrenched in theoretical discussions concerning amnesic disorders (Jacoby, 1982; Kinsbourne & Wood, 1982; Schacter & Tulving, 1982). In terms of this categorization, it appears

that individuals with organic amnesia are deficient with regard to episodic memory but retain semantic memory.

Empirical findings support the episodic-semantic distinction with regard to organic amnesia. Jacoby and Witherspoon (1982) found that amnesics spelled homophones so as to denote previously presented meanings of the homophones (e.g., "musical instrument that employs a REED"), although they could not reliably indicate in a later recognition task the words which had been presented to them.

Schacter, Harbluk, and McLachan (1984) report the occurrence of source amnesia in some amnesic individuals, a phenomenon not unlike that reported by Jacoby and Witherspoon. Patients were able to respond correctly to question prompts concerning previously presented facts but were unable to identify the source of the factual knowledge. This phenomenon was termed "source amnesia." The significance of this occurence is that it is evidence of the learning of new semantic associations which may be apparent in implicit memory but not in explicit memory.

Graf and Schacter (1985) report an associative effect in implicit memory for unrelated word pairs. As a study task, amnesic patients used word pairs in meaningful sentences. In a later word completion task, a few letters of the second word of each pair was presented, and was cued either by the original first word of the pair (same context), or by a different word (different context). It was found that more

of these target words were reproduced in the word completion task than could be accounted for by chance. It was also found that more of these target words were completed when preceded by the word they had been paired with in the study task than when preceded by a different word. That is, these findings suggest that priming of the target words occurred, as Jacoby and Witherspoon (1982) had observed, but also that an associative connection developed between word pairs during the study task. As the patients could not explicitly recall the word pairs which were used in the study task, the associative connection was apparently registered in implicit memory.

The evidence with patients with organic amnesia suggests that retention of semantic information may be demonstrated without reportable awareness and that learning of associations may occur without reportable awareness of the learning episode. This is certainly different than a naive picture of amnesics "forgetting everything" and supports the distinction between implicit and explicit memory.

Implicit and Explicit memory in Non-amnesics

Evidence indicates that the dissociation of memory in amnesics may also become apparent in normal memory functioning and is therefore not entirely a function of memory pathology. A number of studies have sought to produce amnesic phenomena in normal individuals to see what

similarities may exist between amnesic and normal populations (e.g., Graf, Mandler, & Haden, 1982). The studies to be discussed in this section have been divided to consider effects in implicit and explicit memory first for single words as stimuli and then for word pairs as stimuli. These are considered separately because the evidence demonstrates that different effects can be found with the different stimuli. This difference has been attributed to the learning of associative connections between words.

Implicit and explicit memory for single words. The most significant finding from the literature to be reviewed is that single words may be primed in tasks which demonstrate implicit memory and that these effects are often independent of performance on tests of explicit memory. While this has been found with individuals with organic amnesia, Graf et al. (1982) sought to generalize this finding to a normal population. Graf et al. presented subjects with a list of common words to memorize. The two tests of retention were a word completion task, where the first three letters of target words were presented among other prefix stems (i.e., "DEF__" for "DEFEND") to be completed as words, and cued recall. When subjects studied the target words for graphemic qualities of the words (such as number of vowels), recall for these words was low (8% of the target words were recalled). On word completion, however, target words were

reproduced more frequently (28% of stems were completed as study words). This is in contrast to a base rate of word completion (i.e., "correct" completion of control words which had not been previously presented) of 6%. Performance on the word completion task, which demonstrated an implicit remembering of the studied words, exceeded performance on recall, a task which did involve explicit remembering of the studied words.

Tulving, Schacter, and Stark (1982) found that the completion of graphemic word fragments (e.g., "_YS__RY" as "MYSTERY") was significantly primed one hour after target words had been studied. This priming effect endured seven days later such that word completion performance did not decrease with elapsed time. In contrast, recognition performance (that is, recognition of words as items presented during the study task) decreased from one hour to seven days after study, with performance initially above that of fragment completion to performance well below it.

Graf and Mandler (1984) provide additional support for the notion that implicit memory tasks can be primed. They demonstrated that priming may be effected even by a study task in which target words are analyzed for graphemic qualities unrelated to their meanings. Moreover, they provided an important demonstration that the differences cited for implicit and explicit memory tasks are not related to the difficulty of the task demands. Rather, they

provided evidence that different test instuctions with identical testing cues led to differences in performance (i.e., reproduction of target words). Graf and Mandler presented subjects one set of prefix stems in both word completion and cued recall. In word completion, instructions were given to "complete each cue with the first word that comes to mind." In the cued recall task, subjects were instructed to use the cue to help to "recall the words from the presented list" (1984, p. 563). Words which had been studied for their graphemic structure were reproduced significantly more often in word completion than they were in cued recall. Thus, the target words were primed, and reproduction of them did not require reportable awareness of the study situation. As well, this priming occurred without subjects' intentional analysis of the meanings of the words. Finally, the nature of the demands on memory in the task, and not the difficulty of the task, led to the difference in performance on word completion and cued recall.

Jacoby and Dallas (1981) demonstrated that words presented in a study task could prime the perceptual recognition of those words in a masking procedure. Two tests measured subjects' retention of the presented items, recognition and what these researchers termed "perceptual recognition." In this latter task, letter strings were presented briefly to subjects and were followed by a masking

stimulus. Subjects were required to name the word which was presented. These researchers reported a significant priming effect in perceptual recognition performance and this effect was independent of the level of conscious recognition of the word as a studied item. While this study addressed perceptual or attentional (Johnston & Dark, 1986) processes, its findings are consistent with the results from other studies currently under discussion which would consider this effect evidence of implicit memory.

Priming of words in an implicit memory task has also been demonstrated in tasks which prevented reportable awareness of the items. Eich (1984) extended Jacoby and Witherspoon's (1982) findings with amnesics to a normal student population. Subjects repeated aloud an essay which they heard presented to one ear. In the other ear were presented homophones, in a context which biased the less common interpretation/spelling (e.g., easy-PREY). Subjects could not reliably indicate in a later recognition test the words which had been presented in the unattended presentation. A significant influence of bias in the unattended presentation was found on the spelling test, as subjects tended to spell the less common spellings of biased homophones. The meanings of the homophones were registered in memory without the subjects' ability to report on the homophones they had heard.

A variable which has received attention in a number of

studies is the processing requirements during study. Elaborative processing tasks draw attention to the meaning of the stimulus word and have included ratings of liking for a word (Graf et al., 1982; Graf & Mandler, 1984), ratings of the abstractness or meaningfulness of a word (Graf & Mandler, 1984), or responding to questions about the meaning of a particular word (Jacoby & Dallas, 1981). Structural processing tasks have the subject attend to features of the printed word and have included evaluating number of vowels (Graf et al., 1982; Graf & Mandler, 1984), identifying vowels present (Jacoby & Dallas, 1981), or considering graphemic qualities of the word, such as intersecting lines or enclosures (Graf & Mandler, 1984). These two classes of processing during a study phase have consistently produced different levels of performance in tasks revealing explicit memory, where recall or recognition are augmented when study words are elaboratively processed. This effect is not surprising (see Craik & Lockhart, 1972). It is a surprising but consistent finding that these different processing tasks do not have a differential effect on tasks which reveal implicit memory. Graf and Mandler (1984) tested subjects' retention of study list words in word completion and then cued recall, where identical cues were used and only instructions differentiated the tasks. Significant priming effects in word completion were found but were not dependent on the nature of the processing task during the study phase

(i.e., elaborative versus structural processing). No significant difference in level of reproduction of target words was found between target words which were elaboratively studied and target words which were structurally processed. In contrast, elaborated study list words were reproduced in cued recall more frequently than they were reproduced in the word completion task. Structurally processed study list words were reproduced in cued recall less frequently than they were reproduced in the word completion task. Thus, a dramatic dissociation between implicit and explicit memory becomes apparent when considering the processing requirements of the study task. Explicit memory appears to be highly influenced by the type of processing which goes on during study, while words in implicit memory would appear to be registered, or rather, activated (since these are common words which presumably have some pre-existing representation in memory; Graf & Schacter, 1985) somewhat automatically.

A variable which is orthogonal to the processing requirements of the study task is repetition of stimuli during the study task. Jacoby and Dallas (1981) and Graf and Mandler (1984) both report significant effects due to repeated presentations of words during learning. Jacoby and Dallas indicate that performance on both implicit and explicit memory tasks increased with increased number of presentations of the target stimuli during the study phase.

Recognition performance exceeded perceptual recognition performance, that is, studied words were reproduced more frequently in a recognition test than when letter strings were to be named as words. However, performances on these two tasks were parallel: reproduction of the studied words on both tasks increased as a function of increased number of presentations during the study task. This evidence suggests that while automatic activation of implicit memory may occur, it is not fully activated with a single presentation of a word. Rather, with repeated exposures, activation may increase. Exposure may include a subject's own production of a word, as in a cued recall task preceding word completion (Graf & Mandler, 1984). It is not clear from these studies whether a similar process of activation underlies both the effects found with regard to explicit memory and those found in implicit memory. Considering other differences which exist between these two types of memory, this assumption seems unlikely.

The effect of delayed testing after a study phase has been investigated by two researchers who report contrasting results. As reported above, Tulving et al. (1982) found that completion of graphemic word fragments was significantly primed at both one hour and seven days after presentation of the study words; no significant decrease in performance was observed. Recognition performance did decrease over time. At one hour after the study task,

studied words were reproduced in recognition testing more frequently than they were reproduced in fragment completion. At seven days after the study task, studied words were recognized less frequently than they were reproduced in fragment completion. Graf and Mandler (1984) failed to replicate this finding with stem completion, reporting a decrease in implicit memory performance over delays of 0, 20, and 90 minutes. They reported that this difference could be explained in terms of the task demands of word fragment completion in contrast with their own word stem completion task. That is, a word fragment cues a unique, specific study word (e.g., "_E_D_L_M" cues "PENDULUM"), whereas a word stem may cue several alternatives and competing responses to the study word (e.g., "DEF__" as "DEFEND", "DEFEAT", "DEFECT", etc.). The relative strength of activation of the correct response relative to the strength of activation of these competing alternative responses would probably lead to decreased production of the correct response on this particular task.

