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The role of conceptual processing in perceptual identification performance

Michael B. Wasdell
Wilfrid Laurier University

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THE ROLE OF CONCEPTUAL PROCESSING IN PERCEPTUAL IDENTIFICATION PERFORMANCE

By

Michael B. Wasdell

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Abstract

The present research examined the extent to which conceptual processing done at study contributed to perceptual identification priming in an associative priming paradigm. Subjects performed either an elaborative (sentence generation) or non-elaborative (vowel omparison) encoding task on unrelated cue-target pairs presented in a study list. On a subsequent perceptual identification test, old target words were paired with their study trial cues (same context), other study trial cues (rearranged context), novel cue words (new context) and non-word cues (no context). A conceptual processing effect would be evidenced by a significantly higher level of same context priming in the elaborative encoding condition relative to all other conditions. The results revealed that although the level of same context priming was generally higher than that of the other context conditions, there were no differences in the level of priming between the two encoding groups. An analysis of errors suggested that the enhanced same context priming in each of the two encoding groups may be mediated by different processes. Furthermore, the results of this experiment support the hypothesis that priming in the perceptual identification test will benefit to the extent to which there is a match between study and test trial operations.

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Introduction

Considerable research in cognitive psychology has been aimed at attempting to clarify the relationship between performance on different measures of memory. One area of research that has received a great deal of attention has focused on the comparison of performance on indirect and direct measures of memory. The terms implicit and explicit tests of memory (Graf & Schacter, 1985) have become popular nomenclature for describing the procedural aspects of indirect and direct measures, respectively. Schacter (1987) defines implicit memory as the facilitating effect of prior experience on the performance of a task without intentional recollection of the past experience. Explicit memory, however, is characterized by the requirement of a conscious recollection of past events. Since the terms implicit and explicit memory are also used to reflect different underlying structures and processes, the direct/indirect classification will be used here to refer to the methodology of the memory measure and thus focus on the procedural aspects of the test.

Richardson-Klavehn and Bjork (1988) have defined direct measures of memory as those in which reference to specific past events are incorporated into the instructions. Tests of free recall, cued recall, and recognition are considered to be direct tests of memory since, in all cases, the instructions include references to specific target events.

Richardson-Klavehn and Bjork (1988) define indirect measures of memory as those tasks in which the instructions direct subjects' attention to the activity in which they are about to become engaged without making reference to specific past experiences. Evidence of memory is given by an enhanced level of performance on the indirect test for items previously encountered on the study trial compared to items not previously encountered. This facilitation has been found on a variety of indirect measures such as word-stem completion (e.g., Graf & Mandler, 1984), fragment completion (e.g., Blaxton, 1989), perceptual identification (e.g., Jacoby, 1983a), reprocessing text (e.g., Levy & Burns, 1990), and lexical decision (McKoon & Ratcliff, 1986). On tests of word-stem and fragment completion, subjects are required to fill in missing letters of word stems or fragments, respectively. The general finding on these types of tasks is that subjects are able to correctly complete more words if they had previously encountered them in a study list. Similarly, tests of perceptual identification have demonstrated that words presented very briefly are more likely to be identified if they were previously encountered on a study list. This effect of the prior study trial on performance is referred to as the priming effect.

Although facilitation on these tasks is given by subjects' ability to produce or identify words, reading speed and response time are the key measures in tests of

text reprocessing and lexical decision, respectively. Facilitation in text reprocessing is indicated by faster reading times for previously read passages relative to novel passages (e.g., Tardif & Craik, 1989). Similarly, on the lexical decision task, subjects are faster to identify letter-strings as words given prior experience with identical stimuli (e.g., McKoon & Ratcliff, 1986). The critical aspect of all of the indirect memory tests described above is that although no direct reference to a relevant prior event is included in the test instructions, memory for such an event is evidenced by performance facilitation when the task involves stimuli from a previous processing trial.

Dissociations Between Direct and Indirect Measures

Much of the current research on direct and indirect measures of memory has been generated in response to findings of dissociable effects in performance on these two types of tests. Dissociations are evidenced when the experimental manipulation of a particular variable has different effects on the performance of direct and indirect memory tests. For example, Graf and Mandler (1984) demonstrated that varying the type of processing done at the time of study had different effects on the performance of direct and indirect tests of memory. It was reported that while semantic and non-semantic processing of words in a study list had no effect on performance on a word-stem

completion test, performance on tests of free recall, cued recall and word recognition was greatly enhanced following semantic processing of the studied items. These findings are consistent with those of an earlier study by Jacoby and Dallas (1981) in which it was found that manipulations of the type of encoding done at study had a substantial effect on recognition memory performance but not on perceptual identification performance. In addition, Jacoby and Dallas found similar effects when the level of task difficulty was increased at study. These researchers found that solving anagrams produced higher recognition memory than merely reading words at the time of study. Although performance on tests of perceptual identification was better for words encountered in the study list than for new (baseline) words, producing a word as a solution to an anagram provided no advantage over reading a word.

Although encoding manipulations have been shown, generally, to influence performance on direct tests but not indirect tests, the pattern of results is reversed when the modality of presentation of study and test items is changed. The general finding is that performance on indirect memory tests is impaired when the modality (auditory/visual) of the test trial differs from that of the study trial. However, performance on direct tests is relatively unaffected by such changes (Jacoby & Dallas, 1981; Graf, Shimamura, & Squire, 1985).

Other evidence of dissociable effects comes from studies of memory disordered subjects. Several studies (e.g., Graf, Squire, & Mandler, 1984; Squire, Shimamura, & Graf, 1987) have shown that although the performance of amnesic subjects on direct tests of memory is disrupted, performance on indirect tests is similar to that of normal control subjects.

The finding of functional dissociations between direct and indirect test performance has been taken as supportive evidence of the workings of multiple memory systems. For example, Tulving (1984, 1985) has suggested that performance on direct tests of memory is mediated by an episodic memory system while indirect tests of memory access information from a semantic memory system. According to Tulving (1984), the distinction between episodic and semantic memory lies in the types of information each system is thought to process. The general nature of the episodic memory system is such that it deals with information specific to past events. Direct tests of memory are thought to tap the episodic system since they typically require the remembering of a particular past event. The nature of semantic memory, however, is less specific. Semantic memory is thought to handle more abstract information such as rules, concepts and schemas that contribute to general knowledge. It is these abstract components of knowledge which are thought to be accessed when performing indirect tests of memory.

Although evidence of functional dissociations between direct and indirect test performance has been taken as support for the notion of multiple memory systems, Tulving (1985) notes that a stronger case for the memory systems approach is given by evidence of stochastic independence between direct and indirect test performance. The assessment of stochastic independence differs from that of functional dissociations in that it does not require the experimental manipulation of a particular variable. Instead, stochastic independence is observed when performance on a particular test item in one test does not predict the performance on that same item in a different test.

Tulving (1985) argues that observations of stochastic independence signify the absence of processes common to each of the tests being compared. Thus, stochastic independence between direct and indirect test performance would be indicative of separate and non-overlapping systems (namely episodic and semantic memory) mediating performance in each of the two types of tests.

Confirmation of stochastic independence between direct and indirect test performance has been obtained by several researchers (e.g., Jacoby & Witherspoon, 1982; Tulving, Schacter, & Stark, 1982). For example, in an experiment designed to assess the relation between the time-course of retention of priming effects in word fragment completion and

that of recognition performance, Tulving et al. (1982) provide evidence of both functional and stochastic independence. A functional dissociation between fragment completion and recognition performance was manifest in the finding that fragment completion performance remained stable over a seven day period while recognition accuracy decreased substantially. This was complemented by the finding of stochastic independence between recognition and fragment completion performance. Tulving et al. report that when the order of administration of the two tests was such that subjects were tested for recognition prior to fragment completion, stochastic independence was observed. Thus, the probability of successful fragment completion did not vary as a function of accuracy on the preceding recognition test.

However, stochastic independence was not observed when the fragment completion test was administered prior to the recognition test. Tulving et al. (1982) suggested that the failure to find stochastic independence in this arrangement may be due to the fact that the completion test provided an additional study trial for those items which were correctly completed.

Although the data provided by Tulving et al. (1982) do seem to suggest some differences in the processes mediating direct and indirect test performance, the relation between direct and indirect tests and the episodic and semantic distinction is somewhat obscured. Specifically, the finding

of a long-lasting priming effect on the fragment completion test is incompatible with the notion that access to information held in semantic memory is dependent on the short-lived activation of abstract representations.

In conjunction with the Tulving et al. (1982) findings, the data presented by several other researchers suggest that the distinction between episodic and semantic memory is not wholly supported by dissociations between direct and indirect test performance. For example, the finding that indirect test priming is reduced by changes between study and test in the modality of item presentation (Jacoby & Dallas, 1981) and by changes in typography (Roediger & Blaxton, 1987) does attribute some importance to information that is specific to the initial encoding episode. Evidence of this nature indicates that indirect test priming cannot be entirely explained within the framework of semantic memory.

While some experimental manipulations affect indirect test performance in a manner which are outside the boundaries of a semantic memory system, Tulving et al. (1982) maintain that indirect tests may access some unspecified system that is different from semantic memory. This assertion is largely based on the assumption that observations of stochastic independence imply the operation of two non-overlapping memory systems. This interpretation, however, is problematic in that evidence of stochastic

independence has been obtained between fragment completion and perceptual identification performance (Witherspoon & Moscovitch, 1989). With respect to Tulving's (1984, 1985) views concerning stochastic independence, it is unclear as to how such independence can be obtained between two tests which are thought to be mediated by the same memory system. Thus, it seems that stochastic independence does not provide sufficient evidence to support the multiple memory systems approach.

A further concern with respect to stochastic independence is whether any theoretical importance should be attributed to measures of dependence or independence between tests. Hintzman and Hartry (1990) suggested that the weakness inherent in most experiments assessing stochastic independence between two tests is the assumption that there is uniformity among the items used, thus ignoring the extent to which differences between items may contribute to observations of independence/dependence. In a series of experiments, Hintzman and Hartry measured the degree of dependence between fragment completion and recognition performance using several subsets of the items employed by Tulving et al. (1982). The construction of these subsets of the Tulving et al. words was based on the extent to which recognition and fragment completion performance was correlated with a variety of subjective and qualitative characteristics of the items. Hintzman and Hartry found

that the degree of dependence/independence between fragment completion and recognition was different for different subsets of words. This finding is of particular importance since it appears that evidence of stochastic independence can be dependent on the type of items used and, therefore, may not specifically represent differences in the nature of the tests employed.

An alternative interpretation of the dissociative effects reviewed here is that they are the manifestation of differences in the processing requirements of each of the two types of tests. Several investigators have suggested that indirect memory tests are perceptually driven while direct tests are conceptually driven (Jacoby, 1983a; MacLeod, 1989; Roediger & Blaxton, 1987). According to this view, priming effects on indirect tests should be sensitive to manipulations of the physical features of the stimuli while performance on direct memory tests should be affected by conceptual manipulations. Clearly the finding that elaborative processing of study items only affects performance on direct tests lends support to this interpretation. Similarly, the effects of modality change on indirect memory test performance fits well with the notion that indirect tests are sensitive to perceptual processes.

In order to examine the extent to which perceptual processes mediate performance on indirect tests of memory,

Roediger and Blaxton (1987) manipulated modality of presentation, typescript and the clarity of the stimuli. Performance on a fragment completion test revealed that although priming was observed for both visually and auditorally presented stimuli, greater priming was found for items presented visually. That is, greater facilitation was found on the indirect test when the modality was consistent across study and test trials. Furthermore, priming in the visual condition was greater when the typography (hand printed) of the stimuli was maintained across presentation and test trials. This pattern, however, was not found for test stimuli that were typed. Roediger and Blaxton also report greater priming effects when the perceptual features of the study words (blurred or in focus) were reinstated at the time of testing. These findings demonstrate that the maintenance of the same perceptual features across study and test trials is a critical factor in maximizing the level of priming.

Although Roediger and Blaxton (1987) were successful in demonstrating the sensitivity of fragment completion performance to perceptual manipulations, there is a growing body of research that has found that conceptual processes play an integral role in the mediation of some priming effects.

Conceptual Factors in Reprocessing Transformed Text

One vein of research that has been successful in

demonstrating the role conceptually driven processing plays in indirect measures of memory has employed text reprocessing speed as the critical dependent measure. The basic procedure in these experiments involves subjects reading a series of passages and later reading new passages as well as rereading old passages. The amount of priming in this paradigm is given by shorter rereading times for old passages relative to reading times for initial and new passages. Several investigators (e.g., Kolers, 1975; Horton, 1985; Levy & Burns, 1990) have employed manipulations of surface features and text context in order to determine the relative contributions of perceptual and conceptual factors to these text reprocessing benefits. The following is a review of some of the studies that have examined the roles of conceptual and perceptual processing in reading text.

