Implicit memory for new associations: An interactive process approach.

by

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ABSTRACT

Three experiments that examined the role of data driven and conceptually driven processes in implicit memory for new associations found that associative priming reflected episodic memory for the procedures that were used to interpret an item's visual pattern at study. Cue-target pairs were studied and the proportion of targets that were produced on a word stem completion task was higher when the stem was completed in the context of the original cue word than when the stem was paired with a cue that had been associated with different target at study. This context effect emerged following both semantic relational processing and a non-semantic copying task suggesting a role for integral processing in associative priming. Data driven processing did not contribute independently to associative priming as a context effect failed to emerge when the cue words were orthographically similar to the study cue. In addition, when the visual pattern was held constant at study and test, a context effect emerged as more targets were produced as completions when the original interpretation of the cue's visual pattern was reinstated at test than when the interpretation was altered. In all three experiments, word stem completion performance was optimally facilitated when both the context word's visual pattern and the conceptual interpretation of the pattern were reinstated at test, thus suggesting that associative priming was contingent upon reprocessing the interaction of the data driven and conceptually driven operations that were applied at study.

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In recent years, considerable attention has been focused on work comparing explicit and implicit measures of memory (for a review, see Richardson-Klavehn & Bjork, 1988; Schacter, 1987). Explicit memory tests refer to the more traditional tasks, such as recognition and recall, that require the individual to consciously recollect a prior encoding episode. In contrast, implicit tests do not require the subject to deliberately retrieve information from memory. Instead, awareness is focused on the completion of a task, and memory for information acquired during the experimental session is expressed as a facilitation in task performance for the studied items in comparison to new items. This facilitation is known as a repetition or direct priming effect.

Interest in implicit tests has been sparked by the finding that performance on these measures is often independent or dissociated from explicit memory. For example, the neuropsychological literature has documented cases where individuals afflicted with organic amnesia performed as well as normal memory individuals on implicit memory tasks, in spite of severe impairments of recall and recognition memory (for a review, see Shimamura, 1986). Studies using normal populations have also found that many implicit and explicit memory tests dissociate experimentally. For example, while recall and recognition memory usually benefit more from deep semantic elaboration than from shallow non-semantic processing, the magnitude of priming on some implicit tests has not been differentially affected by levels of processing manipulations (Carroll, Byrne, & Kirsner, 1982; Graf and Mandler, 1984; Graf, Mandler, & Hayden, 1982; Hashtroudi, Ferguson, Rappold, & Crosniak, 1988; Kirsner, Milech, & Standen, 1983). In contrast, repetition priming effects have been eliminated or attenuated by changes at retrieval in an item's encoding modality (Bassili, Smith, & MacLeod, 1989; Roediger & Blaxton, 1987a), typecase (Masson, 1986), and representational format (Weldon & Roediger, 1987). The impairments that result from changes in an item's surface information at study and test, however, are less severe for recognition memory (Kirsner & Dunn, 1985).

Over the years, several theories have been advanced in order to account for the dissociations between implict and explicit memory. In turn, each of these theories have offered a different conceptualization of how memory is organized. Some work has used the dissociations as evidence for the functionalist view that memory reflects the fluent reprocessing of the operations that were applied to a stimulus at study. For example, Jacoby (1983) and others (Blaxton, 1989; Nelson, Keelean, & Neagro, 1989; Roediger & Blaxton,1987a, 1987b; Weldon, Roediger & Challis, 1988, Weldon & Roediger, 1987) have adopted a transfer appropriate processing view (Morris, Bransford, & Franks, 1977) that maintains that priming reflects episodic memory for the match between the processing operations carried out at study and at test. From this framework, many of the explicit memory tests are viewed as being primarily conceptually driven, and therefore, are influenced more by semantic elaboration than by a non-semantic study task. Many of the implicit tests are considered to be primarily data driven, relying on the recapitulation of the sensory/perceptual processes carried out at study (Nelson et al., 1989; Weldon et al., 1988). As such, these tests would be sensitive to changes in an item's surface structure between study and test. The processing view does not dichotomize all implicit tests as being data driven and all explicit tests as conceptually driven, but it does maintain that retrieval tests can be ordered on a continuum such that they are either mediated primarily by data driven processes or primarily by conceptually driven processes (e.g. Blaxton, 1989).