While this explanation resolves the apparent discrepancy between Tulving et al. (1982) and Graf and Mandler (1984), the parameters of implicit memory with regard to performance after delayed testing are not made clear.

A number of researchers have indicated that the performance of implicit and explicit memory tasks may be independent. While this seems somewhat apparent from

studies which have been described, a few researchers have demonstrated this independence statistically. Tulving et al. (1982) found that the joint probability of word fragment completion and recognition was not higher than the product of the simple probabilities; that is, one did not occur systematically with the other. Eich used this procedure and found equivalent results with regard to recognition and spelling of biased homophones. As well, he used a chi-square statistic to measure the degree of dependence between recognition and spelling bias and failed to find a significant effect. These demonstrations of statistical independence add further support to the distinction which has been drawn between implicit and explicit memory.

Implicit and explicit memory for word pairs. To recapitulate, research will next be discussed which addresses implicit and explicit memory for word pairs. The most significant finding from this body of research is that associations between words may be learned and may influence implicit memory tasks independently of recall or recognition of the learning episode.

Graf and Schacter (1985) found that word pairs presented to individuals without memory impairment became associated in a study task. This association primed later performance on word completion, a task which demonstrates implicit memory. Subjects analyzed the word pairs by comparing

vowels in the words which made up each pair. Their retention of the word pairs was later tested in cued recall and in word completion, where prefix stems of the second word of each studied pair were presented. As Graf and Mandler (1984) found, presentation of the target words in a task which did not emphasize their meanings led to word completion performance which exceeded recall performance. Graf and Schacter found this effect with word stems cued by the word they were paired with during the vowel comparison task (same context) and with word stems cued with words other than the word they were paired with during the vowel comparison task (different context). No significant difference was found in word completion performance as a function of same or different context during testing. A dissociation in memory was apparent which is consistent with the findings presented concerning implicit and explicit memory for single words as stimuli.

The notion of context, as described above, has been a point of contention among researchers (Carrol & Kirsner, 1982; Graf & Schacter, 1985; McKoon & Ratcliff, 1979; Neely & Durgunoglu, 1985). McKoon and Ratcliff (1979) had subjects study pairs of unrelated words. They then tested subjects' retention of the word pairs in a lexical decision making task. They reported that the newly learned associations between the unrelated words led to a significant priming effect in lexical decision making when

target words were preceded by their mates from the study task. This priming effect occurred in terms of shortened response time for deciding whether a string of letters constituted a real word. McKoon and Ratcliff concluded that this priming effect in lexical decision making indicates the formation during a study task of an association between unrelated words which is registered in semantic memory. Others, however, have failed to find this priming effect using similar procedures. Carrol and Kirsner (1982), for instance, found that the study of the word pairs facilitated recognition performance, but did not facilitate lexical decision making. This was found both when target words were cued by the word they were paired with during the study task (same context) and when target words were cued with words other than the word they were paired with during the study task (different context). This latter finding was also reported by Neely and Durgunoglu (1985), who used procedures similar to Carrol and Kirsner's. The implication of these studies is that the associative effect did not occur in implicit memory.

McKoon and Ratcliff (1986a) presented further evidence to strengthen their original position. Focusing on the brief time that they found was required for a newly learned associate to prime its pair, they suggested that awareness of the learning episode could not be a mediating variable in the effect. This suggests that the associative effect was

in fact mediated in implicit memory. That is, the effect occured with an interstimulus interval which was too brief to allow a strategic recollection of the episode of learning. Moreover, Carrol and Kirsner's (1982) failure to find a significant priming effect in implicit memory after subjects studied target words is weak evidence beside demonstrations of significant priming effects (Jacoby & Dallas, 1981; McKoon & Ratcliff, 1979).

Conflicting results have been found with regard to the effect of context in implicit memory for word pairs. As reported earlier, Graf and Schacter (1985) found that word completion performance exceeded cued recall performance after a vowel comparison task. No difference was found between completion of word stems cued by the word they were paired with during the vowel comparison task (same context) and completion of word stems cued with words other than the word they were paired with during the vowel comparison task (different context). In contrast to this, both McKoon and Ratcliff (1979) and Graf and Schacter (1985, using patients with organic amnesia) found that target words which were cued by the word they had been paired with during an elaborative study task (same context) were primed relative to target words which were cued by a word other than the one with which it was paired during study (different context). This facilitative effect was the basis of these researchers' conclusions that an associative link was learned between

paired words. Thus one set of results indicates no difference due to context in testing, while the other set demonstrates a facilitative effect of reproducing in testing the same context as was in the study task.

Graf and Schacter (1985) resolved this discrepancy by demonstrating the importance of the processing requirements of the study task. Their results appear to indicate that the association of two words which has a facilitative effect in implicit memory is learned through study of the words which emphasizes their meanings. This association does not appear to be learned in study tasks which focus on the graphic qualities of the words. Graf and Schacter (1985) presented unrelated word pairs to subjects in a study task which required either elaborative processing of the words (constructing a meaningful sentence using those words) or vowel comparison between the two words. As reported earlier, words from the vowel comparison task were primed in word completion and no significant differences occurred as a function of having the same or different context in testing as in the study task. For the semantically processed word pairs which were tested in a different context, the level of word completion was similar to the level of word completion of structurally processed word pairs. That is, no significant difference in word completion was found among structurally processed target words which were tested in the same context as in the study task, structurally processed

target words which were tested in a different context than that in the study task, and semantically processed target words which were tested in a different context than that of the study task. All of these words were reproduced more frequently in word completion than in cued recall. In contrast to these words, semantically processed words which were cued in testing by the same words which had preceded them during the study task were reproduced significantly more frequently on word completion. Thus a significant interaction was found between the variables "context of testing" and "processing requirements during study." Graf and Schacter reported that the advantage given to a semantically processed word by a return in testing to the context of study indicated an associative effect between previously unrelated words. They also emphasized that this effect was mediated in implicit memory.

Graf & Schacter (1985) found that cued recall performance also increased as a function of elaborative processing, which should be expected (Craik & Lockhart, 1972). This finding raised the question for Graf and Schacter as to whether explicit recall had mediated the interaction effect in word completion which was just reported. That is, the pattern of parallel results between word completion and cued recall might indicate that subjects used a strategy in word completion of recalling the learning episode, and that therefore associations were not necessarily registered in

implicit memory. Graf and Schacter (1985) presented another experiment in which patients with organic amnesia were incorporated into the experimental procedure. Amnesic patients, matched controls, and student controls all replicated the pattern of word completion performance reported above, with comparable levels of performance evident among the three groups of subjects. That this effect was not mediated by explicit memory for the associations was most apparent with the amnesic group, for whom cued recall performance was significantly below that of word completion performance. Graf and Schacter argued against seeing this effect as a function of the difference in the difficulty of the word completion and cued recall tasks, since both student and matched controls performed better on recall (the "hard" test) for words in the same context than in word completion (the "easy" test). Furthermore, success on an item in cued recall did not predict success on the same item in word completion. Graf and Schacter (1985) therefore concluded that the facilitative effect of the association learned between two words in an elaborative study task was not due to explicit recall of the learning situation but was mediated in implicit memory.

Schacter and Graf (1986) further pursued the issue of associative effects between unrelated word pairs to determine the influence of different types of elaborative

processing on implicit and explicit memory for word pairs. Their four experiments outline three factors which influence the associative effect. First, the level of processing, operationalized as sentence production with a word pair versus generating a single word to link a word pair, did not have a differential effect on implicit memory. Word completion performance for words from both processing tasks did not differ, and both tasks led to significantly higher performance in same versus different context in testing. Thus, the associative effect occurred with equal strength in both tasks. In contrast, cued recall performance was found to be significantly higher with the sentence generation task than with the word generation task, as a levels of processing hypothesis would predict (Craik & Lockhart, 1972). Second, subject generation of an elaborative sentence versus merely reading an elaborative sentence produced similar effects for word completion. The emphasis from this experiment is that production of the elaboration by the subject does not appear to contribute in terms of facilitated implicit memory performance. For cued recall, generation versus reception produced a large significant effect, which is consistent with predictions by Hasher and Zacks (1979) concerning automatic versus effortful processing. Third, meaningful processing of two words as a unit or pair was found to be necessary to produce an associative effect in implicit memory. Elaboration of the

single word consitituents of a pair was not sufficient to produce this effect. These three findings seem to suggest that an associative effect may occur in implicit memory when two words receive some minimal degree of meaningful elaboration of their relationship together. Explicit memory, in contrast, is influenced in a more analog fashion, varying with the degree of semantic processing which occurs, consonant with a levels of processing perspective (Craik & Lockhart, 1972).

While the independence of tasks revealing implicit and explicit memory has been implied in the current discussion, it has also been stated explicitly by researchers in this area. The differences in priming effects in implicit and explicit memory are readily evident where explicit memory performance has fallen below that of implicit memory performance. However, when parallel effects are reported for these two processes, especially concerning the associative effect in implicit memory, some doubt may arise as to whether a distinction in memory holds. To address this concern, Graf and Schacter (1985) reported that patients with organic amnesia demonstrated an associative effect in word completion without the ability to report an awareness of the study task in which learning had taken place. As well, a chi-square analysis to test the dependence of cued recall and word completion with both amnesic and normal subjects failed to reach statistical

significance. Schacter and Graf (1986) argued against the notion that associative effects in implicit memory are mediated by conscious appreciation or recollection of the learning episode. Were this so (a) word completion performance would have been equivalent to cued recall performance, (b) an effect of levels of semantic processing would have been found with word completion, (c) word completion performance would increase toward the end of testing as subjects switched to a recollective strategy, and/or (d) post-experimental interviews would uncover recollective strategies. None of these effects were found. Schacter and Graf (1986) concluded that the implicit memory for new associations is independent of explicit memory for those associations.