In a series of experiments conducted by Kolers (1975), subjects read sentences at study that were presented in a normal or geometrically inverted orientation. On a subsequent test in which subjects read inverted sentences, Kolers found that while initially reading sentences in either form increased reading speed at test, having prior experience with the sentences in inverted form resulted in faster reading times than did prior experience with the sentences in normal form. Kolers also found that the magnitude of this facilitation for initially normal

sentences decreased when the initial processing of the passages was auditory or when the passage was presented in a different language. Taken together, these findings indicated that reading was facilitated by memory for the physical aspects of the text. Although Kolers suggests that the transfer observed in these experiments is mediated by pattern analyzing operations, the role of semantic operations is acknowledged in that reinstating the perceptual features on the second reading served to increase the magnitude of the facilitation rather than produce facilitation per se. For example, Kolers reports that although the auditory presentation of a sentence reduces the amount of facilitation on a subsequent reading trial, rereading times were still shorter than initial reading times. Thus, some degree of cross-modal facilitation was obtained. This suggests that the perceptual features of the stimuli confer only part of the information needed to observe priming effects in the rereading task.

In contrast to the view put forth by Kolers (1975), Horton (1985) suggested that reading a sentence in inverted orientation at study requires more semantic processing than reading a sentence in normal orientation. Therefore, this greater amount of semantic processing could be used to facilitate subsequent rereading of the same inverted sentence. In order to test for the possible effects of perceptual and semantic processing on rereading speed,

Horton had subjects initially read sentences that were presented in normal, inverted, or reversed orientations. On the second reading, the sentences appeared in the reversed or inverted orientation. Horton hypothesized that both perceptual and semantic processing would be useful in those conditions in which the second presentation of a sentence had the same transformed typography as the first. In conditions in which the typography of the second reading was different from that of the first, it was hypothesized that perceptual processing would not be useful since the pattern analysis required for the second reading would not be the same as that for the first reading. That is, the pattern analysis for inverted text is not the same as that for reversed text. Therefore, in this condition, only semantic information that was retained from the first reading would be useful.

The results of Horton's (1985) experiments replicated Kolers' (1975) earlier finding of faster reading times for transformed passages that were initially read in a transformed typography relative to those initially read in a normal orientation. As previously noted, Kolers interpreted this result as evidence of perceptually based transfer. However, Horton also reported no differences in reading times between the same and different transformed typography conditions. If perceptual processing was responsible for the facilitation found on the second reading, reading times

in the same typography condition should have been faster than those in the different typography condition. Since this was not the case, it appears that memory for perceptual processing from the first reading plays a relatively small role in rereading transformed sentences. Horton suggests that the facilitation observed on the second reading is largely a result of the transfer of semantic processing information from the first reading.

In contrast to the view proposed by Horton (1985), Masson (1986) was concerned with testing two hypotheses pertaining to the type of skill that is evident in reading typographically transformed words. Masson conducted a series of experiments that demonstrated that the skill developed in reading transformed words is one that involves memory for the perceptual analysis of specific instances rather than a general skill. For example, in Masson's Experiment 3, subjects studied a list of word triplets in which words were printed in alternating upper and lower case letters. At test, subjects reread the same words either in the same pattern of alternating upper and lower case letters that was presented at study, or in a complementary pattern. The results of this experiment showed that rereading times for same pattern test items was faster than those of the complementary pattern items. These results demonstrate a transfer of specific perceptual information such as interletter patterns and word shape. This finding supports

the view that skill in rereading transformed words is based, in part, on the perceptual analysis of specific instances.

Although Masson (1986) argued against the development of a general skill in reading transformed text, Tardif and Craik (1989) argue that Experiments 1, 2, and 4 reported by Masson (1986) show evidence of a general skill along with an effect related to the specific words encountered. For example, Masson (1986, Experiment 1) presented subjects with word triplets in which the letters in each word were mirror images of their normal orientation. In addition, only half of the letters available in the alphabet were used to form the words employed during this phase. The time taken to read each of these triplets in a normal, left to right fashion, was measured. During the test phase, subjects were required to read three types of transformed word triplets. These were composed of items that were presented during the study phase, new words containing the same letters as those presented at study, and new words composed of letters that were not presented during the study trial. Reading times for the test items showed that there was greater transfer for previously studied words than for either of the new word triplets. Although Masson (1986) suggests that facilitation in reading transformed words is dependent on reinstating the specific perceptual features of the stimuli, it should be noted that reading times for new words formed from familiar transformed letters were faster than those of new words

formed from unfamiliar letters. Therefore, reading transformed words seems to be influenced by the development of a general skill and an additive effect of reinstating the stimuli that were present during the study phase.

As can be seen from these studies, there appears to be a number of factors that influence the facilitation of rereading transformed text. This problem was addressed by Tardif and Craik (1989). These authors suggested that although the design of Horton's (1985) study allowed him to examine the effects of specific semantic and perceptual processing in reading transformed text, it did not permit examination of the roles of general skill and the retention of gist. Tardif and Craik had subjects read passages in a normal typography and in two of three different transformed typographies. One week later, subjects read old and new passages in all three of the different transformed typographies. Tardif and Craik reported shorter reading times in all of the transformed typography conditions for passages that had been encountered during the initial processing trial relative to new passages. Similarly, shorter reading times were recorded for both old and new passages presented in familiar typographies than for those presented in a new typography. Tardif and Craik note that the failure to find a significant interaction between the transfer associated with repeating a particular passage and that of repeating a particular typography indicated the

retention of both general skill in reading a specific typography and the meaning of a passage.

In a subsequent experiment (Tardif & Craik, 1989, Experiment 2), subjects reread paraphrases and original versions of the first passages read either in an original or new transformed typography. As in the first experiment, no interaction was found between typography and type of passage, thus indicating the retention of a general skill in reading a particular typography. Although priming was observed for both paraphrased and original passages, more priming was obtained when original passages were reprocessed. Tardif and Craik suggested that this indicates that the retention of conceptual information is comprised of both retention of the gist of a passage and of specific lexical information.

Conceptual Factors in Reprocessing Normal Text

Recently, Carr, Brown, and Charalambous (1989) were interested in determining whether the facilitation observed in rereading text is best explained by an episodic or an abstractionist framework. According to an abstractionist model, facilitation in reprocessing text is related to the activation of lexical representations of individual words. Under conditions of repeated exposure, the reactivation of these representations becomes faster thus making a response more readily available. Since this facilitation is related to the lexical representations of individual words, the

conceptual relationship between words in a given text is not considered to be involved in mediating faster rereading times. Similarly, the abstractionist view proposes that memory for the specific perceptual details of the episode creating the activation are not the basis for the facilitation observed in text reprocessing.

In contrast, the rationale of the episodic argument is that priming observed on indirect memory tests is mediated by the memory of specific past experiences. According to this model, rereading a particular text will be influenced by the type of processing done during the initial encounter. Thus variations in surface features and context should affect the level of priming obtained on subsequent readings.

In order to test these two models, Carr et al. (1989) manipulated contextual and surface form features between initial and second readings of normally oriented text. The contextual manipulation involved the presentation of short texts either in their intact coherent form, or in a scrambled version in which word order was randomly rearranged. In addition, the perceptual manipulation involved the presentation of texts in typewritten or handwritten forms. The results of this study showed that although reading times were faster for previously read passages, this reprocessing benefit was not reduced by changes in context or surface features of the text. Carr et al. (1989) propose that the facilitation observed in

rereading text is due entirely to the activation of word level representations rather than contextual operations. Furthermore, they add that these representations are abstract as opposed to episodic in nature. Thus, their results support an abstractionist model.

Carr et al. (1989) suggest that the inconsistency between their findings and those of others (e.g., Kolers, 1975; Masson, 1986) is largely due to the nature of the task demands on each of the reading trials. These researchers proposed that contextual and perceptual features of the stimuli do not contribute to the reprocessing benefit when the initial and reprocessing tasks are similar. Conversely, as the informational demands become dissimilar, the dependence of priming effects on information derived from the conceptual and surface features of the stimuli increases. However, Carr et al. note that the inconsistency between their findings and those of other text reprocessing studies may be due to differences between the processing requirements in reading transformed versus normal text. Carr et al. suggest that changes in the perceptual and conceptual features of normally oriented text do not reduce the level of priming since the fluency in reading a normal typography can generalize to variations within that typography. However, when reading an unfamiliar typography, conceptual and perceptual processes become more important in facilitating subsequent rereadings.

In order to investigate the role of contextual processes and task requirements in reading normal text, Levy and Burns (1990) conducted a series of experiments in which text context was varied between readings of normally oriented text. Across three experiments, the amount of context was reduced by changing inter-paragraph, intra-paragraph, and sentence information between readings. This procedure allowed for the measurement of reprocessing benefits when only word, word plus sentence, and word plus sentence plus intra-paragraph information was maintained across passage repetitions. The main finding of these experiments was that the magnitude of the reprocessing benefit decreased as the amount of contextual information between reading trials was reduced. The finding that words initially read out of context did not produce as much facilitation to reading the same words in context as did initially reading contextually-bound words is inconsistent with the results reported by Carr et al. (1989). For example, Carr et al. (1989, Experiment 1) report that the magnitude of the facilitation effect was unchanged when subjects reread a scrambled version of the initial text. Levy and Burns (1990) suggest that the discrepancy in the results reported here may be representative of differences in the methods employed in the two studies. Specifically, Carr et al. had subjects read stimuli aloud while Levy and Burns had subjects engage in silent reading. Levy and Burns

suggest that the required sequential verbalization of individual words in an oral reading task may not promote conceptual processing.

Overall, the results of Levy and Burns' (1990) experiments favour the notion that the facilitation gained in rereading text is largely attributable to contextual factors. Moreover, Levy and Burns argue that reprocessing benefits are dependent on the extent to which the processing done during the initial reading is reinstated during the reprocessing task. This interpretation opposes Carr et al.'s (1989) suggestion that specific perceptual and conceptual processing do not contribute to priming effects when the reprocessing task is similar to the initial encoding task. Levy and Burns add that when the processing requirements of the first and second reading are matched, contextual overlap between the two trials plays a key role in mediating the amount of facilitation observed. This contextual overlap is particularly important when the stimuli are specifically of a contextual nature.

The importance of maintaining the same processing demands across trials in indirect tests of memory is illustrated in the findings of Levy and Kirsner (1989). In the first of a series of experiments, subjects were presented with a list of isolated target words or with target words embedded in meaningful text. The indirect memory test that was used was perceptual identification.

Levy and Kirsner report that priming effects were found only for items that were initially presented in isolation. However, in subsequent studies, they found that when the transfer test was rereading the target texts, facilitation was observed when the initial task involved reading of meaningful text. These results indicate that priming effects are dependent on the extent to which the initial and reprocessing tasks have similar processing demands.

Conceptual Factors in Word-Level Tests

Although studies that employ text reprocessing provide insight into the role of conceptual processing in indirect tests of memory, the majority of the studies use tests of word-stem completion, fragment completion and perceptual identification. The following will highlight some of the research that has been designed to examine the contribution of conceptual factors to performance on these tests.

In a widely cited study, Jacoby (1983a) examined the effects of contextual information on perceptual identification performance. During a study phase, subjects were exposed to target words that were either read in isolation, read in the presence of a contextually related item, or generated from a semantic cue. Jacoby suggested that performance on the perceptual identification task is mediated by the amount of perceptual processing which the subject engages in at study and that the presence of contextually related information at study would reduce the

amount of perceptual processing. Consistent with this hypothesis, his results showed larger priming effects for target words that were initially read in isolation than for items that were generated in the presence of a semantic associate. This finding parallels that of Levy and Kirsner's (1989) perceptual identification experiment in which a larger priming effect was obtained from context-free study words. Jacoby interpreted these findings as evidence that word-level priming measures are sensitive to the amount of data-driven processing.

Results similar to those of Jacoby (1983a) were reported by Blaxton (1989). Blaxton found that the amount of priming obtained on a fragment completion task was less for target items that were initially paired with a contextual cue than for items initially presented in isolation. In a subsequent experiment, Blaxton found that priming effects in this fragment completion task were reduced when the typography (uppercase elite/lowercase italic) of the target stimuli changed between study and test trials. This parallels effects reported by other researchers when surface features are manipulated (e.g., Gardiner, 1988; Roediger & Blaxton, 1987). However, when subjects were required to mentally image the target item's referent at study, this effect was not found. In fact, when the typography of target items was not consistent across study and test trials, the size of the priming effect was

significantly greater for the imagery group than for the non-imagery group, thus indicating evidence of conceptual processes. These findings led Blaxton to suggest that the processing demands of fragment completion tests may incorporate both perceptual and conceptual components. Blaxton adds that the effects of conceptual processing may be enhanced in a compensatory manner when conditions are not conducive to perceptually based transfer. The idea here is that when perceptual features are inconsistent across study and test trials, there is a greater reliance on conceptual operations on the test trial.

Although Blaxton (1989) found greater priming in the imagery group than in the no imagery group when there was a change in typography across study and test trials, it should be noted that priming in the imagery group was not affected by changes in typography. Thus changes is typography resulted in lower levels of priming only in the non-imagery group. Therefore, the differences in Blaxton's data may not reflect the workings of a compensatory mechanism. Instead, it could be argued this pattern of results was influenced by the extent to which there was an overlap of operations between study and test trials. According to this interpretation, changes in the typography did not affect the imagery group's performance since the stimuli were initially subjected to conceptual encoding. Therefore, completion performance in the imagery group may not have been dependent

on perceptual processing since this type of processing was not encouraged during the study trial. However, since conceptual processing of the study words was not encouraged in the non-imagery group, it seems reasonable that this group's performance would have been more sensitive to changes in the perceptual features of the stimuli on the test trial.