In contrast, others have used the dissociations as support for the structuralist view that memory reflects the retrieval of a memorial representation. For example, proponents of an activation view (Graf & Mandler, 1984; Graf, Squire, & Mandler, 1984; Warrington & Weiskrantz, 1982) argue that implicit memory reflects the automatic activation of the study list item's unitized representation. These pre-existing structures have been termed unitized representations (Hayes-Roth, 1977) because they are thought to consist of discrete,

integrated units that are retrieved in an all or none fashion. Retrieval of this sort is known as redintegration. The finding that amnesics demonstrate priming of familiar words, but fail to show priming of nonwords that do not have unitized representations, has been used to support this view (Cermak, Talbot, Chandler, & Wolbarst, 1985; Diamond & Rozin, 1984).

A phenomenon that has been difficult to conceptualize from either the transfer appropriate processing view or from the activation view is implicit memory for new associations (Graf & Schacter, 1985; Graf & Schacter, 1987; Graf & Schacter, 1989; Schacter & Graf, 1986; Schacter & Graf, 1989; Schacter & McGlynn, 1989). Here, unrelated cue-target pairs (e.g. MOTHER-WINDOW) were studied, and then at test the first three letters of the target were either presented with the word with which it had originally been paired at study (e.g. MOTHER-WIN_____) or with a different word. Subjects were instructed to either recall the study list word that fit the stem (letter-cued recall) or to fill in the stem with the first word that came to mind (word stem completion). Associative memory was demonstrated on both tasks, in that the proportion of previously studied items used to complete a fragment was higher when the target stem was presented in the context of the word it had originally been paired with at study. The term "context sensitive priming" is used to refer to associative memory effects observed on an implicit measure.

The work on implicit memory for new associations conducted to date, has found that context sensitive priming is contingent upon semantic relational processing at study (Graf & Schacter, 1985; Schacter & Graf, 1986; Schacter & McGlynn, 1989). In this way, letter-cued recall and word stem completion are similarly affected by an experimental variable. For both tasks, performance in the same context condition reliably differed from the different context condition when subjects processed a meaningful association between

the word pairs, but not when the encoding task emphasized the individual meaning of the words (e.g. pleasantness rating), or when a nonelaborative vowel comparison task was used (Graf & Schacter, 1985). However, unlike explicit memory, implicit memory for the new associations is not influenced by the type of elaborative processing. Schacter and Graf (1986) found that while letter-cued recall benefitted from having subjects generate, as opposed to read, a meaningful association between the word pairs, context sensitive priming was not differentially affected by the generation task. In addition, although implicit memory for new associations has been found to be contingent upon semantic relational processing, it is also modality specific. Schacter & Graf (1989) found that performance on a visual word stem completion task was higher in the same than in the different context condition when the words were visually presented at study, but not when initial exposure to the items was in the auditory modality. In contrast, a change in modality did not eliminate the associative memory effect on the letter-cued recall test.

Implicit memory for newly established associations is problematic for the activation view because priming cannot be mediated by the activation of a pre-existing representation (see Richardson-Klavehn & Bjork, 1987). At the same time, this phenomenon is problematic for the transfer appropriate processing framework. Proponents of this view (Roediger & Blaxton, 1987b) have suggested that tasks considered to be primarily data driven may also have a conceptual component, and that by placing a word fragment in the context of another word at test, the test cue may become a conceptually driven one. Although this claim may account for the elaboration dependent nature of context sensitive priming, it cannot account for the modality specificity of the phenomenon because the context effect should not have been eliminated by changes in surface information if the task were primarily conceptually driven.