Implicit and Explicit Memory: A Summary

The evidence reviewed suggests that implicit memory and explicit memory are sensitive to different aspects of encoding. Encoding of semantic information (a word) into implicit memory is relatively automatic, as demonstrated in studies which allow minimal awareness of stimuli during the study task (e.g., Eich, 1984; Marcel, 1983a). This activation may be made stronger by repetition (repeated automatic activation) but apparently is not sensitive to, or therefore determined by, processing requirements of the study task (Graf & Mandler, 1984; Schacter & Graf, 1986;

Jacoby & Dallas, 1981). For word pair associations to be encoded in a form that can be expressed without explicit recollection of the learning episode, the associative link between the words must be elaborated; activation of the individual constituents of the pair seems to be insufficient. Encoding of information which may be explicitly recalled or recognized is sensitive to the type and levels of encoding (semantic or non-semantic) and to effort in study (as per Hasher & Zacks, 1979).

A number of authors have suggested retrieval processes which seem to be consistent with the implicit-explicit memory distinction. Ideally, these should help to account for the different levels of reproduction of target words in the different implicit and explicit memory tasks. Mandler (1980) suggests that recognition performance is determined by both a retrieval process and by familiarity with a stimulus. Jacoby and Dallas (1981) propose a very similar dual process model, in which recognition performance is dependent upon perceptual fluency with a word (of which familiarity may be the phenomenal aspect), and elaboration of the word. It may be that a single underlying memory representation exists, different aspects of which are tapped by implicit and explicit memory. One aspect of a memory representation may be encoded automatically (single words) or with some elaboration (word pairs) such that the information influences, or can be tapped by, an implicit

memory task. However, explicit memory may require a different aspect of the representation (perhaps a marker, such as familiarity) to allow for conscious, intentional retrieval of information.

While it is parsimonious to propose one memory store versus two or more, a clear-cut picture is not suggested by the literature which has been discussed. If a single memory representation underlies both implicit and explicit memory, why are there situations in which reproduction of target words in explicit memory exceeds their reproduction in implicit memory and situations in which implicit memory exceeds explicit memory? Furthermore, as has been stated, performance on tasks which reveal implicit and explicit memory have been found to be independent. Doubtless this could also be accounted for by considering separate processes which access a single store, but insufficient information is currently available with which to state a firm case (Graf & Schacter, 1987; Schacter & Graf, 1986).

One point of interest regarding retrieval concerns situations in which explicit recall has been less successful in reproducing studied words than is an implicit demonstration of retention. Mediation of performance without explicit awareness seems to be an operationalization of the construct "the unconscious" (Marcel, 1983b; Shevrin & Dickman, 1980). Taken from an empirical perspective, this notion does tend to lose its exotic Freudian flavor.

Motivation in Nonconscious Semantic Processing

It appears that a number of experimental psychologists would agree, to a greater or lesser extent, with the assertion that processing of meaningful information may occur without reportable awareness. It is likely that fewer of these would be willing to make the statement that motivation plays a role in mediating which processess become available for conscious introspection. Such a statement seems to tap into the psychoanalytic tradition, a model of behavior most experimental psychologists would tend to shun. Empirical findings on this issue suggest that a blanket rejection of a behavioral phenomenon on the basis of its being observed by, and commented upon by, psychoanalytic theory is not warranted (Glucksberg & King, 1967; Glucksberg & Ornstein, 1969; Hawryluk, 1977; Martin, Hawryluk, Berish, & Dushenko, 1984)

Zajonc (1980) asserted that cognition and affect are functionally independent processes. More specifically, he argued that an affective judgement about a stimulus occurs prior to the development of a cognitive (conscious) representation of that stimulus. Kunst-Wilson and Zajonc (1980) reported that affective preferrence for briefly presented geometric stimuli (i.e., degree of liking) more accurately discriminated previously presented items from new items than did a recognition test. Recognition performance

did not exceed a chance level. From Zajonc's (1980) presentation, it may be concluded (1) that affective processing of stimuli occurred which was sufficient to facilitate a preference discrimination, and (2) that this processing occurred without reportable awareness. A synthesis of this notion with previously presented concepts would suggest that affective judgement is an important aspect in the semantic analysis of a presented stimulus.

It has been demonstrated that stimuli may come to have an affective meaning as a consequence of their association with another stimulus. Corteen and Wood (1972) presented a study which was similar in some respects to Lewis (1970). That is, a dichotic listening procedure was used to investigate the analysis of some significant stimuli as they were presented to the non-attended ear. The significant stimuli in this study, however, were city names which had previously been paired with shock presentations. The dependent variable was autonomic response as a consequence of stimulus presentation. This was operationalized as a galvanic skin response (GSR) change of at least 1 K ohm occurring within 3 seconds of stimulus presentation. Subjects attended to the required shadowing of a passage of prose presented to the right ear. Corteen and Wood found that a significantly greater number of autonomic responses were observed for presentation of the punished city names than were observed for non-shock-associated nouns. They also found that city

names in general produced more responses than did non-shock-associated nouns, although half of these city names had not previously been associated with shock. Through a detailed post-experimental interview, it was found that subjects were generally unable to identify the nature of the unattended message, and those that could identify stimuli as words made no reference to city names. When asked, all subjects denied having heard any city names in the unattended message. Corteen and Wood made the tentative suggestion that autonomic responses to critical stimuli indicated a complex semantic analysis, rather than peripheral acoustic analysis, occurring independently of an attention shift and subsequent awareness. Added dimension is given to this conclusion of semantic analysis by the observation that autonomic responses generalized to nonpunished words which were categorically related to the punished words (i.e., to other words which were also city names). These conclusions are consistent with previously discussed studies which also report semantic analysis without subject awareness.

Another facet of this study, which is important for the current discussion, is that the stimuli of interest were made significant to the subjects as a consequence of being paired with electric shock. It would appear, then, that part of the semantic content of a stimulus word which is subject to pre-attentive analysis is its affective valence;

this conclusion would be consistent with Zajonc (1980).

These conclusions were not supported by Wardlaw and Kroll (1976) who reported a failure to replicate Corteen and Wood (1976) despite "every attempt... to follow the original procedure as closely as possible" (p.360). However, Wardlaw and Kroll have themselves received criticism from other researchers for apparent methodological incompatibilities with the original paradigm. Forster and Govier (1978) note that Corteen and Wood lost approximately one third of their subjects due to subject unwillingness to tolerate the level of shock delivered. That Wardlaw and Kroll reported no such attrition, and used only three trials in their conditioning procedure, suggests that they "did not use a sufficiently large number of word-shock pairings for their comparatively low level of shock" (Forster & Govier, 1978, p. 293). Martin (1980) indicates that there is significance to the fact that Wardlaw and Kroll counterbalanced the ear of presentation during dichotic listening, whereas Corteen and Wood had presented the unattended message solely to the left ear. Wardlaw and Kroll's implicit assumption here was that the ear receiving the unattended message was unimportant. To the contrary, Corteen, in a personal communication to Martin, "indicated that attempts to present the unattended message to the right ear are seldom successful" (Martin, 1980, pp. 42-43). This suggests that Wardlaw and Kroll's findings were confounded by effects stemming from ear of

presentation of the attended/unattended message.

Further support for Corteen and Wood (1972) also comes from another replication as reported by VonWright, Anderson, and Stenman (1975), who found similar results. Together with these other researchers (Forster & Govier, 1978; Martin, 1980), they support the integrity of Corteen and Wood's findings. They also support the conclusion that there is "a fairly sophisticated degree of processing occurring without awareness" (Corteen & Wood, 1972, p. 312).

While the studies just discussed indicate that stimuli may evoke a galvanic skin response through their association with an aversive stimulus, another line of evidence suggests that stimuli may be selectively forgotten if they are associated with an aversive stimulus. Glucksberg and King (1967) presented an experimental paradigm which they suggested was a laboratory analogue of the psychodynamic concept of repression. Their experiment proceeded in three phases. Right handed male subjects first memorized a list of paired associates (ten nonsense syllables paired with ten English words). In the second phase, subjects read aloud a different list of ten English words, some of which were followed by the presentation of an electric shock. Subjects were required to learn to predict which words preceded the aversive stimulus and which words did not. The words in this list were distantly associated with the English words in the first list, that is, through mutual association with

a third word. For example, "stem" is associated with "smell" because both words are primary associates of "flower", but are not directly associated with each other (as derived from published norms). In the third phase, subjects were to recall the English words from the first list. It was found that the words which were associates of the punished words were less likely to be recalled than were control words. A second experiment made it clear that this was not due to retroactive interference, but actually was a function of the motivation employed. That is, Glucksberg and King anticipated the argument that the punished words in the second list might have been better learned by subjects, and that it was this superior retention, rather than the punishment, which interfered with recall of the words from the first list. This latter hypothesis was not supported when appetitive rather than aversive motivation was employed (i.e., when monetary rewards rather than electric shocks were associated with second list words; Glucksberg & King, 1967). Selective forgetting was not observed with appetitive motivation, while the effect maintained for the punishment-associated words. Retroactive interference was therefore not mediating the effect, as one would expect comparable forgetting in both of these situations.

Weiner and Higgins (1969) criticised Glucksberg and King's (1967) conclusions. From their replications of the Glucksberg and King paradigm, Weiner and Higgins concluded

that the degree to which the first list words were originally learned influenced retention, and therefore how they were later recalled. They concluded that motivation was not an appropriate variable to which to appeal in describing this experimental phenomenon. Glucksberg and Ornstein (1969) presented a rebuttal. They allowed that an interaction of original learning with punishment may have taken place; intuitively, an influence of original learning on retention seems reasonable. However, these authors made it clear, through a logical reinvestigation of Glucksberg and King (1967) and through a detailed item analysis using data from Glucksberg and King (1967) and Weiner and Higgins (1969), that original learning was insufficient to explain derived patterns of retention. Rather, they found that punishment was a significant variable in considering these differential recall effects, supporting the original conclusions of Glucksberg and King. Other results supportive of this conclusion come from later replications of the paradigm by Hawryluk (1977), and by Martin et al., (1984).

Experimental Design and Rationale

Empirical evidence has been presented which suggests that a stimulus may be retained in memory without reportable awareness or recall of that stimulus. This phenomenon has been termed implicit memory (Schacter & Graf, 1986). As well, evidence suggests that the semantic processing of a stimulus may occur in a situation in which that stimulus does not reach conscious expression, a phenomenon which may be termed subliminal perception/registration. It seems also that an important aspect of a stimulus which may influence the recall or other reproduction of the stimulus from memory may be its affective valence, and moreover that this affective quality may come about as a learned association. For example, it has been demonstrated that one may react, in terms of GSR, to an unattended presentation of a word made significant through prior pairings with shock (Corteen & Wood, 1972). Another effect of pairing with punishment appears to be interference in the recall of words associated with the punishment (Glucksberg & King, 1967).