Associative Priming Effects

Conceptual factors have also been shown to influence the level of priming on tests of word-stem completion (Graf & Schacter, 1985; Schacter & Graf, 1986). In two experiments, Graf and Schacter (1985) found that repetition priming effects were influenced by the formation of meaningful associations between unrelated word pairs. In these experiments, subjects performed a vowel comparison task or were required to generate a meaningful association between unrelated word pairs (e.g., window-REASON) during the study phase. During the test phase, subjects were presented with three letter stems of target words that were paired with either the stimulus words with which they were paired during the study trial (same context condition - e.g., window-REA___), or with a new unrelated word (different context condition - e.g., officer-REA___). Graf and Schacter reported that although significant priming was observed for both types of context items in the elaborative encoding condition, reinstating the original study trial

stimulus words significantly enhanced the size of the priming effect. That is, more priming was found for same context items than for different context items. Significant priming effects were also found when subjects did not engage in elaborative processing at study. However, the amount of priming did not differ across the same and different groups and was equivalent to the different context conditions following elaborative encoding.

Graf and Schacter's (1985) discovery of associative priming effects is of particular importance to the study of indirect measures of memory. Their findings not only demonstrate that performance on indirect tests can be influenced by conceptual processes, but they also illustrate the importance of matching study and test trial operations in eliciting conceptual effects.

In a related study, Schacter and Graf (1986) further examined the relationship between elaborative processing and priming effects. They were specifically interested in whether differing degrees and types of elaborative processing would differentially affect word-stem completion performance in the paradigm employed by Graf and Schacter (1985). The results showed that the enhanced priming effect in the same context condition, relative to the different context condition, was unaffected by variations in the degree and type of elaborative processing required during the study trial. However, it was shown that this

elaboration requires the formation of a relationship between the stimulus-target pairs for the associative effect to be observed. For example, Schacter and Graf (1986, Experiment 4) had subjects engage in one of two types of elaborative processing at study. In the pleasantness rating task, subjects were required to rate each of the individual words in an unrelated pair on their pleasantness. In the sentence generation task, subjects were required to establish a meaningful association between each of the two unrelated words. The results of this study revealed associative priming effects in the sentence generation condition only. Thus, associative priming appears to depend on the extent to which the elaborative encoding task establishes a semantic relationship between the unrelated items.

Although priming of new associations has been shown to depend on elaborative processing (Graf & Schacter, 1985; Schacter & Graf, 1986), recent evidence has suggested that perceptual features may mediate this effect. Schacter and Graf (1989) have found that the enhanced priming in the same context condition is dependent on the consistency of the modality of presentation of items across study and test trials. Schacter and Graf report significant associative priming effects when study and test trial items were presented in the visual modality. However, when the modality of presentation of study items (auditory) was different from that of test items (visual), no priming

differences were found between the same and different context conditions. Therefore the associative effect was eliminated by the study-test modality shift. This finding seems to be in conflict with the interpretation provided by Blaxton (1989). Blaxton suggested that conceptual processing may serve as a compensatory mechanism when the indirect memory test does not provide the conditions necessary for transfer of perceptually processed information. According to this view, the study-test modality shift in Schacter and Graf's (1989) studies should have provided an opportunity for the maximum transfer of conceptual information in order to compensate for the lack of perceptual transfer. Although the findings of Schacter and Graf (1989) do not support the notion of a compensatory process, they do confirm Blaxton's (1989) suggestion that priming effects may be mediated by both conceptually and perceptually driven processing. However, Schacter and Graf's (1989) data seem to suggest that conceptual benefits are contingent on the reinstatement of study trial perceptual features on the transfer test.

Although the evidence of associative priming reviewed above is provocative with respect to the role of conceptual processes, there is some recent evidence that such effects may also be related to test awareness (Bowers & Schacter, 1990). The issue of test awareness has been discussed by several investigators (e.g., Graf & Mandler, 1984; Masson,

1989). However, evidence of functional dissociations and preserved priming in amnesic and normal subjects has led to the supposition that priming on indirect tests is mediated by unconscious retrieval processes.

Bowers and Schacter (1990) have defined test awareness as the subject's realization that study trial items are being repeated on the indirect memory test. Test unawareness is characterized by the lack of knowledge of this study-test relationship. These researchers conducted a series of experiments to determine whether priming effects could be obtained for subjects classified as test unaware. The classification of subjects as aware/unaware was based on responses to a post-experimental questionnaire. In their first experiment, Bowers and Schacter had subjects read a list of single words and then perform a standard word-stem completion test. The results of this experiment yielded significant levels of priming in test aware and test unaware subjects but the level of priming in these two groups did not differ. Bowers and Schacter note that the critical finding of this experiment is that significant priming effects were found for subjects who did not realize that study trial items appeared on the completion test.

Although the findings of Bowers and Schacter's (1990) first experiment suggest that awareness is not necessary in order to obtain significant priming effects, the results of subsequent experiments do not lend support to this notion.

In these experiments Bowers and Schacter were interested in determining whether associative priming effects could also be obtained from test unaware subjects. The results showed that significant associative priming effects were confined to subjects who indicated an awareness that study trial items were used in the stem completion test. Thus, no evidence of associative priming was observed in test unaware subjects.

Bowers and Schacter (1989) suggest that since priming was obtained for unaware subjects in the single word but not the associative paradigm, there may be different memory processes mediating performance in each of these tasks. One possible interpretation of these results is that the associative priming effect is related to conscious retrieval operations. However, evidence of intact associative priming effects in amnesic subjects (Graf & Schacter, 1985) raises some concerns in accepting this explanation. In addition, there are some aspects of Bowers and Schacter's data that suggest caution in drawing strong theoretical conclusions. First, Bowers and Schacter report that performance in the different context condition did not exceed the baseline level for test unaware and, in some cases, test aware subjects. This finding is inconsistent with previous reports of significant priming for different context items in the associative priming paradigm (Graf & Schacter, 1985; Schacter & Graf, 1986). Second, the baseline levels of

completion performance in the associative priming experiments were somewhat lower overall than baseline measures reported in similar experiments (e.g., Graf & Schacter, 1985). Taken together, these two components of Bowers and Schacter's data suggest that there has been some deviation in their data from the typical findings in the associative priming literature. However, the issue of awareness in associative priming certainly deserves further experimental investigation, and accordingly was incorporated into the present study.

Transfer from Text to Isolated Words

Other researchers (Oliphant, 1983; Levy & Kirsner, 1989; MacLeod, 1989) have examined priming of individual words that were initially encountered as parts of meaningful text. In Oliphant's (1983) study, subjects read target words that were either embedded in the text of preexperimental instructions or presented individually in a study list. On a subsequent lexical decision task, evidence of priming was observed only for those subjects who initially studied target items that were presented in isolation. No priming was found for target words that were initially processed as parts of meaningful text.

Findings similar to those of Oliphant (1983) on tests of fragment completion and perceptual identification have been reported by Levy and Kirsner (1989) and MacLeod (1989). As previously noted, Levy and Kirsner suggested that priming

effects are dependent on the extent to which the initial and reprocessing tasks have similar processing demands. In contrast to this interpretation, MacLeod has suggested that the presence of contextual information at the time of study reduces the amount of perceptual processing. Therefore, when isolated words are reprocessed, the size of the priming effects is drastically reduced. This view is consistent with that of Jacoby (1983a). MacLeod tested this notion by presenting subjects with short texts that contained target words in phrases where they did or did not make sense. The results of a fragment completion test showed little priming for target words that were initially processed as parts of meaningful phrases. However, MacLeod found reliable priming effects for those target items that were embedded in nonsensical phrases.

Although Levy and Kirsner (1989) and MacLeod (1989) report similar transfer effects from text to isolated words, it is important to note the differences in their interpretations of these findings. MacLeod suggests that priming of individual words is dependent on the extent to which they are "contextually-bound" during the initial processing trial. This interpretation is based on the assumption that performance on word-level transfer tests is mediated by perceptual processes.

However, Levy and Kirsner (1989) have proposed that the similarity of the processing demands between the initial and

reprocessing event play a key role in determining the magnitude of the priming effect. Thus, when the processing demands of the study and test trials are matched, more priming will be obtained, regardless of whether those processing demands involve perceptual or conceptual information. According to this view, MacLeod's failure to find priming effects on the fragment completion test for contextually-bound words may be due to the different processing requirements of the initial and reprocessing tasks. Furthermore, one could argue that priming was obtained for target words initially presented in nonsensical phrases since these items might have been processed in a fashion similar to the processing of isolated words, as would be required at test. Thus, there might have been a better match of study and test trial processing for MacLeod's 'context free' words.

Procedural Consistency

In a recent review of the literature, Masson (1989) advocates the notion that all indirect measures of memory are susceptible to the effects of both conceptual and perceptual processing. Masson argues that the limited evidence of conceptual processing effects on word-level transfer measures is due to experimental designs in which the original processing operations are not recruited for the transfer test. This interpretation also accounts for decreases in the level of priming when the perceptual

features of target stimuli, such as modality and typescript, are changed (e.g., Jacoby & Dallas, 1981; Roediger & Blaxton, 1987). Masson proposes that changes in the perceptual or conceptual processing of target items between study and test trials serve to constrain the processing operations that are available to the subject. Therefore, when the subject is unable to apply the procedures used during the study trial to the reprocessing task, weaker priming effects will be observed. Masson notes that by adopting this view, researchers can abandon the idea that indirect measures of memory only tap perceptual processes.

The importance of reinstating processing on word-level transfer tests is illustrated in the findings of Graf and Schacter (1985). As previously noted, these researchers found significantly greater priming on a word-stem completion test when the test items were paired with their original study trial cues. Since this effect was found only when subjects engaged in elaborative processing of the study trial word pairs, it is clear that the contribution of conceptual processing is evidenced only when the transfer task reinstates the original processing operations.

Similarly, Gardiner (1988) challenged Jacoby's (1983a) findings of a negative generation effect by hypothesizing that positive generation effects might be obtained on indirect memory tests if there was greater overlap between study and test processing. During the study trials of

Gardiner's study, subjects were presented with target words paired with semantic cues. Subjects were required to either read the target word or generate the target word from a fragmented version of its true form. On a subsequent fragment completion test, target fragments were presented either in their original form, or with a different combination of letters and blank spaces (thus providing the conditions necessary for evaluating priming in high and low study-test overlap, respectively). Priming effects in the generate and read conditions were similar when different fragments were used at test. However, when the same fragments were presented as test items, more priming was found for fragments that were initially generated than for those that were presented as complete words.

Since generating a word is considered to involve more conceptual processing than simply reading (Roediger, Weldon, & Challis, 1989), Gardiner (1988) interpreted these results as evidence of the contribution of conceptual processes to priming effects. Although Gardiner's findings are provocative, they should be interpreted with caution. The point to be made here is that the enhanced priming in the generate condition may be due to perceptual processes rather than conceptual processes. It could be argued that the fragments used in the generate condition provided a better match to the perceptual characteristics of the test fragments than did the intact words in the read condition.

Thus, the enhanced priming observed for generated targets may be the result of reinstating initial perceptual processing operations on the transfer test. Although these results do not provide clear evidence of conceptual processing, it is possible that fragment completion performance might have been enhanced if this test had been semantically cued. That is, Gardiner's failure to demonstrate unequivocal conceptual processing effects might have been due to the fact that conceptual processes were not reinstated on the fragment completion test.

Summary

In evaluating the research that has attempted to delineate the contribution of conceptual processes to priming effects, it is evident that there is a marked difference in the results obtained on word-level and text-level transfer measures. Whereas text-level transfer tests provide a clear indication of the important role of conceptual processing in indirect measures of memory, evidence of this role is somewhat limited on word-level transfer tests. Although word- and text-level transfer tests differ on a variety of characteristics such as the types of stimuli and measures used, there is also a considerable difference in the degree of similarity between the processing carried out on the study and test trials. This difference may be a critical factor in accounting for the discrepant results pertaining to the role of conceptual

processes in indirect measures of memory.

As previously noted, Masson (1989) proposed that evidence of conceptual and perceptual processing on indirect measures of memory is dependent on the correspondence between the processing demands of the encoding and reprocessing trials. With respect to this view, studies that employ text reprocessing as an indirect memory test could be considered to have a high correspondence of study-test procedures. This characteristic, however, is not always present in studies that employ word-level transfer tests. Although the majority of these studies do match the perceptual features of the study and test trial stimuli, the reinstatement of conceptual operations on the indirect test is often neglected. For example, in Jacoby's (1983a) experiment, it could be argued that there was a better match between the study and test trials in the no context condition than in the two context conditions. That is, the processing required to read a word on the encoding trial was very similar to the processing required by the perceptual identification task. However, the conceptual encoding induced by reading or generating a word in the presence of a semantic associate was not reinstated on the perceptual identification test. Thus, the larger priming effects found in the no context condition may be due to a greater correspondence between study and test trial procedures, rather than a result of this measure's apparent sensitivity

to the amount of perceptual processing done at study.

In summary, there is clear evidence demonstrating conceptual processing effects on some indirect measures of memory. Although the majority of the studies reporting significant conceptual effects are confined to the text reprocessing literature, it is becoming increasingly clear that performance on word-level transfer tests may be influenced by conceptual processes. Graf and Schacter's (1985) finding of associative priming effects on fragment completion performance certainly lends credibility to this assertion. Furthermore, evidence of cross-modal priming effects on measures of rereading text (Kolers, 1975), fragment completion (Roediger & Blaxton, 1987) and perceptual identification (Levy & Kirsner, 1989) suggests that something other than perceptual processes facilitates performance on these tests.