Schacter, and his associates (Graf & Schacter, 1989; Schacter & McGlynn, 1989) share with the activation view the idea that implicit memory is mediated by the redintegration of a unitized representation. In the case of familiar words, a unitized representation is established via the automatic activation of pre-existing representations. In the case of unrelated word pairs, the two separate units are integrated into a single unit via semantic relational processing. The resulting unitized representation can be thought of as a single interpretation of the two words, or as associative information that relates the two words together. Implicit memory for new associations reflects the redintegration of this unitized representation. The modality specificity of context sensitive priming is claimed to be due to sensory/perceptual information being encoded in conjunction with the storage of the joint meaning of the word pairs (Graf & Schacter, 1989). By definition, redintegration requires that all the processes encoded at study be recapitulated at test. As such, if the sensory/perceptual analysis conducted at study is not repeated at test, then the semantic association cannot be accessed. Graf and Schacter's interpretation accommodates the transfer appropriate processing view, in the sense that redintegration requires that the processes used to establish the unitized representation be re-enacted at test (e.g. Schacter, Cooper, & Delany, 1990). At the same time, their view also maintains that activation has a role in mediating implicit memory, as priming involves activating a unitized representation consisting of either a single word or a pair of words bonded by semantic relational processing.

Graf and Schacter's (1989) conceptualization of context sensitive priming is able to account for the finding that the phenomenon is both elaboration dependent and modality specific - a finding that the transfer appropriate processing framework cannot reconcile. The present study, however, examines whether implicit memory for new associations could best be conceptualized from a procedural view of memory (Kolers, 1979; Kolers &

Roediger, 1984). Kolers argued that memory should not be conceptualized as the retrieval of a product established via the analytical encoding activities carried out at study, but rather as the retrieval of the actual collection of procedures or operations that were applied during the original interaction with the stimulus. In this framework, no distinction between data driven and conceptually driven processes is made. Instead, processing is viewed as the entire collection of operations applied during the original encounter with the stimulus, and memory is expressed through the fluent re-enactment of the procedures at test.

A procedural memory interpretation of implicit memory has been advanced in Masson's (1989; Masson & Freedman, 1990) component process framework. Much like Kolers' conceptualization, implicit memory is characterized as recruiting the entire collection of processes carried out at study from episodic memory. In contrast to the transfer appropriate processing view, the component process view does not characterize implicit memory tests as being primarily data driven or primarily conceptually driven. Instead, processing is viewed as an interaction of the two processes, where a conceptual interpretation is recruited from a visual pattern at study. Fluent reprocessing is a function of retrieving the collection of procedures that were originally involved in interpreting the visual pattern.

In this study, it is hypothesized that implicit memory for new associations is mediated by the fluent reapplication of a conceptual interpretation of the word pair's visual pattern. The purpose of Experiment 1 is to examine whether context sensitive priming can be observed following a nonelaborative study task as encoding operations play different roles in the component process and the unitization/redintegration framework. Schacter and Graf (1989), claim that context sensitive priming reflects modality specific access to the associative information that was encoded at study via semantic relational processing. If context sensitive priming reflects access to semantic associative information, then priming

should not be observed following processing that does not elaborate the joint interpretation of the word pairs (Graf & Schacter, 1989; Schacter & Graf, 1989). The component process view, however, does not characterize memory as successfully accessing the products of the study operations, but rather as reflecting the fluent reapplication of the entire collection of operations applied at study. As such, context sensitive priming should be observed when the collection of processes originally used to relate the word pairs are reapplied at test, regardless of whether processing elaborated a semantic association.

In addition, in the present study it is thought that the role that transfer appropriate processing plays in context sensitive priming is different from that described by Schacter and Graf (1989). These researchers claim that access to conceptual information is contingent upon establishing visual components that are "by-products of perceptual processing" (p.11); data driven and conceptually driven processes are characterized as independent processes that operate upon different aspects of the stimulus at encoding, and upon different components of the representation at test. For example, conceptually driven processes encode associative information, and a visual component is established as a result of data driven processes operating upon the stimuli's sensory/perceptual pattern at encoding. In the present study, it is thought that context sensitive priming reflects memory for the data driven and the conceptually driven processes applied at study. However, data driven and conceptually driven processes are not independently applied to different aspects of the stimulus at encoding. Instead, processing consists of conceptual operations analyzing the item's perceptual pattern. This processing results in the recruitment of a semantic interpretation of the visual information, and memory reflects the re-enactment of the procedures that originally recruited the conceptual interpretation from the visual pattern at study. Thus, reinstating only the visual analysis carried out at study will not result in

context sensitive priming because processing actually consisted of an interaction of data driven and conceptually driven processes.