In the current study, the concern has been to demonstrate that a stimulus presented to an individual may be retained in memory, despite the fact that the stimulus has not been attended, and cannot later be consciously recognized by the individual. Moreover, the effect on memory performance of the pairing of an aversive stimulus with target stimuli in

an unattended presentation was to be investigated. The demonstration of an effect on memory performance following this unattended pairing would suggest that associations may be registered even when direct attention or conscious effort is not involved.

Eich (1984) has demonstrated that an unattended presentation which suggests a context for a homophone can influence the later spelling of that homophone. He presented subjects with homophones as an unattended presentation to the left ear during a shadowing task which was presented to the right ear. Each homophone was preceded by a word intended to modify its interpretation. For example, the modifier "easy" connotes the interpretation "prey" rather than "pray", although these two words share pronunciation, and the latter of the two is statistically the more common interpretation. Eich biased the less common interpretation (LCI) of each of the critical homophone pairs. Subjects were unable to identify the words heard in this unattended presentation, as indicated by their performance on a recognition test. On a spelling test, however, the probability of spelling LCI homophones was found to be significantly greater for those homophones which had been presented and biased than for control homophones which had not been presented. Eich thus demonstrated a semantic influence of unreportable stimuli, an effect which Jacoby and Witherspoon (1982) found with amnesics, but not

with a normal population.

Spelling is a measure of retention which, like lexical decision or reaction time, does not require deliberate remembering of a stimulus. However, unlike lexical decision or reaction time measures, spelling is a task which requires that a subject actively bring information to mind (i.e., a sequence of letters) so as to report on it. It may therefore represent a behavior which may be susceptible to motivational effects, much as Glucksberg and King (1967) had studied recall. Pairing a homophone context with an aversive stimulus in an unattended presentation may lead to an inhibition of the production of that spelling in a subsequent spelling test. Eich's procedure appears to be useful in further investigating motivation as a variable in nonconscious semantic processing.

Ross (1985) attempted to replicate Eich (1984) and to extend his findings by introducing loud noise as a punishing stimulus
in unattended homophone presentations. Eich's results were replicated, that is, previously presented homophone contexts tended to be reproduced in a later spelling test in the absence of accurate, reliable recall. However, punishment was not found to have a significant effect in reducing the probability of spelling the homophones from the punished contexts. It is possible, however, that Ross' failure to find this effect was due to the methodology which was used.

Ross used Eich's modified homophones in her punishment procedure. These LCI homophones had an average normative probability of spelling of .24. Ross' manipulation may have been limited by a basement effect. That is, this probability of spelling may represent a minimal frequency of occurrence of the less common spelling, such that it is difficult to reduce this probability further. If punishment did not exert a robust effect, this situation may have obscured a true effect.

The current study attempted to replicate Eich's (1984) paradigm, incorporating into it a punishing stimulus so as to investigate the effect of aversive conditioning in mediating homophone interpretation. Modified homophones were presented to the unattended ear during a dichotic presentation, while the other ear attended to a passage of prose which was to be repeated aloud and verbatim (i.e., was to be shadowed). The dependent variables were measured after the shadowing task. Subjects were asked to indicate anything which they recalled from the unattended presentation. Homophones from the unattended presentation were presented among other words (including other homophones), and subjects were asked to distinguish the words which had been presented from new words. All of the homophones from the unattended presentation were included in a spelling task so that subjects' interpretation of these homophones could be determined.

Half of the modifying words connoted LCI homophones. These presentations represented an attempt to reproduce Eich's findings. Half of these presentations were followed by presentation of loud noise as a punishing stimulus. To control for an effect of a basal probability of spelling the LCI homophones, the other half of the modifying words which give context to the homophones connoted the more common interpretations (MCI). Again, half of these presentations were followed by a presentation of the punishing noise. This presentation was intended to control for a basement effect in probablity of spelling. That is, if Ross (1985) failed to detect an effect of punishment due to the difficulty in reducing an already low probability of spelling, it was reasoned that a decreased probability of spelling might be observed if the more common interpretations of the homophones were punished.

Other research has indicated a concern that momentary attending to the unattended channel may occur in the shadowing of a passage of prose (Corteen & Dunn, 1974; Dawson & Schell, 1982). Such a concern is relevant where the dependent measure is being observed during the shadowing task, as it was in Corteen and Wood's (1972) paradigm. Such a shift in attention would preclude a conclusion that processing of a stimulus occurred outside of reportable awareness. In the present study, the dependent measure was observed after the shadowing task was completed. A

shadowing task appears to heavily tax the resources of the subject. Subject performance during shadowing was monitored for pauses, and the subject was required to paraphrase the story accurately after shadowing. With such precautions, evidence of a small degree of attention shifting during shadowing would not be theoretically damaging. As long as subjects are unable to report on the nature of the unattended stimuli in the recall or recognition tasks, one would be able to say that any effects found in the spelling task were mediated without subject awareness.

One further methodological concern of significance arises from using a dichotic listening paradigm to investigate the influence of unattended aversive stimuli. Literature on the organization of cortical functions in the human brain suggest that stimuli impinging on the individual will have different effects depending on whether the left or the right cerebral hemisphere receives stimulation.

Brain Laterality and Dichotic Listening

A large literature has developed to address the lateralization of cerebral functions of the human brain. That is, many functions, probably the most conspicuous of which is speech, are not represented bilaterally in the brain, but appear to be predominately subsumed by one hemisphere or the other. Speech was localized as a left hemisphere function by early researchers such as Broca and

Wernicke, who observed the loss of functions attributable to lesions of the left cerebral cortex (Geschwind, 1972). More current methodologies have supported and extended this observation (for reviews see Corballis, 1980; Gazzaniga, 1985; Milner, 1971; Ornstein, 1972). In general, it has been suggested that the left hemisphere of virtually all right handers (92%) and most left handers (69%) is responsible for receptive and expressive language (statistics from Milner, 1974). The right hemisphere, in contrast, is represented as being responsible for processes characterized as parallel and holistic in nature. The right hemisphere has also been represented as being the dominant hemisphere for processing emotion, such as emotional content in facial expression (Ley & Bryden, 1979), or as emotional content of stimulus words experimentally associated with punishment (Hawryluk, 1977).

Much information concerning the lateralization of functions and the apparent interaction of the cerebral hemispheres in processing bilaterally presented stimuli has been produced by experimental procedures which have investigated visual perception effects. Vision is a perceptual system whose sensory pathways project contralaterally. That is, stimuli presented to the right of the midline of one's visual fields will stimulate the left hemiretinae of the eyes, which are innervated such that the stimuli ultimately impinge on the left hemisphere first.

Stimuli may thus be targeted, within the limitations of a given paradigm, so as to be received by either the left or right cerebral hemisphere (Gazzaniga, 1985).

To some extent, analagous findings have been reported by investigators using auditory stimuli, as in dichotic listening paradigms. King and Kimura (1972) reported that the left ear was more accurate in identification of human vocal non-speech sounds, such as laughing or sighing. Haggard and Parkinson (1971) present similar findings, reporting a left ear advantage for identifying emotional content in spoken sentences. Carman and Nachishan (1973) attempted to eliminate possible contamination effects due to verbal processing requirements during emotional processing. They presented subjects with human vocal non-speech sounds but required a non-verbal response from them. Their results were consistent with King and Kimura's and Haggard and Parkinson's, indicating a left ear advantage in processing emotional content of stimuli.

Unlike visual perception, stimuli impinging on one ear (as compared to one half-visual field) are not registered contralaterally, but rather they project bilaterally. Thus, a stimulus presented to one ear will be registered, to some extent, in both cerebral hemispheres. Certainly the hemispheres do not receive equal activation; this is apparent from the dichotic listening studies indicated above. It has been reported that there is a functional

asymmetry in auditory perception during dichotic listening (Kimura, 1967; King & Kimura, 1972).

For the current study, the ultimate pattern of recognition and of spelling of the homophones presented to the unattended ear was subject to effects due to lateralization of cortical functions, and also to effects arising from functional differences between contralateral and ipsilateral auditory pathways (Kimura, 1967). The ear of presentation of the unattended message is only indirectly predictive of brain organization (Sidtis, 1982), however, and therefore is not entirely predictive of the resulting memory effects. This is especially true where the stimuli of interest to the study are to be unattended as earlier studies do not aid in predicting the effects of unattended stimuli (Carman & Nachishan, 1973; Haggard & Parkinson, 1971; King & Kimura, 1972). Corteen observed that the presentation of an unattended message to the right ear does not produce a pattern of results congruent with results from left ear presentation of the unattended message (Martin, 1980). Wardlaw and Kroll (1976) failed to replicate Corteen and Wood (1972), and this has been attributed to confounding of results due to the counterbalancing of ear of presentation (Martin, 1980). Some consistency in results appears to have accrued mostly with studies which have presented an unattended message to the left ear, and a distractor task to the right ear (Corteen & Wood, 1972;

Eich, 1984; Forster & Govier, 1978). It is therefore predicted that the hypothesized effects concerning recognition and spelling of homophones will be found when the unattended presentation is delivered to the left ear. With regard to the the unattended presentation delivered to the right ear, studies of localization of function, functional asymmetry of auditory perception, and dichotic presentations of unattended target stimuli allow only the prediction that a pattern of results similar to those of the left ear will not be found.

Summary

Evidence reviewed indicates that the meaning of a stimulus may be processed without reportable awareness of the stimulus. Affective valence appears to be an important aspect of the semantic content of a stimulus, and this valence may be a learned association. The current study proposed to investigate whether a homophone may be influenced in an unattended presentation such that its spelling is influenced on a later task. LCI homophones were presented with biasing words to see if the less common spellings would subsequently be given by subjects. As an orthogonal condition, some homophone contexts were paired with a loud aversive noise to see if this association would later decrease the frequency of spelling of the homophones connoting the punished contexts. A third variable of

interest was the ear of presentation of the unattended message. Past research suggests that equivalent patterns of results cannot be expected when the unattended presentation is delivered to the left versus the right ear. This difference is also suggested by neuropsychological findings which indicate some functional differences between the cerebral hemispheres and also functional differences between contralateral and ipsilateral auditory pathways.