In order to assess the contribution of conceptual factors to priming effects on word-level tests, the notion that indirect tests are only perceptually driven must be suspended. Instead, a view that acknowledges that performance on these tests can be mediated by both perceptual and conceptual processes needs to be adopted. Since the extent to which there is an overlap between study and test trial processing appears to be a determining factor in obtaining maximal priming for conceptually processed information, it seems possible that conceptual effects could

be induced on word-level transfer tests if the degree of overlap between encoding and test is maximized.

The Present Research

The purpose of the present study was to examine the contribution of conceptual processing to the level of priming when the conceptual overlap between study and test trial processing is manipulated. The indirect measure of interest was performance on a perceptual identification test. This test was selected to provide a measure of priming since previous research has failed to find any direct evidence of conceptual processes mediating its performance. The lack of evidence of conceptual effects in this test has sustained the assumption that, more than any other indirect memory test, the perceptual identification test is entirely data driven. It is noteworthy that conclusions regarding the processing demands of the perceptual identification test have been based entirely on experimental conditions in which the test item has been presented in isolation (e.g., Jacoby, 1983a; Jacoby & Dallas, 1981). Associative effects have not been assessed in this paradigm.

Recently, Roediger et al. (1989) have developed a model for classifying the processing requirements of both direct and indirect measures of memory. This model is based on the assumption that direct and indirect tests access different types of information. It is assumed that most direct memory

tests rely largely on conceptual processing while most indirect tests depend largely on perceptual processing. A further assumption is that performance on both direct and indirect tests is enhanced when there is a greater correspondence between study and test trial procedures.

Given these assumptions, Roediger et al. (1989) have defined data (perceptually) driven tests as those in which performance is higher for items initially read in isolation than for items that were initially generated from a semantic associate. A reversal of this pattern identifies conceptually driven tests. This definition of data and conceptually driven tests is based on Jacoby's (1983a) finding of a negative generation effect in perceptual identification performance, and a positive generation effect in recognition performance.

Roediger et al. (1989) argue that the positive/negative generation effect distinguishes between perceptually and conceptually driven tests on the basis of processing consistency. Thus perceptually based tests will show a negative generation effect since there is a greater correspondence between study and test trial operations for no context items since reading a word in the absence of a semantic associate involves primarily data driven processing. Assuming that test performance is best when there is a high correspondence between study and test trial operations, a higher level of test performance in the no

context condition would indicate that the test is data-driven. A similar argument can be made for the relationship between the positive generation effect and conceptually driven tests.

According to Roediger et al.'s definition, most standard direct tests of memory, such as free and cued recall, can be classified as conceptually driven. In contrast, these researchers speculate that most indirect tests are data-driven. Given the framework from which Roediger et al. make their test classifications and Jacoby's (1983a) results, it is not surprising that the perceptual identification test has been classified as data-driven. Blaxton's (1989) finding of superior fragment completion performance on no context items relative to generate items has also led to its classification as data-driven.

Although Roediger et al. (1989) suggest that perceptual and conceptual processing represent endpoints on a processing continuum, their model of test classification does not discriminate between the processing components of different tests given the same classification. A further problem is that Roediger et al. do not discuss how the conceptual processing effects found in text reprocessing and associative priming paradigms can be accounted for by their model of test classification. As previously discussed, the conceptual effects found in these two indirect testing methods seem to be related to the extent to which study

trial operations match those of the test trial. Although Roediger et al. acknowledge the importance of this correspondence when study trial processing is manipulated, they do not describe their model in the context of test trial manipulations of conceptual information. Since matching study and test trial operations seem to be needed to observe conceptual processing effects on indirect measures, then it is possible that Roediger et al.'s data-driven classification of the perceptual identification test is incorrect.

Although performance on the perceptual identification test has been considered to be mediated by perceptual processing (Jacoby, 1983a; Roediger et al., 1989), there is some evidence that enhanced perceptual processing is not the only basis for the facilitation observed on this test. Using a signal detection analysis, Ratcliff, McKoon, and Verwoerd (1989) have shown that the enhanced ability to identify previously studied words is due to a decision bias rather than an increased sensitivity to the perceptual components of the task. In their experiments, Ratcliff et al. presented target words (e.g., died) and visually similar control words (e.g., lied) in a perceptual identification test. The control words used in these experiments were not presented during the study trial. Ratcliff et al. reported higher probabilities of identifying target words when they were initially encountered during a study trial than when

targets were shown for the first time on the perceptual identification trial. Although this outcome parallels the priming effects reported by others (e.g., Jacoby, 1983a; Jacoby & Dallas, 1981), Ratcliff et al. also found that subjects were more likely to give target words as responses to the presentation of visually similar control words when the targets had been presented in the study trial. Ratcliff et al. suggested that the large proportion of intrusion errors in the identification of control words may reflect a bias to report previously encountered words.

In order to test this bias interpretation, Ratcliff et al. (1989) gave subjects a forced choice task following each perceptual identification trial. In this task, subjects were required to select which of two words (a target and a control word) was presented as the perceptual identification item. The results of a signal detection analysis showed that *d'* (sensitivity) did not improve when target words were presented during the study trial. This finding indicates that the facilitation gained by the prior presentation of perceptual identification items is due to a bias to report those items rather than an enhanced ability or sensitivity to detect them.

In interpreting their results, Ratcliff et al. (1989) speculate that the bias found on the perceptual identification test may occur early in the perceptual processing of an item and is not likely to be at the level

of consciousness (cf. Masson, 1989). In addition, these researchers propose that their bias interpretation of priming in the perceptual identification test can be generalized to describe priming effects in other indirect tests, and in so doing incorporates differences in the processing requirements of these tests. Thus, when perceptual processing is the basis of the priming effect, a bias operating at the perceptual level may be the source of the priming. Similarly, when conceptual or other types of processing are the basis for the priming effect, a bias operating at these levels may be the source of the priming. This qualification is of particular importance since the contribution of both conceptual and perceptual processes is not excluded from the bias interpretation. Notably, this also allows Ratcliff et al. to account for demonstrations of stochastic independence between two tasks (e.g., Witherspoon & Moscovitch, 1989) in which bias effects may be operating at different levels.

It should be noted at this point that, while Ratcliff et al. (1989) provide strong evidence of a bias factor operating in the perceptual identification task, it is not entirely clear that their results can be generalized to the results of other studies which have used this task. Specifically, several aspects of their procedure may have predisposed their results. First, while subjects studied sentences prior to the perceptual identification task (a

procedure which is not conducive to priming, e.g., Levy & Kirsner, 1989, Experiment 1), the words of the sentence were presented one at a time in succession on a screen. This study procedure might be expected to enhance processing of perceptual features of the words more so than if the entire sentence was presented at one time. Second, and perhaps more important, the subjects were instructed prior to the study trial that they should "read the sentences because they might be helpful on the subsequent perceptual identification tests" (p. 381). Third, to reinforce this instruction, the experimental procedure involved an alternating sequence of study trials and perceptual identification tests, thereby giving subjects every opportunity to make (deliberate) use of encoding and test strategies to enhance the role of bias. Finally the use of the forced choice test in which a previously studied word is presented on every perceptual identification trial along with a second word (Experiments 2-5) could be expected to further reinforce this bias. It is not clear, then, whether these features of the procedures are crucial to the results obtained and therefore whether they generalize to studies of perceptual identification performance in which the procedures do not lend themselves to such effects. Further research is needed to assess the role of these methodological features of their studies on the bias effects which they have reported.

Another component that has been shown to affect the level of priming in the perceptual identification test is list context. Jacoby (1983b) reported higher levels of priming on the perceptual identification test when there was a greater proportion (0.90) of target words on the test list than when this proportion was low (0.10). Based on this finding, Jacoby suggested that priming in the perceptual identification test is mediated by the cues available on the test trial. Thus, priming will benefit by a higher level of contextual reinstatement.

However, it should be noted that subjects in Jacoby's (1983b) higher proportion condition were also informed that the test list contained study trial words, while this relationship was not explained to subjects in the low proportion condition. Therefore, the different levels of priming found in the high and low proportion conditions may be due, in part, to subjects engaging in conscious retrieval operations in the high proportion condition.

Although the proportion of target words on the test list and test instructions were confounded, Jacoby (1983b) favored the list context interpretation. A similar interpretation of Jacoby's data has been offered by Masson (1989). Masson suggested that the additional benefit conferred by a higher proportion of target words is due to the recruitment of memory for experiences encountered during the initial encoding trial (Masson, 1989). Masson notes

that these experiences include the initial processing of a particular word and other list words. Thus, memory for perceptual and/or conceptual encoding operations may be recruited. The memory for encoding trial experiences is thought to make a correct response more accessible when the appropriate target words are presented on the perceptual identification test since the context in which items were initially encountered is recruited. Masson's list context interpretation is particularly interesting since it acknowledges the potential of both conceptual and perceptual processes to influence priming on the perceptual identification test when there is a greater overlap of study and test trial procedures.

Since, according to Masson (1989), the recruitment of memory for conceptual operations is implicated in the list context effect, then it is entirely plausible that conceptual priming effects may be obtained under conditions of high contextual correspondence. One experimental paradigm that provides the opportunity to manipulate the context in which target words are presented at test is the associative priming procedure used by Graf and Schacter (1985). Since this procedure has been successful in demonstrating the importance of reinstating study trial conditions in order to observe the effects of conceptual processing on the word-stem completion test (Graf & Schacter, 1985; Schacter & Graf, 1986), it may also prove to

be a valuable tool for measuring conceptual priming effects in the perceptual identification test. Thus, the present research investigated the role of conceptual processing in perceptual identification performance within the associative priming framework.

Procedural Overview. The general procedure of the present experiment followed that of Graf and Schacter (1985). During the study phase, subjects were required to process (elaborative or perceptual) unrelated word pairs. For one group of subjects, the processing task required the generation of sentences that established a semantic relationship between the words in each pair. For the other group, the processing task required subjects to compare the number of vowels in each of the words that constitute a pair. Following a filler task, critical (previously studied) and baseline (unstudied) words were presented in a perceptual identification test. Critical target words were presented in the context of four different classes of cue words. In the same context condition, critical target words were paired with their original study trial cue. In the rearranged and new context conditions, critical target words were recombined with other study trial cue words and with novel cue words, respectively. Finally, critical target words in the no context condition were presented with non-word cues (a series of X's). Following completion of the perceptual identification test, a questionnaire was

administered in order to probe subjects for test awareness. This questionnaire contained the same questions as that used by Bowers and Schacter (1990).

Hypotheses

Since the procedure is analogous to that of Graf and Schacter (1985), a similar pattern of results was expected. However, since the present experiment utilized the perceptual identification test as the indirect measure of memory, the critical measure of priming was given by the difference between the probability of correctly identifying critical target words and that of identifying baseline words. It was expected that a general priming effect would be observed. This effect would be characterized by a higher probability of identifying critical target words than baseline words across all context and encoding conditions. Given the results obtained by Graf and Schacter (1985; Schacter & Graf, 1986), it was predicted that the level of priming would not differ significantly across context conditions in the vowel comparison group. Schacter and Graf (1986) have demonstrated that associative priming effects are dependent on establishing an association between cue and target words at the time of encoding. Therefore, if associative information is to influence perceptual identification performance, then it should occur in the elaborative encoding condition. It follows that the level of priming for the sentence generation group should be

higher for same context items than for rearranged, new and no context items. No differences were expected among the rearranged, new and no context conditions.

Although test awareness was measured post-experimentally, no a priori expectations pertaining to these data were formed since the Bowers and Schacter (1990) study was the only published report evaluating test awareness, and test awareness had not been used at all with the perceptual identification test. In addition, Bowers and Schacter's (1990) unusual pattern of associative priming results did not lend itself to formulating specific predictions on the awareness issue.

Method

Subjects

Twenty-six undergraduate students attending Wilfrid Laurier University were recruited to participate in the experiment. Subjects were randomly and evenly assigned to one of two encoding conditions (sentence generation or vowel comparison). The data collected from an additional three subjects were omitted from the analysis. One subject's data were excluded since this subject's baseline performance fell to a near zero probability on the test trial. The data obtained from a further two subjects were omitted since these subjects reported visual impairments which impeded test trial performance.

Materials

The experimental materials were composed of 316 unrelated nouns (4-8 letters in length) that were drawn from the Francis and Kucera (1982) norms. The range of word frequencies was between 1 and 100 occurrences per million. From this pool, individual words were randomly assigned to one of six lists. These included a practice list (6 words), two study trial lists (80 words in each), a filler list (80 words), a perceptual identification set-up list (50 words), and a new cue list (20 words).

Study List Construction. Half of the 80 words in each of the two study lists were randomly paired with the

remaining 40 words to form two separate lists of 40 unrelated cue-target pairs (see Appendices A and B). For half of the subjects, one list of 40 pairs served as the critical pairs on the study trial while the other list served as the study trial critical pairs for the remaining half of the subjects. The lists not presented to subjects during the study trial were presented on the perceptual identification test to provide a baseline measure of performance. In addition, the six practice words were randomly paired to form three unrelated cue-target pairs (see Appendix C). These served as practice items prior to the presentation of the study list.