Hypotheses

The following hypotheses were advanced:

(1) Homophones will be spelled so as to denote the interpretation presented in the unattended presentation. That is, LCI homophones will be spelled with a greater probability when their meanings are biased in the unattended message than when homophones are not previously presented. This may or may not be true when the MCI homophones are biased, due to a possible ceiling effect. This effect of spelling will occur where subjects cannot recall unattended stimuli, and are unable to reliably recognize unattended stimuli from among a list of other homophones and common nouns.

(2) Homophones will be spelled so as to denote the alternative interpretation to the context presented where that context has been associated with the presentation of aversive noise. That is, LCI homophones will be spelled

with a greater probability when the respective MCI homophones are associated with punishment in the unattended message than when the homophone is not previously presented. This may or may not be true when the LCI homophones are associated with punishment, due to a possible presence of a basal probability of spelling. Again, the effect of spelling will occur where subjects cannot recall unattended stimuli, and are unable to reliably recognize unattended stimuli from among other homophones and common nouns.

(3) Recognition and spelling of homophones will be mediated by ear of presentation such that hypotheses (1) and (2) will be supported when the unattended message is presented to the left ear of each subject. This interaction is not expected when the unattended message is presented to the right ear of each subject, due to lateralization of hemispheric functioning and functional differences between contralateral and ipsilateral auditory pathways.

Method

Subjects. Eighty right handed male undergraduate students were recruited as subjects in the study. Students were recruited from University of Manitoba introductory psychology classes, in which research participation is a course requirement. Students were informed that the study would involve loud, unpleasant, but harmless noise. They were also made aware that the study was restricted to those with normal hearing in both ears, and for whom English was their primary language (first language spoken and language spoken at home).

Materials

Handedness Questionnaire. A brief questionnaire, based on a questionnaire developed by Raczkowski, Kalat, and Nebes (1974) was used to screen subjects for preferred hand. Fourteen questions pertained to activities such as writing, throwing a ball, or kicking a ball. As well, the subject was asked to indicate any known family history of sinistrality (left handedness). Right handedness is highly correlated with a left hemisphere dominance for language. It was therefore deemed desirable to stress both right handedness and family history of right handedness in an attempt to control for extraneous effects due to variability in the organization of cortical functions.

Stimuli. The current study used Eich's (1984) 32 homophones, which were drawn from published norms (Galbraith & Taschman, 1969). The drawing was random, with the following restrictions: (1) the normative probability of spelling a homophone in line with its less common interpretation (e.g., "PREY" as opposed to "PRAY") not be greater than .40 or less than .10, and, (2) the spellings of the two interpretations of a homophone involve an equal number of letters.

Eich divided homophones into the classes old homophones and new homophones. Old homophones (OHs) were those which were presented to a subject as an unattended message during a shadowing task. New homophones (NHs) were not presented during shadowing, but were included as controls on tests of recognition and spelling. Homophones were divided into groups by Eich (1984) such that the average normative probability of uncommon spelling was constant (p=.226) between two groups of equal size (N=16). See Table 1 for a listing of OHs and NHs.

Insert Table 1 about here

At recording, OHs were preceded by a word which was intended to bias the interpretation of each homophone. Eich's (1984) list of modifiers was used to bias the less common interpretation of each of these homophones (e.g.,

Table 1

Homophones Appearing in the Recognition and Spelling Tests

Old Homophones		New Homophones
Less Common Bias	More Common Bias	
taxi FARE (.13)	county FAIR (.87)	BEAT (.13)
youngest SON (.30)	rising SUN (.70)	POLL (.18)
disc BRAKE (.10)	coffee BREAK (.90)	PIER (.23)
easy PREY (.13)	minister PRAY (.87)	SEAM (.18)
window PANE (.15)	arthritis PAIN (.85)	COARSE (.18)
movie ROLE (.25)	dinner ROLL (.70)	HERE (.23)
garage SALE (.35)	ship SAIL (.65)	HEEL (.33)
stainless STEEL (.37)	thief STEAL (.63)	PAIL (.37)
fillet of SOLE (.28)	immortal SOUL (.72)	REEL (.18)
tall TALE (.20)	monkey TAIL (.80)	PEAR (.20)
stripped BARE (.13)	grizzly BEAR (.87)	WEEK (.33)
slim WAIST (.23)	toxic WASTE (.77)	CELL (.32)
sneak PEEK (.30)	mountain PEAK (.75)	GAIT (.13)
deep SEA (.20)	look and SEE (.80)	SOAR (.18)
daily MAIL (.30)	macho MALE (.70)	STAKE (.15)
ocean FERRY (.20)	tooth FAIRY (.80)	MADE (.30)

Note: The normative probability of spelling a homophone, derived from Galbraith and Taschman (1969), appears in parentheses following that homophone. Mean normative probability of uncommon spelling for Old Homophones and for New Homophones is 0.226.

easy-PREY). As well, a new list of modifiers was used to bias the more common interpretation of each of the homophones (e.g., minister-PRAY). Two separate lists of these critical pairs were prepared. One list, randomly selected, contained eight critical pairs intended to bias the less common interpretations of the OHs (OH-LCIs), presented with the other eight OHs, which were intended to be biased toward their more common spellings (OH-MCIs). The other list of critical pairs counterbalanced this list. That is, homophones which were OH-LCIs in the first list were OH-MCIs in the second list, while homophones which were OH-MCIs in the first list were OH-LCIs in the second list. Each list was recorded eight times in differing random orders of presentation. Critical pairs were presented at the rate of 4 seconds/pair, representing 1 second for presentation of the modifier, 1 second for the presentation of the homophone, and 2 seconds of silence before the next critical pair presentation. In addition to this schedule, half of the homophones which were OH-LCIs and half of the homophones which were OH-MCIs were followed by one-half second of silence, then one-half second of loud white noise (105 dB), and then by one second of silence, after which the next critical pair was presented. The presentation of white noise was triggered by metal foil attached to the audio tape, which completed an electrical relay. A timer controlled the onset and offset of a presentation of white

noise from a noise generator.

The presentations of the critical pair lists were bordered by eight noncritical word pairs, which acted as buffer material. These noncritical pairs were composed of a modifier preceding a non-homophone (e.g., hilton-HOTEL). Four of these noncritical pairs were presented once preceding critical pair presentations (primacy pairs), and the other four noncritical pairs were presented once after critical pair presentations (recency pairs). The rate of presentation was that for the critical pairs, that is, 4 seconds per pair. These noncritical pairs were in turn bordered by a single presentation of the English alphabet both prior to the primacy pairs and after presentation of the primacy pairs. The 26 letters were presented at the rate of one letter per second.

The letters, critical pairs and noncritical pairs were presented by a male voice, and recorded on a single track of a stereophonic tape recorder. On the other track of the same tape was recorded a passage of prose narrated by a male voice at the approximate rate of 85 words per minute. The length of the passage was synchronized with the presentation of the unattended message. That is, the passage began as the subject heard the letter "A" of the alphabet sequence, continued as the subject received the unattended presentation of primacy pairs, critical pairs, recency pairs, and the letter sequence, and ended after the subject

heard the final letter "Z". Critical pairs were thus presented approximately 40 seconds after shadowing began, and finished 40 seconds before the passage of prose finished.

The attended essay and unattended word pairs and letters were presented to the subject on separate channels of foam padded headphones. A microphone was placed before the subject, plugged into a tape recorder to record all of the subject's responses.

Procedure

Subjects were tested individually in an automated procedure. The experiment proceeded in two phases, first, the dichotic presentation of stimuli, and then the recognition and spelling tests.

Each subject was seated in a sound attenuated chamber. Typed instructions briefly indicated the nature of the experiment, and included the handedness questionaire. Subjects were informed that should they feel the need or desire to leave the experiment, they were be free to do so without penalty. They were invited to listen to a presentation of the white noise delivered through the headphones so that they could decide whether or not they wished to continue. Subjects rated the noise on a five-point Likert-type scale anchored by the statements extremely unpleasant and not at all unpleasant. These instructions also indicated to the subjects how to wear the

headphones through which a verbal presentation was to be given. Approximately half of the subjects (n=27) were given instructions to place a marked side of the headphones over their left ear. The marked side of the headphones was the channel through which the unattended message was presented. The other half of the subjects (n=30) were given instructions to place the marked side of the headphones over their right ear. The experimenter was present in the room to ensure that the headphones were properly placed over each subject's ears and to inform each subject that further instructions would be given over the headphones. The experimenter then left the chamber, turned on the recording tape recorder, and began the stimuli presentation.

Standardized instructions were delivered to all subjects over the headphones. The subjects were told that it was their task to shadow (repeat aloud and verbatim) a passage presented to them. They were told that it was the purpose of the study to investigate the distracting effect of extraneous information and random loud noise on an individual's ability to shadow and comprehend narrated material. Each individual was told that he would later be tested for comprehension and recall of the narrated passage after it had finished, and that he should therefore attend closely to the narration. Two brief (25 word) sentences were presented to the subjects, one sentence to each ear, as practice for the shadowing task. This procedure was

intended to ensure that each subject was able to discern what was to be presented through each channel of the headphones. Accomplishing this, the subject was then asked if he understood the procedures and what was required of him, being asked to respond orally with "yes" or "no".

The shadowing task took approximately 10 minutes. The attended passage was presented at approximately 72 dB, while the unattended stimuli were presented at approximately 64 dB (as described by Eich, 1984).

After completing the shadowing task, subjects were asked to give a short (1 minute) spoken synopsis of the passage they heard. They were told to start their synopsis at the sound of a tone and to end at the second sounding of that tone.