Test List Construction. The materials used in the perceptual identification test trial included all forty target words presented on the study trial, forty baseline pairs and forty filler pairs. Each of the forty target words was randomly assigned to one of the four context conditions. In the same context condition, the target words from ten study trial pairs were presented with their original study trial cues. In the no context condition, target words were paired with a non-word cue (a series of six X's). In the rearranged context condition, ten study trial cue-target pairs were selected and rearranged such that each cue word was paired with a different target word. Thus, these cue words had been seen previously, but in the presence of different target words. The ten study trial

target words assigned to the new context condition were randomly paired with ten new cue words that were drawn from the list of twenty 'new cue' words (see Appendix D). Thus, in this condition, the cue words were not among those presented in the study trial. Tests for baseline items were constructed in a similar fashion, although the type of cue variable was, in fact, a dummy variable since these items had not been studied previously.

In addition to the materials described here, a further eighty unrelated words were included in the perceptual identification test. A random half of these words were randomly paired with the remaining words to form forty unrelated cue-target filler pairs (see Appendix E). These filler items were used in order to help disguise the fact that the test items included previously studied words. Thus, each list of words on the perceptual identification test was composed of forty critical pairs, forty baseline pairs and forty filler pairs. Thus, one third of the words presented for identification had been studied previously. For each block of 12 perceptual identification trials, the word pairs consisted of four pairs from each of the critical, baseline and filler lists. The four critical and baseline pairs were selected such that each of the four context conditions was represented within a block of 12 trials (one pair from each context condition). The remaining list of 50 words (see Appendix F) was used in the

perceptual identification practice trials. All stimuli were presented via an IBM personal computer with a monochrome monitor (white on grey display) with a 640 X 480 screen resolution.

Procedure

Practice Phase. Subjects sat a comfortable viewing distance from the computer screen. The experimental session began with the presentation of an example of a cue-target pair and a sentence that related the two words, or a correct vowel comparison response, depending on the subject's encoding condition. Subjects in the sentence generation condition were instructed that their task was to generate a meaningful sentence that related the two words in each pair. In the vowel comparison condition, subjects were required to determine whether the words in each pair had the same number of vowels. Following the example, three practice pairs were presented (see Figure 1). Cue and target words were presented side by side for a duration of 4 seconds. Subjects were required to read each word aloud and then verbally produce their sentence or vowel comparison decision immediately following stimulus offset. Presentation of all pairs was under the experimenter's control.

Study Phase. Following the practice trials, subjects were informed that they would be presented with an additional forty pairs of words. Subjects were also informed that the procedure for the study trial would be the

same as it was for the practice trial (see Figure 1). The forty study trial pairs were randomly ordered for each subject. The presentation duration for each pair was the same as that of the practice trials.

Perceptual Identification Setup. Once all study list pairs had been presented, subjects were administered five sets of ten perceptual identification trials (see Figure 2). These trials served both as a filler task and as a means for establishing stimulus and delay interval durations in order to ensure a similar level of accuracy across subjects. Prior to the presentation of each item, two horizontal bars were presented in the centre of the screen for approximately 250 milliseconds (ms). These bars served to direct the subject's attention to the location of the ensuing word. Following offset of the location cue, a word was briefly presented which, in turn, was followed by the presentation of a pattern mask (a series of ten ampersands). This mask covered the area in which the word had appeared. The mask remained on until the subject provided a verbal response, or to a maximum of 4 seconds. This was followed by an intertrial interval of approximately 16 ms. The stimulus duration and the delay interval between stimulus offset and mask onset were approximately 32 and 16 ms respectively for the first block of 10 trials. These durations were increased or decreased (in 16 ms units) prior to the presentation of the first perceptual identification trial in

each of the ensuing blocks of trials. The use of 16 ms units in this experiment was due to a software constraint in which the minimum refresh cycle duration was 16 ms. This procedure was carried out until the probability of correctly identifying the ten words in a set was raised or lowered to .40-.60 on two consecutive blocks of 10 trials.

Test Phase. Once the durations for the perceptual identification task had been established, the test trial began (see Figure 3). The 120 test pairs were administered such that cue and identification target words were presented individually in the centre of the screen. Thus, for a given pair, the trial procedure began with a location cue (duration=250 ms) which was followed by the presentation of the cue word for 1 second. A 500 ms interval began with the cue word's offset. Subjects were required to read each cue word aloud. In order to obscure the relation between study and test trial items, subjects were informed that the purpose of the test phase was to determine what effect the cue word had on the identification of the target word. Subjects were further instructed that they should report the first word that came to mind for each perceptual identification item. These instructions did not make specific reference to the study trial and avoided inducing subjects to make assumptions about the study-test relationship between cue and identification words. The perceptual identification of target words from each pair

followed the presentation of each cue. Word and delay interval durations in this phase were the same as those that gave a .40-.60 probability of identification in the previous phase. The perceptual identification procedure was composed of a 250 ms location cue, the presentation of the identification word, delay interval and a mask. Subjects had four seconds following the mask onset to report the identification word. This was followed by a 16 ms intertrial interval. Subjects were instructed to read aloud each cue and identification word. Subjects were also required to give a response to each perceptual identification item even if they could not correctly identify the word. All procedures in this phase were timed and controlled by the computer. Each perceptual identification response was tape recorded and scored by the experimenter as correct or incorrect.

Awareness Questionnaire. Following completion of the test phase, subjects were probed for their awareness of the relation between study and test trial words. The questionnaire consisted of the four questions used by Bowers and Schacter (1990). Thus subjects were asked the following questions: 1. What did you think was the purpose of the perceptual identification task you just completed? 2. What was your general strategy in identifying the words? 3. Did you notice any relation between the words you saw at the beginning of the experiment and the words on the perceptual

identification trial? 4. While identifying words, did you notice whether you identified some of the words with words you saw earlier in the experiment? Responses to these questions were scored according to Bowers and Schacter's criteria. Thus, any mention of the study phase in the responses to the first two questions or a positive response to the last two questions resulted in the subject being classified as test aware.

Design and Analysis

Design. The experimental design was a 2 X 4 mixed factorial. The between subjects factor was encoding condition (sentence generation vs. vowel comparison) and the within subjects factor was context (same, rearranged, new and no context).

Scoring. The level of priming was given by the difference between the probability of correctly identifying critical target words and that of baseline words. Four priming scores were obtained for each subject. These pertained to each of the four context conditions. Thus, for each subject, probabilities were calculated, individually, for identification of the forty baseline target words and of the ten critical target words in each of the four context conditions. These probabilities were converted to a measure of priming (critical target minus baseline probabilities) for each context condition.

Analysis and Statistical Predictions. These priming

measures were entered into a 2 (encoding condition) X 4 (context) split plot analysis. It was expected that the analysis would yield a significant interaction between encoding condition and context. This would be characterized by significantly higher levels of priming in the sentence generation group than the vowel comparison group for same context items. No differences were expected between these two groups for the new, rearranged and no context conditions. However, a significant amount of priming was expected in each of these latter three context conditions for both encoding groups. Priming in each of these conditions was determined by a Dunnett's test of contrasts.

Results

All subjects provided responses to each of the test phase perceptual identification items. Unless otherwise stated, a level of significance of .05 was adopted for each of the following analyses.

Baseline Probabilities

In order to confirm that baseline performance did not differ between the two encoding groups or across the four context conditions, baseline probabilities were subjected to a 2 X 4 split plot analysis in which encoding condition was the between subjects factor and test context was the within subjects factor. The mean baseline probabilities are presented in Table 1. This analysis yielded no significant main effects of encoding condition, $F(1,24)=1.18$, $MS_e=0.14$, or of test context, $F(3,72)=1.87$, $MS_e=0.03$. The interaction between these two factors was also nonsignificant, $F(3,72)=0.42$, $MS_e=0.03$.

The lack of any significant differences in the baseline probabilities allows the use of an overall baseline probability in calculating the level of priming in the subsequent analyses. Thus, for each subject, one baseline probability was obtained by calculating the mean of the baseline probabilities across the four context conditions. This procedure provided the most stable estimate of baseline performance.

Priming

The measure of primary interest in this experiment was the level of priming. Priming was calculated by subtracting the overall baseline probability from the probability of correctly identifying critical target words in each of the four context conditions. Thus the level of priming was calculated for each of the same, rearranged, new and no context conditions. These priming data were entered into a 2 (encoding condition) X 4 (test context) split plot analysis. The mean priming scores are presented in Table 2. It was hypothesized that associative priming effects would be evidenced by an interaction between encoding condition and test context. However, the interaction between encoding condition and context was not significant in the present analysis, $F(3,72)=0.90$, $MS_e=0.02$. In addition, there was no effect of encoding condition, $F(1,24)=0.04$, $MS_e=0.04$. There was, however, a significant main effect of test context, $F(3,72)=2.83$, $MS_e=0.02$. A Fisher's LSD test (LSD=0.078) revealed that priming in the same context condition was significantly higher than priming in the rearranged and new context conditions, but did not differ from the level of priming in the no context condition. Comparisons of the level of priming between rearranged and new context, rearranged and no context, and new and no context conditions resulted in no significant differences.

In order to determine whether performance on critical

target items exceeded baseline performance, Dunnett tests were conducted. These tests (d_D=0.086) revealed that overall performance in each of the four context conditions was significantly higher for critical target items than for baseline items. However, when the data were analyzed for each of the sentence generation and vowel comparison groups separately, the Dunnett test (d_D=.137) revealed that critical target item performance significantly exceeded baseline performance only for same and new context items in the sentence generation group and for same and no context items in the vowel comparison group.

Same vs. Different Context Priming

An alternative method of analyzing the data collected from an associative priming experiment is to collapse priming scores across the rearranged, new and no context conditions in order to compare the level of priming in the same context condition to that of a condition in which the context was different. This procedure has been used by Graf and Schacter (1985) in which their "different context" condition consisted of three different types of cue-target pairs that were comparable to the rearranged, new and no context pairs used in the present study.

In order to follow more closely Graf and Schacter's (1985) method of analysis, priming scores from the present experiment were collapsed across the rearranged, new and no context conditions thus forming an overall "different

context" condition. These and the data from the same context condition were submitted to a 2 (encoding condition) X 2 (same vs. different context) split plot analysis. The results of this analysis parallelled those of the previous analysis. Specifically, the analysis failed to yield the expected interaction between encoding condition and test context, $F(1,24)=0.28$, $MS_e=0.01$. As in the previous analysis, there was a significant main effect of test context, $F(1,24)=13.16$, $MS_e=0.01$, but not of encoding condition, $F(1,24)=0.00$, $MS_e=0.02$. Table 3 shows that the main effect of context is characterized by a higher level of priming for same context items than for different context items. Dunnett tests ($d_D=0.09$) revealed that the probability of correctly identifying critical target words was significantly higher than that of identifying baseline words in the same and different context conditions for both encoding groups.

In summary then, a similar pattern of priming was observed in each of the analyses of same, rearranged, new and no context pairs and the analyses of same and different context pairs. Although both of these analyses revealed higher levels of priming for same context pairs, the manipulation of encoding condition had no effect on the overall level of priming. This replicates earlier findings which have shown that manipulations of the level of encoding do not produce differential effects on the perceptual

identification test (e.g., Jacoby & Dallas, 1981). In addition, no significant interactions between encoding condition and test context were obtained, thus failing to provide direct evidence of associative priming as defined by enhanced same context priming being restricted to the elaborative encoding group.

Awareness

A secondary objective of the present study was to examine the potential relationship between awareness and associative priming. As previously discussed, awareness was assessed by means of a post-experimental questionnaire. Using Bowers and Schacter's (1990) criteria for classifying subjects as test aware (spontaneously mentioning the study trial in response to either of the first two questions, and/or a positive response to either of the last two questions), all subjects in the sentence generation condition were classified as test aware. Similarly, twelve of the thirteen subjects in the vowel comparison condition were classified as test aware.

Since Bowers and Schacter's (1990) method of categorizing subjects as test aware and test unaware did not result in an appropriate number of subjects being classified as unaware in the present experiment, an alternative awareness criteria was chosen. Responses to the awareness questionnaire were recoded in order to give a measure of the level or degree of awareness reported by each subject. The

level of awareness score was given by the number of questions to which awareness was indicated in the responses. This method of assessing the level of test awareness yielded one awareness value for each subject. The potential range of these values was from 0 (awareness not indicated in any responses) to 4 (awareness indicated in all four responses). Since Bowers and Schacter (1990) did not include a perceptual encoding group, separate analyses were conducted for each of the sentence generation and vowel comparison groups in the present experiment.

Sentence Generation Group. The range of awareness values in the sentence generation group was from 2 to 4. Although these subjects show awareness according to Bowers and Schacter's (1990) criteria, we chose to classify them as either high awareness or low awareness subjects. This was accomplished by classifying awareness values greater than or equal to the median reported awareness value (median=3) as high awareness and those below the median value as low awareness. Thus nine subjects were classified as high awareness and four were classified as low awareness. Two Friedman tests were conducted in order to determine whether the level of priming was higher for same context items than for different context items for each of the high awareness and low awareness subjects. The results of these tests revealed significantly higher priming for same context items than for different context items for high awareness

subjects, $\chi^2(1)=4.0$, but not for low awareness subjects, $\chi^2(1)=1.0$.