Instructions given over the headphones informed each subject that a second part of the experiment would begin. They were told that a secondary purpose of the experiment was to examine their retention of the words to which they were not attending. They were asked to indicate aloud anything which they recalled as having been presented. They were given 1 minute to respond. After this, the recognition test had each subject listen to a series of words, indicating aloud whether he believed that word had been presented to his unattended ear, indicating either "yes" or "no". The recognition test included the OH-LCIs, the OH-MCIs, the primacy pairs, the recency pairs, and sixteen

new homophones. One randomly assigned listing was presented to all subjects. In addition to these words, 24 new non-homophones were added to each list.

Each subject was informed that he would hear a word spoken, and that he should respond, indicating "yes" (the word was heard in the unattended presentation) or "no" (the word was not presented / was not heard) at the sound of a warning tone or beep. The recognition test was presented at the rate of one word every 6 seconds. The stimulus word was presented in the first second of that interval. A 0.5 second tone presentation was given on the fourth second of the interval. The next word was given 6 seconds after the start of the interval.

Following the recognition test, subjects were asked to spell aloud a series of words. They were told that they would again hear a word, and that after hearing a warning tone they should repeat the word and spell it. It was emphasized to the subjects that they would not have much time to respond, so if they were not sure of a word's spelling they should give the first spelling that came to mind. The spelling test included all OHs, all NHs, all eight noncritical pairs, and 24 new non-homophones, of which 12 had been presented in the recognition test. One random order was presented to all subjects. Pacing of words in the spelling test was 6 seconds per stimulus word. The word was presented in the first second of the interval, a 0.5 second

tone presentation was presented two seconds into the interval, and the next word was presented 6 seconds from the start of the interval.

Subject performance on the shadowing task and on both the recognition and spelling tests was monitored by the experimenter in an adjacent room. Subject responses on the recognition and spelling tests were recorded manually by the experimenter; the tape recordings were used for verification of responses. Subjects were debriefed with the intention of making clear to them the purpose and nature of the experiment. The experimenter then assigned the subject credit and dismissed him.

Results

Subject Selection

Eighty subjects recruited from Introductory Psychology classes participated in the experimental procedures. Restrictions excluded subjects who were not male and who did not learn English as their first language. Data from subjects were excluded from analyses for one of two reasons. First, as subjects were not restricted from participation during recruitment on the basis of handedness, data from 16 subjects who reported left handedness were not analyzed. Second, because of equipment malfunctions during the experimental procedure, data from seven other subjects was not considered in analyses.

Some subjects whose data were analyzed were not exclusively right-handed, that is, they did not indicate that they were right-handed on all of the tasks on the handedness questionnaire. They were, however, predominately so: three subjects indicated that they were left-handed with respect to four of fourteen tasks, and four subjects indicated that they were left-handed with respect to three of fourteen tasks. All other subjects included in analyses indicated that they were exclusively right-handed, and all subjects were right-handed with respect to writing and drawing. Additionally, fourteen subjects indicated that a member of his family was left-handed. These subjects were not excluded from analyses for at least three reasons.

First, although left-handedness, measured in terms of activities performed or familial sinistrality, correlates less well with left hemisphere dominance for language functions than does exclusive right-handedness, Milner (1974) indicates that even most left-handers (69%) are left hemisphere dominant for receptive and expressive language. For the purposes of this study, the fact that the subjects above were manifestly right-handed on a majority of tasks was taken to be a sufficient and appropriate indication of right-handedness. That is, the study was not intended to investigate the lateralization of cortical functioning per se. Rather, consideration was to be given to memory effects in a dichotic listening procedure with respect to differing ears of presentation, albeit with some degree of control for lateralization of function. Second, the current inclusion of a handedness measure contrasts the procedures of Corteen and Wood (1972) and Eich (1984) who did not give consideration to subject handedness. The exclusion of left-handed individuals is, in this respect, a relatively stringent procedure in dichotic listening procedures where memory functioning is of primary interest. Third, maximizing sample size was an important consideration which, in the light of the two prior points, seemed to outweigh any benefit of excluding the subjects who were not exclusively right-handed.

All subjects demonstrated adequate hearing in both ears,

operationalized in terms of their ability to repeat the two sentences presented to respective ears.

Shadowing performance

Subjects invariably indicated a "yes" response when asked if they understood the procedures required of them. Accordingly, all subjects performed the shadowing task as they were instructed. That is, the essay presented was repeated aloud by each subject virtually word for word, except for pauses in which it seemed evident that a word had not been heard or understood. Subjects as a whole recovered quickly from such pauses, such that long pauses (longer than approximately 4 seconds) were not observed. Synopses supplied by subjects reflected the content of the essay presented; these were not recorded, as the measure of interest, recognition, was to be recorded more carefully later in the procedure. Likewise, recall of unattended words was not subject to formal analyses. Fifteen subjects reported that they could not identify any stimuli from the unattended presentation. Thirty-three reported that they had heard the alphabet presented. Overlapping with these latter subjects, 32 subjects reported words which they recalled as having been heard. Thirteen subjects reported having heard one word-pair or word from a pair, nine subjects were able to recall two words/word-pairs, and four subjects recalled three words/word-pairs. Eleven of these subjects also reported words as recalled which were not in

in the unattended presentation. Six subjects reported only words which were not in the unattended presentation.

Subjects rated the unpleasantness of a single white noise presentation at the beginning of the procedure, which allowed them to decide whether or not to participate further in the study. A second rating was made at the end of the study to determine subjects' impressions of the noise after having had experience with it. The difference between the first rating (M = 3.035) and the second rating (M = 2.768), as assessed by t-test with 95% confidence interval, was found to be significant ($t(56) = 2.30$). Thus subject ratings of the unpleasantness of the noise tended to be less after the shadowing procedure/noise presentation than it was after an initial single presentation. This difference, though significant, was small (M = 0.250).

Recognition Test

The proportion of homophones from the unattended presentation reported by subjects as having been heard (i.e., "yes" responses) were tested in an analysis of variance (ANOVA). A 2 X 2 X 2 mixed model fixed effects ANOVA tested the effects of the independent variables Ear of Presentation (i.e., of the unattended message: left, right), Valence (neutral, aversive), and Homophone Type (more common or less common spelling). With the confidence interval set at 95%, only one significant difference became

apparent, which was a main effect of Ear of Presentation, $F(1,55) = 4.49$. This effect indicates that more homophones were identified as being from from the unattended presentation when that presentation was made to the left ear ($M = 0.313$) than when that presentation was made to the right ear ($M = 0.204$). Table 2 summarizes the ANOVA results; means are presented in Table 3.

Insert Tables 2 and 3 about here

A second ANOVA was necessary to determine if the proportion of homophones identified from the unattended presentation differed significantly from the proportion of homophones which were not presented but were identified by subjects as having been presented. That is, subjects who received the unattended presentation in the left ear may not have been accurate in their identification of previously presented homophones, but rather they may merely have indicated "yes" responses more frequently. A 2 X 2 mixed model fixed effects ANOVA was therefore performed. This analysis was not included as part of the prior analysis, as Presentation Status (i.e., Old Homophones from the unattended presentation, and New Homophones) was not orthogonal to the variables Valence and Homophone Type. Ear of Presentation and Presentation Status were varied with the dependent measure of proportion of homophones from the unattended presentation reported by subjects as having been heard (i.e., "yes" responses). With a confidence interval of 95%, only one significant difference was found, a main effect, again, of Ear of Presentation, $\underline{F}(1,55) = 4.03$. This effect again indicates that more homophones were identified as being from from the unattended presentation when that presentation was made to the left ear ($\underline{M} = 0.298$) than when

Table 2

2 (Ear of Presentation) X 2 (Valence) X 2 (Homophone Type) Mixed Model Analysis of Variance for Proportion of Homophones Recognized.

Source	df	MS	F	p
Ear	1	10.765	4.49	.038
Error	55	2.396		
Valence	1	0.158	0.42	.520
Error	55	0.376		
Homophone	1	0.158	0.23	.634
Error	55	0.689		
Ear X Valence	1	0.142	0.38	.541
Error	55	0.376		
Ear X Homophone	1	0.901	1.31	.258
Error	55	0.689		
Valence X Homophone	1	1.421	2.09	.154
Error	55	0.681		
Ear X Valence X Homophone	1	0.112	0.16	.686
Error	55	0.681		

Note: Ear, Ear of Presentation; Homophone, Homophone Type.

Table 3

Mean Recognition of Homophones from the Unattended Presentation.

Ear	Valence	Homophone	N	Mean	SD
Left	No Noise	MCI	27	1.367 (0.342)	1.159 (0.290)
		LCI	27	1.233 (0.308)	1.104 (0.276)
	Noise	MCI	27	1.067 (0.267)	0.868 (0.217)
		LCI	27	1.333 (0.333)	1.028 (0.257)
Right	No Noise	MCI	30	0.963 (0.241)	1.018 (0.255)
		LCI	30	0.667 (0.167)	0.961 (0.240)
	Noise	MCI	30	0.852 (0.213)	0.949 (0.237)
		LCI	30	0.778 (0.194)	1.013 (0.253)

Note: Ear, Ear of Presentation; Homophone, Homophone Type; MCI, More Common Interpretation; LCI, Less Common Interpretation.
Nonparenthesized values represent the mean number of homophones recognized of 4 homophones presented per cell; values in parentheses represent the proportion of homophones recognized.

that presentation was made to the right ear ($\underline{M}$ = 0.195). See Table 4 for a summary of the ANOVA results; seeTable 5 for means. Homophones from the unattended presentation were not identified as having been previously presented significantly more frequently than were New Homophones. This finding is consistent with the conclusion that subjects for whom the unattended presentation was made in the left ear were not displaying accuracy in selecting from a list of previously presented homophones, but were more likely indicating positive recognition more frequently.

Insert Tables 4 and 5 about here

Spelling Test

A 2 X 2 X 2 mixed model fixed effects ANOVA with 95% confidence interval was performed with the dependent measure being probability of spelling a homophone so as to denote its less common interpretation. The independent variables in this analysis were Ear of Presentation (left, right), Valence (neutral, aversive), and Homophone Type (more common, less common). Contrary to the hypotheses forwarded, no significant differences were found, that is, no main or interaction effects were found with respect to Homophone Type, Valence, or Ear of Presentation. Table 6 summarizes ANOVA results; Table 7 presents means.

Table 4

2 (Ear of Presentation) X 2 (Presentation Status) Mixed Model Analysis of Variance for Proportion of Homophones Recognized.

Source	df	MS	F	p
Ear	1	0.304	4.15	.046
Error	55	0.073		
Status	1	0.017	1.56	.217
Error	55	0.011		
Ear X Status	1	0.001	0.08	.784
Error	55	0.011		

Note: Ear, Ear of Presentation; Status, Presentation Status.

Table 5

Mean Proportion of Recognition of Homophones from the Unattended Presentation.

Ear	Status	N	Mean	SD
Left	Old	27	0.313	0.198
	New	27	0.283	0.227
Right	Old	30	0.204	0.189
	New	30	0.185	0.202

Note: Ear, Ear of Presentation; Status, Presentation Status.

Insert Tables 6 and 7 about here

While the previous analysis failed to find significant differences in the spelling of the homophones from the unattended presentations, an additional interest of the study was to attempt to replicate Eich's (1984) findings. This was not accomplished in the previous analysis as Presentation Status (Old or New Homophone) was not orthogonal to Valence or Homophone Type. Instead, to determine whether an unattended presentation of the uncommon interpretation of a homophone facilitated the later spelling of that interpretation, a *t*-test was performed. The spellings of less common, unpunished homophones from the unattended presentation to the left ear of subjects was compared to the spellings of an equal number of randomly selected New Homophones. A significant difference in the probability of spelling homophones so as to denote less common interpretations was not found ($t(26) = .34$, $p > .05$), indicating that Eich's pattern of results were not replicated in the current study.

Table 6

2 (Ear of Presentation) X 2 (Valence) X 2 (Homophone Type) Mixed Model Analysis of Variance for Proportion of Homophones Spelled with Less Common Spelling.

Source	df	MS	F	p
Ear	1	0.012	0.22	.638
Error	55	0.052		
Valence	1	0.039	0.59	.446
Error	55	0.067		
Homophone	1	0.024	0.35	.556
Error	55	0.068		
Ear X Valence	1	0.017	0.26	.612
Error	55	0.067		
Ear X Homophone	1	0.041	0.60	.442
Error	55	0.068		
Valence X Homophone	1	0.054	0.92	.342
Error	55	0.058		
Ear X Valence X Homophone	1	0.076	1.30	.260
Error	55	0.058		

Note: Ear, Ear of Presentation; Homophone, Homophone Type.

Table 7

Mean Proportion of Homophones from the Unattended Presentation Spelled to Denote the Less Common Interpretation.

Ear	Valence	Homophone	N	Mean	SD
Left	No Noise	MCI	27	0.340	0.275
		LCI	27	0.324	0.247
	Noise	MCI	27	0.287	0.236
		LCI	27	0.287	0.248
Right	No Noise	MCI	30	0.244	0.242
		LCI	30	0.356	0.327
	Noise	MCI	30	0.300	0.206
		LCI	30	0.281	0.172

Note: Ear, Ear of Presentation; Homophone, Homophone Type; MCI, More Common Interpretation; LCI, Less Common Interpretation.

Discussion

As reported in the results, the current study did not provide evidence to support the hypotheses put forward in the introduction to this paper. That is, it was not found that the homophones presented in the unattended presentation were reproduced on the spelling test with any reliability. A punishing effect of aversive noise was not found in the spelling of the previously presented homophones. Finally, an effect on spelling due to the ear of presentation of the unattended homophones was not found. These observations were also made in the absence of an effect on recognition performance by subjects, aside from a main effect of Ear of Presentation.

The recognition performance found in the current study is consistent with the hypotheses presented, that is, it seems evident that subjects were not able to discriminate previously presented homophones from new ones. To have supported the hypotheses of the current study, however, some significant differences needed to have been observed with respect to the spelling of homophones. A three-way interaction effect was expected between Ear of Presentation, Valence, and Homophone type. For the less common version of homophones presented to the unattended left ear, the probability of spelling that uncommon version was expected to be higher for unpunished homophones than for punished

homophones. For the more common version of homophones presented to the unattended left ear, the probability of spelling the complementary uncommon version of the homophones was expected to be higher for punished homophones than for unpunished homophones. In addition to this pattern of results, a comparison between less common, unpunished homophones presented to the unattended left ear and an equal number of New Homophones should have revealed that the previously presented homophones were more frequently spelled to denote the uncommon interpretation. This would have represented a replication of Eich's (1984) pattern of results. With respect to unattended presentations made to the right ear of subjects, pairwise comparisons were not expected to reveal significant differences among the four (Valence X Homophone Type) cell means.

The means for the spelling of the uncommon version of homophones did not approximate these expected findings. The means for the homophone presentations made to the right ear of subjects more closely approximate the expected results than do the means for the unattended presentations made to the left ear. While this is contrary to the third hypothesis of the study, the apparent differences in means are likely to be spurious as they were not supported in statistical analyses. Nevertheless, future research in dichotic listening, especially that which employs punishing stimuli, may benefit by controlled comparisons of

presentations to both ears.

The current set of results demand some explanation. At least three possible explanations exist to address the current lack of support for the research hypotheses. One is that the hypotheses put forward are based on false premises. That is, one might conclude that implicit memory does not in fact exist. The current study might be regarded as a body of evidence which attests to the nonexistence of implicit memory effects. This conclusion would account for the absence of effects on homophone spelling due to both aversive noise and ear of presentation, as these variables were hypothesized to influence the memories which were implicit or unconscious.

It is, of course, impossible to support this conclusion through the lack of significant findings from a single study. First, the logic of experimental methodology does not allow one to conclude that groups are equivalent and that no effect of the variable exists. Second, a body of research has demonstrated phenomena which together suggest a construct like implicit memory or "an unconscious." Any subsequent empirical findings would need to be evaluated against the weight of this prior research. The current study is insufficient to tip the scales in opposition to this body of research.

A second explanation to account for the lack of significant findings in the current study is error in the

experimental procedures or in the statistical analyses performed. Error is an accepted factor in experimental research, to the extent that it is formalized in statistical models of analyses. Thus, the concern is not the absolute presence or absence of error within some stage of the hypothesis testing procedure, but rather it is the extent to which error has occurred. As noted in the Results section, there is not a readily identifiable source of error which can account for the reported results.

A third attempt to explain the current lack of support for the hypotheses forwarded draws on both of the explanations above to suggest that the effects of unattended presentation and implicit memory are not large or robust. It is suggested that these effects were not found because of the relative complexity of the current design. That is, the lack of significant findings may attest to the fact that these effects are subtle and are not to be found when the basic parent paradigms are varied too widely. The present procedures may have been inappropriate to detect the effects sought, but this is discovered in retrospect, and was not to be predicted from previous evidence.

Two findings which did not bear directly on the hypotheses of the study were significant. The first of these was the comparison of noise ratings before the shadowing task and after the spelling test. The lower later rating suggests that some habituation to the noise

presentation occurred. It may also suggest that the noise was not as punishing as it was intended to be. This would, in part, help to account for the apparent absence of punishment effect. It needs to be held in mind, however, that an effect of punishment may not have been found not because of absence of effect but because of lack of power to detect it.

The second effect which requires discussion is the main effect of Ear of Presentation on recall. As addressed in the Results, this does not appear to suggest that subjects who heard the unattended homophones in the left ear were more accurate in their recognition of presented homophones, but rather that a response bias was operating such that these subjects gave more positive identifications. It is not clear why this should have been the case. This is, in fact, somewhat counter to what one may expect. That is, unattended words presented to the right ear of right-handed individuals would be registered in the left hemisphere, which is, most probably, the dominant hemisphere for language functioning for these individuals. Having been presented to the right ear, one might expect that these unattended words would be better recalled. In light of these predicted findings, it seems likely that the effect of Ear of Presentation on recall of unattended homophones is not a simple function of the lateralization of cortical functions. Whether this occurred as a function of the more

complex interactions of ipsilateral and contralateral auditory pathways during dichotic listening is beyond the scope of this study.

The current study suggests only general directions which future research may follow to achieve more satisfying results. The research base with regard to implicit memory phenomena is still in its youth, and its parameters are still being tested. Eich's (1984) study, with other investigations of memory for unattended or minimally attended stimuli, is also far from explaining the memory functions which appear to be occurring. Further research, especially experiments which wish to combine research streams, may profit from simpler designs than that currently employed, to build a base of replicable results which in turn foster a broader understanding of what appear to be subtle and elusive memory phenomena.

References

Baddely, A. (1982). Amnesia: A minimal model and an interpretation. In L.S. Cermack (Ed.), Human Memory and Amnesia. Hillsdale, N.J.: Erlbaum.

Carrol, M. & Kirsner, K. (1982). Context and repetition effects in lexical decision and recognition memory. Journal of Verbal Learning and Verbal Behavior, 21, 55-69.

Carman, A. & Nachishan, I. (1973). Ear asymmetry in perception emotional nonverbal stimuli. Acta Psychologica, 37, 351-357.

Corballis, M.C. (1980). Laterality and myth. American Psychologist, 35, 284-295.

Corteen, R.S. & Dunn, D. (1974). Shock associated words in a nonattended maeesage: A test for momentary awareness. Journal of Experimental Psychology, 102, 1143-1144.

Corteen, R.S. & Wood, B. (1972). Autonomic responses to shock associated words in an unattended channel. Journal of Experimental Psychology, 94, 308-318.

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.

Dawson, M.E. & Schell, A.M. (1982). Electrodermal responses to attended and nonattended significant stimuli during dichotic listening. Journal of Experimental Psychology: Human Perception and Performance, 8, 315-324.

Duncan, J. (1980). The locus of interference in the perception of simultaneous stimuli. Psychological Review, 87, 272-300.

Eich, E. (1984). Memory for unattended events: Remembering with and without awareness. Memory and Cognition, 12, 105-111.

Forster, P.M. & Govier, E. (1978). Discrimination without awareness? Quarterly Journal of Experimental Psychology, 30, 382-395.

Fowler, C.A., Wolford, G., Slade, R., & Tassinary, L. (1981). Lexical access with and without awareness. Journal of Experimental Psychology: General, 110, 341-362.