Vowel Comparison Group. Awareness values in the vowel comparison group ranged from 0 to 3, thus indicating that the overall level of awareness in this group was lower than that of the sentence generation group. As in the previous analysis, subjects whose awareness values were greater than or equal to the median value (median=2) were classified as high awareness subjects while those whose values were below the median value were classified as low awareness. Given this criterion, eight subjects were classified as high awareness and five subjects were classified as low awareness.

Friedman tests showed that the higher level of priming in the same context condition for high awareness subjects approached significance, $\chi^2(1)=3.12$, while no significant difference between same and different context priming was found for low awareness subjects, $\chi^2(1)=1.80$.

Overall, these data suggest that differences between the same and different context conditions tend to be larger as the level of awareness increases. Given the use of two different median values and the limited range of the awareness values, it should be noted that these results should be interpreted with caution.

Discussion

It was hypothesized that associative priming effects in perceptual identification performance would be evidenced by a higher level of priming in the same context condition than in the different context condition, but that this effect would be restricted to the elaborative encoding group. Priming in the vowel comparison group was not expected to differ across context conditions. The general pattern of results obtained from the present experiment failed to clearly demonstrate associative priming effects on the perceptual identification test. Although priming in general was highest for same context items, no significant differences were found between the two encoding groups. Thus, the enhanced priming of same context items occurred in each of the sentence generation and vowel comparison groups.

Same vs. Different Context

Since the present experiment was modelled after Graf and Schacter's (1985) study, it is important to comment on the similarities and differences between their results and the results obtained here. Thus, discussion here is in reference to the analysis involving same and different context priming.

The most striking difference between the results presented here and those of Graf and Schacter (1985) is the failure to replicate a significant interaction between encoding condition and test context. Graf and Schacter

found that while priming on same context pairs exceeded priming on different context pairs in their elaborative encoding group, similar levels of priming were obtained for same and different context items in their vowel comparison condition. Although the present experiment demonstrated significantly higher levels of priming for same context than for different context items, there were no priming differences between the two encoding groups.

The finding that priming scores in the same context condition did not differ between the sentence generation and vowel comparison groups does not lend itself to the conclusion that the higher priming of same context items in the sentence generation condition is conceptually based. However, the fact that test context played an important role in the mediation of the level of priming in both groups is of particular importance. Consistent with the notion proposed by Levy and Kirsner (1989), the results of the same versus different context analysis provide supportive evidence that priming on the perceptual identification test is mediated by the extent to which there is a correspondence between the initial encoding and reprocessing events.

Although the nature of the processes mediating the context effect in each of the encoding groups is obscured, it is of interest to note that the results of this experiment are inconsistent with Jacoby's (1983a) views concerning the role of perceptual processing in perceptual

identification performance. According to this view, priming in perceptual identification is mediated solely by the amount of perceptual processing done during the study trial. Since contextually-bound study words would be expected to receive less perceptual processing, they should, therefore, be less likely than context-free words to be correctly identified on a perceptual identification test. In the sense that "contextually-bound" refers to the presence of some semantic relation between study trial words (e.g., Jacoby's, 1983a, context condition consisted of cue and target words that were antonyms) rather than the presence or absence of a context (cue) word, the results of the present experiment showed no significant differences in priming between contextually-bound (sentence generation) and context-free (vowel comparison) words. Thus, it appears that reinstating study trial operations at test has a more profound effect on perceptual identification performance than does the amount of perceptual processing.

It should be noted here that discussion of the relevance of reinstating study trial operations at test refers specifically to the reinstatement of study trial stimuli at test. Such statements, which suggest that more than just study trial stimuli are reinstated on the test trial, have been widely used in the priming literature in reference to a variety of indirect memory tests. Clearly the only indirect test which has consistently provided the

maximal correspondence between study and test trial operations is text reprocessing.

Although the data from the present experiment do not allow for clear conclusions regarding the extent to which the test context effect is mediated by conceptual or perceptual processes in each of the two encoding conditions, these data wholly support the notion that priming is enhanced when there is a greater correspondence between study and test trial operations. Since same context priming was enhanced in both encoding conditions, one possible interpretation is that the enhancement is due to the reinstatement of conceptual and perceptual processing in the sentence generation and vowel comparison groups, respectively. However, such an interpretation is problematic since there exists the possibility that the enhanced same context priming in the sentence generation group may be due to the reinstatement of study trial perceptual features.

However, Graf and Schacter's (1985) finding of enhanced same context priming only in their elaborative encoding group refutes the possibility that their results are due to the reinstatement of the perceptual features of the study trial pairs. The challenge then becomes one of accounting for the discrepancy between the results obtained in the present experiment and those of Graf and Schacter. One interpretation of this discrepancy is related to the types

of processing that different indirect tests may induce.

Although the notion that indirect test performance is not mediated solely by perceptual processes has been the main contention of this research, it does not exclude the idea that the effect of perceptual and conceptual processing may differ across indirect tests. In comparing the demands of the completion test with those of the perceptual identification test, the main difference seems to be one of the level of conceptual operations required. Since the completion test requires subjects to fill in the appropriate letters to form a word, it may require some problem-solving skills, and thus conceptual processing. In contrast, the perceptual identification test requires subjects to correctly identify words that are briefly presented and therefore may not require problem- solving operations.

Given this view, it can be suggested that the higher level of same context priming in Graf and Schacter's (1985) sentence generation group was obtained since the word-stem completion task may have induced conceptual processing. Thus, there might have been a greater correspondence between study and test trial processing in their sentence generation group than in their vowel comparison group.

Alternatively, the discrepancy between the pattern of priming observed in the present experiment's vowel comparison group and that of Graf and Schacter (1985) may be related to the extent to which there is a match between the

perceptual features of study and test trial stimuli. It should be noted that word stems do not provide a good match of the perceptual features that were present during the study trial since only some of the perceptual features at study are reinstated at test. Therefore, lower levels of priming across context conditions in Graf and Schacter's vowel comparison group may be due to this poorer correspondence of perceptual information. It follows then that the higher level of priming for same context items in the vowel comparison group in the present experiment may be due to a higher correspondence (relative to the word-stem completion test) of perceptual features across study and test trials.

Although differences in the processing demands of the word-stem completion and perceptual identification tests have been considered here, the data from the present experiment do not allow for specific conclusions pertaining to the nature of the processes mediating the enhanced levels of same context priming in the sentence generation and vowel comparison groups. That is, the results of the present experiment did not clearly demonstrate associative priming effects on the perceptual identification test that were restricted to the condition in which a semantic association was formed. Therefore, an alternative method of assessing the process involved in the enhanced same context priming effect in the sentence generation group is needed.

One way in which this may be accomplished would be to incorporate an elaborative non-associative encoding condition into the experimental paradigm employed here. Schacter and Graf (1986) found that priming for same context items was enhanced only when the elaborative encoding task required the formation of a semantic association between cue and target words. However, when the elaborative encoding task did not require the formation of a semantic association, the enhanced level of same context priming was not found.

Thus the inclusion of an elaborative, non-associative encoding condition into the procedure used in the present experiment may provide some insight into the processes mediating performance in the sentence generation group. Specifically, such a condition might provide a basis for evaluating the extent to which same context priming in the sentence generation group is mediated by the formation of a conceptual association between cue and target words during the study trial. Thus, if same context priming in the sentence generation group is dependent on the formation of a conceptual association, then it might be expected that same context priming in an elaborative, non-associative encoding group would be similar to priming in the different context condition. However, if same context priming in the performance of the non-associative group was similar to that of the sentence generation group, then it could be concluded

that the formation of a semantic association between cue and target words was not central to mediating enhanced levels of same context priming. Thus, this scenario would favour a purely perceptual interpretation of enhanced same context priming.

The issue of whether the formation of a semantic association is critical in mediating enhanced levels of same context priming in the sentence generation group can also be extended to the priming pattern observed in the vowel comparison condition. It is possible that the enhanced same context priming in the vowel comparison group may be related to the formation of a perceptual association between study trial cue and target words. Since the vowel comparison task requires the comparison of the perceptual features of the study trial word pairs, it seems reasonable to assume that this task establishes an association between each of the cue and target words that may be perceptually based. In consideration of the potential of perceptual identification to have a greater sensitivity to perceptual processing relative to word-stem completion, it is reasonable to suggest that priming of perceptually based associations would be more likely to be apparent in perceptual identification performance. Thus this consideration may account for the discrepancy between the priming observed in the present vowel comparison group and that reported by Graf and Schacter (1985). An interesting direction for future

research might involve the investigation of the types of associations that influence perceptual identification priming.

Although this discussion has addressed issues pertaining to the types of processes that might have mediated the higher priming found for same relative to different context items, it should be noted that since Graf and Schacter's (1985) original associative priming experiment, no other research has attempted to replicate their vowel comparison condition. Thus much of the information available on the factors that contribute to associative priming effects is based solely on the results of experiments in which an elaborative encoding condition has been employed. Had the vowel comparison condition been omitted from the present experiment, the nature of this discussion would have been heavily in favour of conceptual processes mediating the higher level of same context priming.

An additional factor that further constrains a clear interpretation of the results obtained here is the inconsistent measurement of 'different context' priming across associative priming experiments. Although Graf and Schacter's (1985) different context condition was composed of three different types of cue-target pairs, the tendency in subsequent associative priming experiments has been to use cue-target pairs comparable to the new context pairs

employed in the present experiment to measure different context priming. Thus the methods and analyses employed in the majority of associative priming experiments bear limited resemblance to those used in the present experiment.

Same, Rearranged, New and No Context Priming

Although the analysis of same versus different context pairs yielded a significant main effect of test context, the initial analysis in which the test context factor consisted of same, rearranged, new and no context pair types did not provide such a clean demonstration of the importance of reinstating study trial context. In fact, this analysis revealed quite a complex pattern of priming across context conditions and between encoding groups. It should be pointed out, however, that the interpretation of this analysis is somewhat limited since previous research has not examined each of these context conditions separately.

To summarize the results of the analysis which included the four types of test context pairs, only the effect of test context was significant. Post hoc testing revealed that although priming for same context items significantly exceeded that of rearranged and new context items, no differences were found between the levels of same and no context priming, or among rearranged, new and no context priming.

Although no differences in the level of priming among the rearranged, new and no context conditions were

predicted, the finding of no difference between same and no context priming was unexpected. One possible explanation for the high level of priming in the no context condition may be related to the attentional requirements of that condition.

In contrast to same context items, the perceptual identification of no context items may be easier since subjects are not required to read and report a word prior to the perceptual identification word. Therefore the attentional demands in this condition may be different from those of the same context condition. Since no differences were found among baseline measures across the four context conditions, it appears that this attentional advantage is specific to previously encountered items. If this enhanced priming for no context items is related to attention, then the incorporation of a distractor task prior to the perceptual identification item might have provided an appropriate means of equating attentional demands across the context conditions.

A further point to be made with respect to no context priming is that the failure to find a reliable difference between same and no context priming is largely due to a higher level of no context priming in the vowel comparison group than in the sentence generation group. Although an independent groups t-test revealed that the difference between priming in the vowel comparison and sentence

generation groups in the no context condition was not significant ($t(24)=0.97$, $p>.05$), performance in this condition significantly exceeded baseline performance in the vowel comparison group only. Thus, it seems unlikely that an attentional explanation alone could account for the pattern of priming in the no context condition. The logic here is that since a significant level of no context priming was obtained in the vowel comparison condition, but not in the sentence generation condition, there may be some relation between the type of study trial encoding and obtaining significant no context priming. Otherwise, it is unclear as to how an attentional account could describe significant priming in only one group.

As previously stated, the inconsistent use of context conditions in the associative priming literature makes it difficult to provide an adequate explanation of the factors contributing to the pattern of results obtained in the no context condition. However, there are two studies that bear on the issue of no context priming. First, Shimamura and Squire (1989) evaluated no context priming on a word-stem completion test. Although theirs was an associative priming experiment, the experimental design was substantially different from the one employed here in that a separate group of subjects was used to assess no context priming, and a perceptual encoding condition was not included. These researchers reported that priming was greater for same

context items than for different context (comparable to the new context condition in the present experiment) items. Priming on no context items fell between, and was not significantly different from, the levels of same and different context priming.

Given these findings, Shimamura and Squire (1989) suggested that providing a contextual cue word served to facilitate priming in the same context condition and inhibit priming in the different context condition. Since priming of no context items was not of central concern to their study, no explanation of the processes mediating the intermediate level of no context priming was offered. It is important to note, however, that Shimamura and Squire's results show that different methods of measuring contextual change do result in different levels of priming.

In comparing the results obtained by Shimamura and Squire (1989) with the relevant context conditions of the present experiment (same, new and no context conditions), it is interesting to note that the overall pattern of priming in the present experiment is similar to that of Shimamura and Squire. Specifically, priming in the present experiment decreased across same, no and new context conditions. However, the pattern of priming obtained from the present experiment's sentence generation group did not show the intermediate level of no context priming reported by Shimamura and Squire. On the grounds that the pattern of

priming in the present experiment's sentence generation group does not resemble that of Shimamura and Squire, it is difficult to propose a viable interpretation of the processes mediating no context perceptual identification priming.

The second study, which also bears on the results obtained in the present study's no context condition, is Jacoby's (1983a) investigation of the effects of context on perceptual identification performance. Although Jacoby's method and experimental design were quite different from those of the present experiment, it is worth noting that Jacoby's use of contextually-bound and context-free study trial words does have some relevance to the encoding manipulation used in the present experiment. Furthermore, the no context condition used in the present experiment is procedurally comparable to the perceptual identification test used by Jacoby since, in both cases, the perceptual identification trials consist of the presentation of uncued words.

Interestingly, the pattern of priming in the present experiment's no context condition is similar to Jacoby's (1983a) finding of higher perceptual identification priming for no context words than for the context condition words. In fact, the difference in the level of priming between the sentence generation and vowel comparison groups in the present experiment's no context condition (.065) is

comparable to the differences between the context and no context levels of priming reported by Jacoby (.076, .067, .072, Experiments 1, 2 and 3, respectively).

It was suggested earlier in this paper that Jacoby's (1983a) finding of lower priming for contextually-bound words may be due to the failure to reinstate study trial operations on the test trial. In comparison to the pattern of priming in the present no context condition, reinstating the study trial context (same context condition) was sufficient to raise priming to a significant level in the sentence generation group, while having little influence on the vowel comparison group's performance. T-tests, however, revealed no significant differences between same and no context priming in both the vowel comparison and sentence generation groups ($t(12)=0.35$, $p>.05$, and $t(12)=1.93$, $p>.05$, respectively). Despite the fact that the difference between same and no context priming in the sentence generation group was not reliable, it is reasonable to suggest that the general pattern of priming in the no context condition is not inconsistent with other research which has found lower levels of priming for contextually-bound study words that are not cued at test (e.g., Jacoby, 1983a; Levy & Kirsner, 1989; MacLeod, 1989).

Although the pattern of results obtained for no context items has some relevance to other priming studies, the data obtained for new context items are of particular interest

since comparable conditions in the majority of associative priming studies have provided the basis for assessing priming when there is a change between study and test trial context. Given that the overall level of priming for new context pairs was significantly lower than that of same context pairs, it is reasonable to conclude that perceptual identification priming is sensitive to manipulations of test context. In addition, the lower level of new context priming is consistent with the findings of previous investigations of associative priming on word-stem completion (e.g., Schacter & Graf, 1986; Shimamura & Squire, 1989).

One peculiar aspect of the new context data, however, is the finding that a significant level of new context priming was obtained only in the sentence generation group. Although the level of new context priming between the two encoding groups does not differ significantly ($t(24)=0.76$, $p>.05$), it is unclear as to how the provision of a new and semantically unrelated cue word would result in a nonsignificant level of priming in the vowel comparison group.

To offer a speculative explanation here would be particularly difficult since previous research has not evaluated the priming of perceptually encoded words in a condition comparable to the present new context condition. However, it might be suggested that the new context data

seem to indicate that different processes may be mediating the level of priming observed in each encoding group. The logic here is that if the same process was responsible for mediating new context priming in each of the encoding groups, then it would be expected that perceptual identification performance would either significantly exceed or not differ from baseline in both of the sentence generation and vowel comparison groups. As the data obtained in the present experiment do not provide a great deal of insight into the potential processing differences in each of the encoding groups, no definitive explanation can be offered at this point.

Finally, priming in the rearranged context condition was found to be significantly lower than that of the same context condition, and not different from the new and no context conditions. Once again, the lack of previous research which has specifically addressed priming in a comparable condition constrains the interpretation of the data obtained for rearranged pairs. Of concern here is that the lowest overall level of priming was obtained in this condition. One possible interpretation of this low level of priming may be related to the potential for the repeated presentation of a study trial cue word to provide conflicting information pertaining to the upcoming perceptual identification word. This condition, then, may induce some interference and thus result in a nonsignificant

level of priming. The pattern of priming in the rearranged context condition was such that the performance levels in each of the sentence generation and vowel comparison groups were not significantly different from baseline levels. Notably, the sentence generation group showed the lowest level of priming in the rearranged context condition than that obtained in any of the other treatments.

The finding that the level of rearranged context priming in the sentence generation group failed to reach significance is of special interest since significant priming was obtained for this group in the procedurally similar new context condition. In contrast, priming in the vowel comparison condition did not reach a significant level in either of the rearranged or new context conditions.

Although much of the low level of priming found for rearranged context items can be attributed to a change between study and test trial context, the pattern of priming in the sentence generation group is in line with an interference based interpretation. In order to gain some insight into the nature of the processes that mediated the nonsignificant levels of priming in the rearranged context condition, the types of errors made on these test trial pairs were examined.

It was speculated that if the formation of a semantic association was responsible for the enhanced level of priming for same context items in the sentence generation

group, then there may be a bias to provide the original study trial target word as a perceptual identification response in the rearranged context condition. Conversely, if in the vowel comparison group the same context priming is mediated by perceptual processing, then the likelihood of responding to a rearranged context cue with its study trial target word would be lower since a semantic association was not made.

The pattern of errors made on rearranged context pairs confirmed this notion. It was found that approximately 23 per cent of the errors made on rearranged context pairs in the sentence generation group were ones in which a study trial target word was given as the perceptual identification response. Of these responses, 18 per cent were the original study trial target word that had been paired with the test trial cue word. The remaining 5 per cent were other study trial target words. In the vowel comparison condition, only 2 per cent of the errors made on rearranged context items were inappropriate study trial target words. Not one of the corresponding study trial target words was given as a response in this condition.

Since subjects in the sentence generation group tended to provide original study trial target words as responses on rearranged context pairs, it follows that the enhanced level of same context priming in this group may also be mediated by such a bias. As this bias was not present in the errors

made on rearranged context items in the vowel comparison group, it is therefore possible that this bias has resulted from conceptual operations, thus indicating that priming in the sentence generation group may be mediated by the formation of a semantic association between study trial cue and target words.

Although this bias accounted for 18 percent of the errors in the rearranged context condition, the magnitude of this bias may in fact be understated. Since, typically, the identification item presented at test was not physically similar to the studied member of the pair from which the cue came, then any perceptual information the subject picks up from the perceptual identification item may constrain their use of studied items in the rearranged context condition. In the same context condition, however, this constraint may not be present. Therefore, the magnitude of this bias effect may be greater for same context pairs.

It is of interest to note that evidence of a bias to report study trial target words in the rearranged context condition may be related to the bias interpretation of perceptual identification priming offered by Ratcliff et al. (1989). If the bias reported here exemplifies the Ratcliff et al. interpretation, then it would be expected that the occurrence of this bias should be stable across blocks of trials. Such stability, however, was not characteristic of the error bias reported here. Specifically, this bias

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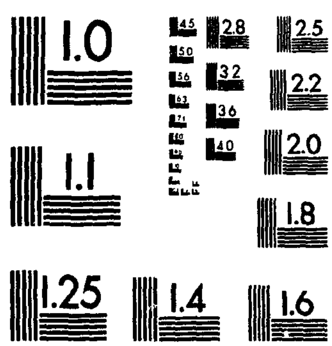

MICROCOPY RESOLUTION TEST CHART
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STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No 2)

accounted for 11 percent of the rearranged context errors in the first three blocks of trials. In the last seven blocks of trials, 20 percent of the rearranged context errors were ones in which the original study trial target word was given as the response. This discrepancy suggests that the bias to report study trial target words may be related to the development of a response strategy during the course of the test phase. However, the fact that 10 percent of the bias errors in the last seven blocks of trials were contributed by a single subject constrains concluding that the development of a response strategy was characteristic of all subjects.

Whereas it appears that there may be a conceptual-associative component mediating priming in the sentence generation group, a more objective method is needed to validate such an interpretation. Once again, the addition of an elaborative, non-associative encoding condition might have been successful in confirming that the rearranged context response bias was due to the formation of a semantic association between cue and target words. An additional consideration with respect to the types of errors made on rearranged context items, is related to the possibility that the observed bias in the sentence generation group may be specific to test context being a within subjects factor. Due to the design of the present experiment, the potential of exposure to same context items to influence performance

on rearranged context items cannot be determined. Thus, the manipulation of test context as a between subjects factor might allow for a stronger statement to be made concerning the apparent associative nature of the errors made on rearranged context pairs.

In summary, the complex pattern of priming across rearranged, new and no context pairs is suggestive of different processes mediating priming in each of the sentence generation and vowel comparison groups. It follows then that the enhanced priming observed in the same context condition may also be influenced by different processes induced by the two encoding conditions. Although the extent to which these processes are conceptually or perceptually based cannot be determined from the present data, the finding of a bias to report study trial target words only in the sentence generation group does suggest that the formation of a semantic association between study trial cue and target words was the critical factor mediating this group's enhanced level of same context priming.

Unlike the analysis involving same and different context pairs which showed a clean demonstration of the facilitating effect of reinstating study trial context on perceptual identification priming, the analysis of same, rearranged, new and no context pairs did not clearly support the notion that priming benefits to the extent to which there is a correspondence between study and test trial

operations. The problem here is that the overall level of priming for same context items was not different from that of no context items. It should be noted, however, that the use of a no context condition in the present experiment may not have been appropriate. Specifically, the fact that the procedure used in the no context condition differs from that of the other context conditions does not meet the objective to assess the effects of contextual change on priming while maintaining procedural consistency across study and test trials.

Aside from the problems associated with the no context condition, the results of the present experiment are very provocative in that reinstating study trial context served to enhance priming on the perceptual identification test. Perhaps the most intriguing aspect of the outcome of this experiment is that presenting study trial cue words at test facilitated the perceptual identification of words that were conceptually processed during the initial encoding episode. This finding is incompatible with the notion that indirect tests, especially perceptual identification, are entirely data-driven.

Although the higher level of same context priming in each of the encoding conditions may be due to the reinstatement of study trial perceptual features, the results of previous research in which priming of contextually-bound words was found to be lower than that of

context-free words (e.g., Jacoby, 1983a; Levy & Kirsner, 1989; MacLeod, 1989) seems to produce problems in accepting such an interpretation. Instead, the results of the present experiment fit well with the notion that priming benefits to the extent to which there is a correspondence between study and test trial operations.

With respect to the associative priming literature, the general pattern of results obtained in the present experiment is largely consistent with that obtained elsewhere. However, the finding that priming of perceptually encoded items also benefitted from the reinstatement of study trial cue words was unexpected since Graf and Schacter (1985) reported no differences across context conditions in their perceptual encoding group. Given Schacter and Graf's (1986) conclusion that associative priming effects are dependent on the formation of a semantic association between cue and target words, there has been some reluctance to conclude that associative priming effects were obtained in the present experiment since no differences were found between the two encoding groups.

However, if the view is adopted that associative priming effects are given by a specific pattern of data, namely higher same than different context priming, then it is quite reasonable to conclude that the results of the present experiment clearly demonstrate associative priming effects in perceptual identification performance. In

addition, by adopting such a view, the association mediating enhanced same context priming would not necessarily have to be conceptual in nature. In this respect, enhanced same context priming may result from th formation of either conceptual or perceptual associations between study trial cue and target words.

Awareness

The overall pattern of priming with respect to test awareness was such that the difference between same and different context priming tended to be larger as the level of awareness increased. Although this pattern tended to be characteristic of both encoding conditions, the difference between same and different context priming in the vowel comparison group only approached significance for high awareness subjects. However, in the sentence generation group, the relation between enhanced same context priming and level of test awareness matched the results obtained by Bowers and Schacter (1990). Thus, in this group, same context priming was significantly higher than different context priming only for the high awareness subjects.

While the awareness results of the present experiment are in accordance with those of Bowers and Schacter (1990), several factors warrant caution in drawing conclusions based on the data presented here. First, almost all subjects in the present experiment were classified as test aware according to Bowers and Schacter's classification procedure.

Second, a method of awareness classification that is different from that of Bowers and Schacter's was used to resolve the above problem. Third, when the method of classification was adjusted, there was an unbalanced number of subjects classified as having high and low awareness in each of the encoding groups. Finally, the cutoff points varied by encoding condition.

In addressing the fact that all but one subject was classified as test aware given Bowers and Schacter's (1990) criteria, it should be noted that in the present experiment, approximately 33 per cent of the test trial words had also been presented on the study trial. In Bowers and Schacter's study, only 15 per cent of test trial words had been presented on the study trial. This difference in the proportion of test trial target words between the two experiments suggests that there might have been a greater opportunity to gain awareness in the present experiment. Although an attempt was made to modify the awareness classification of Bowers and Schacter (1990), the additional fact that the number of subjects in each of the high and low awareness groups was unequal and often quite small justifies exercising restraint in attributing any theoretical importance to the results obtained from the awareness questionnaire here.

Concluding Comments

The key finding of the present experiment is that

priming on the perceptual identification test is dependent on the extent to which there is an overlap between the initial encoding and test trials. Although a clear demonstration of associative priming effects, as defined by Graf and Schacter (1985), on the perceptual identification test was not obtained, it is important to note that the data presented here do not necessarily deny the existence of conceptual processing effects. The finding of enhanced same context priming in the sentence generation and vowel comparison groups is entirely consistent with the notion that priming will benefit to the extent to which there is a correspondence between study and test trial processing. However, the fact that priming in these two groups did not differ raises some concern in accepting the conclusion that different processes mediated the level of priming in each of these two conditions.