Galbraith, G.G. & Taschman, C.S. (1969). Homophone units: A normative and methodological investigation of the strength of component elements. Journal of Verbal Learning and Verbal Behavior, 8, 737-744.

Gazzaniga, M.S. (1985). The Social Brain: Discovering the Networks of the Mind. New York: Basic Books.

Geschwind, N. (1972). Language and the brain. Scientific American, 226, 76-83.

Glucksberg, S. & King, L.J. (1967). Motivated forgetting mediated by implicit verbal chaining: A laboratory analog of repression. Science, 158, 517-518.

Glucksberg, S. & Ornstein, P.A. (1969). Reply to Weiner & Higgins: Motivated forgetting is not attributable to a

confounding of original learning with retention. Journal of Verbal Learning and Verbal Behavior, 8, 681-685.

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.L. (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.L. (1987). Selective effects of interference on implicit and explicit memory for new associations. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 45-53.

Haggard, M.P. & Parkinson, A.M. (1971). Stimulus and task factors as determinants of ear advantages. Quarterly Journal of Experimental Psychology, 23, 168-177.

Hasher, L. & Zacks, R.T. (1979). Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 108, 356-388.

Hawryluk, G.A. (1977). The inhibition of information transfer across the corpus callosum: Neuropsychological investigation of motivated forgetting. Dissertation

Abstracts International, 38(10), 5018-6.

Johnston, W.A. & Dark, V.J. (1986). Selective attention. Annual Review of Psychology, 37, 43-75.

Jacoby, L.L. (1982). Knowing and remembering: Some parallels in the behavior of Korsakoff patients and normals. In L.S. Cermack (Ed.), Human Memory and Amnesia. Hillsdale, N.J.: Erlbaum.

Jacoby, L.L. & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. Journal of Experimental Psychology: General, 110, 306-340.

Jacoby, L.L. & Witherspoon, D. (1982). Remembering without awareness. Canadian Journal of Psychology, 36, 300-324.

Kimura, D. (1967). Functional asymmetry of the brain in dichotic listening. Cortex, 3, 163-178.

King, F.L. & Kimura, D. (1972). Left-ear superiority in dichotic perception of vocal nonverbal sounds. Canadian Journal of Psychology, 26, 111-116.

Kinsbourne, M. & Wood, F. (1975). Short term memory and pathological forgetting. In D. Deutsch & A.J. Deutsch (Eds.), Short Term Memory. New York: Academic Press.

Kinsbourne, M. & Wood, F. (1982). Theoretical considerations regarding the episodic-semantic memory distinction. In L.S. Cermack (Ed.), Human Memory and Amnesia. Hillsdale, N.J.: Erlbaum.

Kunst-Wilson, W.R. & Zajonc, R.B. (1980). Affective

discrimination of stimuli that cannot be recognized. Science, 207, 557-558.

Lackner, J.R. & Garrett, M.F. (1972). Resolving ambiguity: Effects of biasing context in the unattended ear. Cognition, 1, 359-372.

Lewis, J.L. (1970). Semantic processing of unattended messages using dichotic listening. Journal of Experimental Psychology, 85, 225-228.

Ley, R.G. & Bryden, M.P. (1979). Hemispheric differences in processing emotions and faces. Brain and Language, 7, 127-138.

Mandler, G. (1980). Recognizing: The judgement of previous occurrence. Psychological Review, 87, 252-271.

Marcel, A.J. (1983a). Conscious and unconscious perception: Experiments on visual masking and word recognition. Cognitive Psychology, 15, 197-237.

Marcel, A.J. (1983b). Conscious and unconscious perception: An approach to the relations between phenomenal experience and perceptual processes. Cognitive Psychology, 15, 238-300.

Martin, D.G. (1980). Brain laterality and a cognitive/behavioral model of repression and anxiety. Paper presented at Canadian Psychological Association convention in Calgary, Canada.

Martin, D.G., Hawryluk, G.A., Berish, C., & Dushenko, T. (1984). Selective forgetting of aversive memories cued

in the right hemisphere. International Journal of Neuroscience, 23, 169-176.

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.

Milner, B. (1971). Interhemispheric differences and psychological processes. British Medical Bulletin, 27, 272-277.

Milner, B. (1974). Hemispheric specialization: Scope and limits. In The Neurosciences Third Study Program, eds. F.O. Schmitt & F.G. Worden. Cambridge: MIT Press.

Motley, M.T. & Baars, B.J. (1976). Semantic bias effects on the outcomes of verbal slips. Cognition, 4, 177-187.

Neely, J.H. & Durgunoglu, A.Y. (1985). Dissociative episodic and semantic priming effects in episodic recognition and lexical decision. Journal of Memory and Language, 24, 466-490.

Nisbett, R.E., & Wilson, T.D. (1977). Telling more than we can know: Verbal reports on mental processes. Psychological Review, 84, 231-259.

Ornstein, R.E. (1972). The Psychology of Consciousness. New York: Harcourt Brace Jovanovich.

Raczkowski, O., Kalat, J.W., & Nebes, R. (1974). Reliability and validity of some handedness questionnaire items. Neuropychologia, 12, 43-47.

Ross, J.L. (1985). Memory for unattended events and unattended aversive events. Unpublished Honors Thesis, University of Manitoba.

Schacter, D.L. & Graf, P. (1986). 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., Harbluk, J.L., & McLachlan, D.R. (1984). Retrieval without recollection: An experimental analysis of source amnesia. Journal of Verbal Learning and Verbal Behavior, 23, 593-611.

Schacter, D.L. & Tulving, E. (1982). Amnesia and memory research. In L.S. Cermack (Ed.), Human Memory and Amnesia. Hillsdale, N.J.: Erlbaum.

Shevrin, H. & Dickman, S. (1980). The psychological unconscious: A necessary assumption for all psychological theory? American Psychologist, 35, 421-434.

Sidtis, J.J. (1982). Predicting brain organization from dichotic listening performance: Cortical and subcortical functional asymmetries contribute to perceptual asymmetries. Brain and Language, 17, 287-300.

Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), Organization of Memory.

New York: Academic Press.

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, 12, 336-342.

VonWright, J.M., Anderson, K., & Stenman, U. (1975). Generalization of conditioned GSR's in dichotic listening. In P. Rabbit and S. Dornic (Eds.), Attention and Performance, (Vol. 5). Oxford and Stockholm: Academic Press.

Wardlaw, K.A. & Kroll, N.E.A. (1976). Autonomic responses to shock associated words in a non-attended message: A failure to replicate. Journal of Experimental Psychology: Human Perception and Performance, 2, 357-360.

Weiner, B. & Higgins, J. (1969). A mediational paradigm for the study of motivated forgetting: A critical analysis. Journal of Verbal Learning and Verbal Behavior, 8, 677-680.

Zajonc, R.B. (1980). Feeling and thinking: Preferences need no inferences. American Psychologist, 35, 151-175.

Appendix A

Passage Presented During Dichotic Listening.

(From Winner, E., 1986. Where pelicans kiss seals. Psychology Today, 20(8), 24-35.)

The story of how children learn to draw seems at first glance to be a simple one: At a very early age they begin by scribbling with any available marker on any available surface. At first the children's drawings are simple, clumsy and unrealistic; gradually they become more technically skilled and realistic.

But the development of drawing is not quite so simple and straightforward. In fact, the story turns out to be quite complex. Watch a 2-year-old scribbling. The child moves the marker vigorously across the page, leaving a tangled web of circular and zig zag lines. It looks as if the marks themselves are an accident - the unintended result of the child's arm movements. But if you replace the child's marker with one that leaves no trace, the child will stop scribbling. Even though very young children enjoy moving their arms vigorously, they are also interested in making marks on a surface.

If we do not watch a scribble in the making, but only see the final product, it may look like a meaningless tangle of lines. And this is how scribbles have traditionally been viewed -- as nonsymbolic designs. But 1- and 2-year-olds are rapidly mastering the concept that words, objects and

gestures stand for things. So why shouldn't they also grasp that marks on a page can stand for things? Some of the more recent studies of children as they scribble suggest that these early scrawls are actually experiments in representation -- although not purely pictorial representation.

Psychologist Dennis Wolf studied how the drawing of nine children developed from age 1 to 7. He took detailed notes on the process of scribbling, and his investigations show us that children have surprising representational abilities long before they spontaneously produce a recognizable form.

At first the representation is almost entirely gestural, not pictorial. Wolf observed a 2-year-old who took the marker and hopped it around on the page, leaving a mark with each imprint and explaining as she drew, "Rabbit goes hop-hop". This child was symbolizing the rabbit's motion, not its size, shape or colour. The meaning was carried primarily by the marker itself, which stood for the rabbit, and by the process of marking. Someone who saw only the dots left on the page would not see a rabbit. Nonetheless, in the process of marking, the child was representing a rabbit's movements. Moreover, the dots themselves stood for the rabbit's footprints. Here in the child's earliest scribbles we already see glimmerings of the idea that marks on a page can stand for things in the world.

Two-year-olds rarely spontaneously create recognizable

forms in their scribbles, but they have the latent ability to do so. When Wolf dictated to 2-year-olds a list of features such as head, tummy, arms and legs, these children plotted the features systematically on the page, placing them in correct relative positions. But they lacked the notion that a line stands for the edge of an object and had no way to represent parts of features, since each feature was either a point or a patch. The children clearly understood, however, that marks on a surface can be used to stand for features "out there", off the page, and that they can be used to show the relative spatial locations of features.

Typically at age 3, but sometimes as early as age 2, children's spontaneous scribbles become explicitly pictorial. They often begin by making gestural scribbles but then, noticing that they have drawn a recognizable shape, label and further elaborate it. For example, one 3-year-old studied by Wolf, looked at his scribble and called it "a pelican kissing a seal". He then went on to add eyes and freckles so that the drawing would look even more like a pelican and a seal.

Sometimes children between 2 and 3 will use both gestural and pictorial modes at different times. A 2-year-old studied by art educator John Matthews drew a cross-like shape and called it "an airplane". One month later, this same child moved his brush all around in a rotating motion

while announcing, "this is an airplane". The label was the same but the process and products were different. In the first case, the drawing was an airplane because it looked like one. In the second case, it was an airplane because the marker moved like one, leaving a record of the airplane's path.