It has been recommended that the addition of an elaborative, non-associative encoding condition may provide the basis necessary for confirming the nature of the processes mediating performance in each of the two encoding groups. Furthermore, this discussion addressed the issue of the inconsistency in which test context has been measured in associative priming experiments. In this respect, there needs to be a standard by which test context conditions are measured in order to facilitate the comparison of experimental results. In addition, future research should

address the stability of the pattern of priming found in Graf and Schacter's (1985) vowel comparison condition. As performance in this encoding condition is critical to drawing conclusions pertaining to conceptually based associative priming effects, it is imperative that this condition is not omitted from any associative priming experiment.

Although there are some limitations in the extent to which it can be concluded that conceptual processing effects were obtained on this perceptual identification test, the data presented here are especially provocative. Clearly, evidence of the context-dependent nature of perceptual identification priming warrants a departure from the traditional view that perceptual identification priming is mediated solely by perceptual processes.

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Table 1
Baseline Probabilities as a Function of Encoding and Test Context Conditions

Test Context	Encoding Condition: Sentence Generation mean (s.d.)	Encoding Condition: Vowel Comparison mean (s.d.)	Encoding Condition: Combined mean (s.d.)
Same	.538 (.202)	.577 (.231)	.558 (.214)
Rearranged	.431 (.214)	.485 (.270)	.458 (.240)
New	.438 (.214)	.569 (.202)	.504 (.214)
No	.492 (.260)	.592 (.293)	.542 (.276)

Table 2
Priming Scores (Target - Baseline) as a Function of Encoding and Test Context Conditions

Test Context	Encoding Condition: Sentence Generation mean (s.d.)	Encoding Condition: Vowel Comparison mean (s.d.)	Encoding Condition: Combined mean (s.d.)
Same	.210 (.097)	.198 (.131)	.204 (.113)
Rearranged	.079 (.145)	.113 (.127)	.096 (.135)
New	.140 (.174)	.083 (.211)	.112 (.192)
No	.110 (.163)	.175 (.179)	.142 (.171)

Table 3
Priming Scores (Target - Baseline) as a Function of Encoding and Test Context Conditions

Test Context	Encoding Condition		
	Sentence Generation	Vowel Comparison	Combined
	mean (s.d.)	mean (s.d.)	mean (s.d.)
Same	.210 (.097)	.198 (.131)	.204 (.113)
Different	.110 (.100)	.124 (.112)	.117 (.104)

Figure 1. Practice and Study Phase Procedures.

Practice Phase

stimuli = 3 cue-target pairs

Trial Procedure

a) experimenter initiates trial
b) presentation of word pair
-centre of screen
-duration = 4 seconds

CUE TARGET

c) subject responds (vowel comparison or sentence generation)
d) experimenter initiates next trial

Study Phase

stimuli = 40 cue-target pairs from one of two lists

Trial Procedure

a) experimenter initiates trial
b) experimenter selects one list of pairs to be presented in this phase
c) presentation of pair
-centre of screen
-duration = 4 seconds

CUE TARGET

d) subject responds (vowel comparison or sentence generation)
e) experimenter initiates next trial

Figure 2. Perceptual Identification Duration Setting.

stimuli = 50 single words

Procedure - one block of ten words

a) word and delay duration times are set at approximately 16 ms each

b) location cue
-centre of screen
-10 characters in length
-duration = 250 ms

---

c) stimulus word
-centre of screen
-presented following location cue offset
-duration = as given in a) above

d) delay interval
-screen is blank
-duration = as given in a)

e) pattern mask
-covers area in which stimulus word appeared
-duration = 6 sec.

f) inter-trial interval
-duration = 20 ms
-screen is blank

g) parts b) - f) are repeated for the remaining nine words in the block of trials

-following the completion of one block of ten trials, word and delay durations (part a above) are raised or lowered (in units of 16 ms) and the next block of trials is initiated

Figure 3. Test Phase Procedure.

stimuli = 120 word pairs
- cue and target words presented separately

Procedure

a) word and delay interval durations are set (in 16 ms units)

b) location cue (for cue word from given pair)
- -centre of screen
- -10 characters in length
- -duration = 250 ms

---

c) cue word
- -centre of screen
- -duration = 1 second

d) delay interval
- -screen is blank
- -duration = 500 ms

e) location cue (for target word from given pair)
- -centre of screen
- -10 characters in length
- -duration = 250 ms

---

f) target word
- -centre of screen
- -duration - given in a) above

g) delay interval
- -screen is blank
- -duration - given in a) above

h) pattern mask
- -as in Phase 3 section e)

i) inter-trial interval
- -screen is blank
- -duration = 20 ms

repeat b)-i) for each of the 120 pairs.

Appendix A
Study Phase List A

Cue and Target Words
With Francis and Kucera (1982) Frequencies

Cue	Frequency (occurrences per million)	Target	Frequency (occurrences per million)
PLASTIC	23	LICENCE	35
AXIS	34	CORK	09
TABOO	02	IVORY	13
LEGION	02	DEVICE	35
MEADOW	12	KERNEL	03
HARVEST	08	NETWORK	30
CABINET	12	PRIZE	18
ERASER	02	EXPERT	19
TOURIST	15	PIPE	20
BACON	08	TISSUE	41
ABILITY	74	SHOCK	28
PEPPER	12	VEHICLE	33
ADULT	24	CYLINDER	18
ARMY	56	MANIAC	04
YACHT	01	HANGER	01
WRENCH	01	TEMPER	12
CELERY	04	ADVICE	50
WAGON	52	BRIDE	32
VAULT	02	ROUTINE	18
COMB	06	ZIPPER	01
ROMANCE	13	DISCOUNT	08
MIXTURE	30	RHYTHM	21
DINNER	91	WEALTH	20
GENERAL	20	PARADE	23
PIGMENT	09	WARNING	16
OBJECT	53	MAGNET	03
LABEL	17	BARREL	23
FILTER	41	CANDY	15
DIAMOND	08	BANNER	06
BASKET	15	COUNCIL	28
GLUE	07	STEREO	11
SPLINTER	03	VACUUM	20
PRODUCT	80	ESTATE	48
WITNESS	18	ACADEMY	06
CUSTOM	10	FEATURE	29
ALGEBRA	02	SCHEDULE	34
VIRTUE	30	DONATION	02
KETTLE	03	GREASE	09
LIQUOR	42	PRISON	41
DELIGHT	27	DANGER	68
mean frequency=21.725		mean frequency=21.275	
mean word length=6.025 letters		mean word length=6.175 letters	

Appendix B
Study Phase List B

Cue and Target Words
With Francis and Kucera (1982) Frequencies

Cue	Frequency (occurrences per million)	Target	Frequency (occurrences per million)
PENCIL	34	RITUAL	23
DECADE	46	TREE	56
WAVES	51	ROPE	15
APOLOGY	02	ACCIDENT	33
LODGE	09	ICICLE	01
NEEDLE	15	COMFORT	41
VITAMIN	05	KETCHUP	01
PYRAMID	01	RING	34
SILENCE	49	ROBOT	01
MAJORITY	57	EQUATION	33
VIOLENCE	44	OPPOSITE	07
FEAST	03	SPORT	17
NEPHEW	09	ANCHOR	15
HYPNOSIS	03	FLUID	18
JOURNEY	24	LANDLORD	12
PANEL	31	WHEEL	52
PENNANT	09	RUST	07
DUST	65	TEXTILE	24
DECIMAL	03	HAZARD	10
BARGAIN	07	MOTIVE	21
BOOTH	04	CANDLE	16
THESIS	09	POISON	09
SADDLE	22	SOUP	21
STEAM	16	AVERAGE	61
FILM	91	CANCER	20
GASKET	04	PASTURE	10
MONSTER	05	WIDTH	14
BEAUTY	68	SUCCESS	91
SAIL	04	ANGEL	09
CAPITAL	78	SHADOW	27
COMIC	02	OBESITY	04
RAZOR	15	GARBAGE	07
BANDAGE	04	TAPESTRY	05
BATTERY	16	GUEST	35
JARGON	04	LECTURE	13
ENTRANCE	57	BARN	29
TUNNEL	09	STATUE	16
HOOK	03	WHISTLE	03
RAMP	06	CEMENT	09
FEMALE	30	OXYGEN	43
mean frequency=22.850		mean frequency=21.575	
mean word length=6.050 letters		mean word length=6.025 letters	

Appendix C
Study Phase Practice List

Cue and Target Words
With Francis and Kucera (1982) Frequencies

Cue	Frequency (occurrences per million)	Target	Frequency (occurrences per million)
RUBBER	13	JOKE	19
BRIDGE	79	DRAFT	15
LUMBER	30	EROSION	06
mean frequency=40.670		mean frequency=13.330	
mean word length=6.00 letters		mean word length=5.33 letters	

Appendix D
Novel Words for Different Context Pairs

With Francis and Kucera (1982) Frequencies

Word	Frequency (occurrences per million)
MARBLE	18
BUDGET	53
CLOCK	19
VINEGAR	08
INFANT	10
CODE	22
TENSION	55
JUICE	11
FANTASY	12
PEASANT	07
BEEF	26
ADDRESS	68
FAILURE	87
NATIVE	10
ACCENT	09
WILDLIFE	18
RECIPE	08
HIGHWAY	32
OBSTACLE	10
LACE	07

mean frequency=24.500
mean word length=6.150 letters

Appendix E
Test Phase Filler Pairs

With Francis and Kucera (1982) Frequencies

Cue	Frequency (occurrences per million)	Target	Frequency (occurrences per million)
MAID	27	BEHAVIOR	95
ABSENCE	53	KNIGHT	07
TERRACE	07	BORDER	14
ONSET	15	LATEX	02
ECHO	06	SECOND	27
TURRET	03	YARD	03
ALIEN	02	NUCLEUS	11
BOWL	20	DAIRY	16
PATROL	18	SUBURB	13
SOLUTION	56	DISORDER	07
PICNIC	15	RESIDENT	08
OPERA	28	COMPUTER	13
TIMER	01	NOISE	35
TEAM	81	SEGMENT	10
RIDGE	12	PERFUME	10
DEADLINE	06	MATCH	15
BACTERIA	08	GANG	20
CHAIN	46	EPISODE	12
BACHELOR	04	OCTOPUS	01
MANNERS	14	TOWEL	06
FUSE	03	DIGNITY	35
MEDICINE	25	PAYROLL	16
TOKEN	04	SEDAN	02
SALOON	10	PATIENCE	20
SKYLINE	01	FRAME	69
BUBBLE	12	INTERVAL	18
FOAM	36	UTILITY	28
GUARDIAN	02	ENVELOPE	21
ENEMY	88	WIRING	02
STATION	92	BRUSH	29
MODEL	57	FUNERAL	26
HARMONY	22	GYPSY	04
WEDGE	04	SIGN	73
AMATEUR	15	SARCASM	01
NUGGET	01	BATTLE	75
LOTION	08	GRADUATE	21
ASSET	05	ERROR	34
VETERAN	19	FIBER	25
AFFAIR	33	ORNAMENT	04
IDENTITY	55	BENCH	27
mean frequency=22.850		mean frequency=21.375	
mean word length=5.975 letters		mean word length=6.325 letters	

Appendix F
Perceptual Identification Setup Words

With Francis and Kucera (1982) Frequencies

Word	Frequency (occurrences per per million)	Word	Frequency (occurrences per million)
BLANKET	29	DIET	20
FEVER	19	BINDER	01
ELEMENT	52	BAIT	01
TAXATION	10	FLAG	15
COMMENT	35	VICTIM	27
PUMP	08	ALARM	14
SWING	08	HUMAN	36
FABRIC	15	AGENT	44
GOSSIP	13	VISION	55
PLUG	21	PUZZLE	06
OPTION	05	FENCE	30
MORTAR	10	MENACE	09
MUSEUM	16	DIVORCE	23
ZONE	10	UNIVERSE	63
PLASTER	23	MARATHON	01
FRENZY	01	RATTLE	05
HARNESS	10	FAME	17
JUNCTION	04	LEASE	55
USHER	01	FAVOUR	55
ELEVATOR	12	CRIME	32
ECONOMY	78	SURPRISE	44
DARKNESS	43	SHAME	20
SAMPLE	54	SCANDAL	05
LOCUST	06	ENERGY	94
UNION	78	FATIGUE	11

mean frequency=24.880
mean word length=5.96 letters

Appendix G
ANOVA Summary Table 1

Baseline Probability
Encoding Condition X Context (same, rearranged, new, no)

SOURCE	df	MS	F	Sig of F
Encoding Condition	1	.17	1.18	.288
Error	24	.14		
Context	3	.05	1.87	.142
Encoding Condition X Context	3	.01	0.420	.738
Error	72	.03		

Appendix H
ANOVA Summary Table 2

Priming
Encoding Condition X Context (same, rearranged, new, no)

Source	df	MS	F	Sig of F
Encoding Condition	1	.00	.04	.838
Error	24	.04		
Context	3	.06	2.83	.044
Encoding Condition X Context	3	.02	0.90	.444
Error	72	.02		

Appendix I
ANOVA Summary Table 3

Priming
Encoding Condition X Context (same, different)

Source	df	MS	F	Sig of F
Encoding Condition	1	.00	0.00	.972
Error	24	.02		
Context	1	.10	13.16	.001
Encoding Condition X Context	1	.00	0.28	.599
Error	24	.01		