Experiments 2 and 3 were designed in order to examine the modality specific nature of implicit memory for new associations. The purpose of Experiment 2 was to investigate the possibility that performance on the word stem completion task was mediated by memory for the perceptual processes applied to a word pair's visual pattern alone. In Experiment 3, it is suggested that context sensitive priming is modality specific because priming reflects memory for the conceptual interpretation that was recruited from the visual pattern of study. As such, this study attempts to extend the transfer appropriate processing view to consider the possibility that for at least word stem completion, priming is not mediated primarily by data driven processes or primarily by conceptually driven processes, but rather may involve an interaction of the two types of processes.

Experiment 1a

The purpose of Experiments 1a and 1b was to determine whether implicit memory for new associations is contingent upon semantic relational processing. The associative memory work conducted to date has used encoding tasks that could be classified as either integral or nonintegral processing tasks. Nonintegral processing tasks encourage the subject to learn about individual elements rather than the relationship between the elements. An example would be the pleasantness rating task used by Schacter and Graf (1986) in which each of the words in each pair were treated separately - a judgment was made for one word followed by a separate judgment for the other word (also see, Smith, MacLeod, Bain, & Hoppe, 1989). Conversely, integral processing tasks encourage holistic processing by requiring an item's components to be simultaneously processed in relation to one another. An example would include semantic processing that relates the meaning of two words together (e.g. Smith et al., 1989).

The finding that a context effect occurs only following semantic relational processing does not necessarily mean that priming is mediated by the retrieval of semantic associative information. Rather, it may be the case that the procedures applied during encoding operated on the word pair as an integral unit. Therefore, unless the original unit is reinstated at test, the collection of procedures originally applied at study cannot be optimally reapplied at test and reprocessing fluency will be diminished. In this way, Graf and Schacter's (1985) failure to observe context sensitive priming following nonelaborative encoding may be attributed to their use of a vowel comparison task, rather than to a failure to elaborate a semantic association. That is, comparison tasks generally require that attention be focused on the individual elements of an item rather than treating the elements in relation to one another (Whittlesea, 1987; Whittlesea & Cantwell, 1987). If the vowel comparison task did not cause the subjects to process the letters in the word as a unit, let alone integrate the words in the pair together, then the original study procedures applied to a component could be reapplied regardless of whether that component was re-presented with its original context word. Thus, completion performance would not differ for the same and different context conditions (e.g. Schacter & Graf, 1986, Exp. 4)

Experiment 1 examined whether context sensitive priming would be observed following an integral non-semantic processing task where the word pair was copied consecutively. The copying task was chosen as the integral processing task because previous work (Whittlesea and Brooks, 1988) found that copying an entire phrase invited the integral processing of the words in the phrase. The copying task used in Experiment 1 is similar to the one used by Whittlesea and Brooks with the exception that only two words, as opposed to a longer string of words, were copied in succession. The processing of components in succession seems to be a key in integrating components nonsemantically. For example, Smith et al. (1989) encouraged the nonsemantic integral processing of word pairs by

having subjects repeat aloud the two words consecutively. Although it is possible that semantic information about each of the words may be extracted as the person copies the word pair, this task does not encourage the elaboration of semantic information that relates the words together.

In addition, Experiments 1a and 1b further examined the role of data driven and conceptually driven processes in context sensitive priming. According to the transfer appropriate processing view retrieval tasks are either primarily data driven or primarily conceptually driven. Consequently, context sensitive priming would either reflect the recruitment of only the data driven operations or the conceptually driven operations that were applied at study. Although past work has suggested that context effects are contingent upon semantic relational processing (Graf & Schacter, 1985; Schacter & Graf, 1986), it may be the case that implicit memory for new associations reflects memory for the integral processing of the word pairs' visual pattern. For example, Whittlesea and Cantwell (1987) reported that when subjects learned to associate a meaning to a pseudoword, perceptual identification performance was more accurate than when a letter comparison task was used. They claimed that semantic processing incidentally involved the greater perceptual integration of the elements, because processing for meaning required the subjects to attend to the stimulus structure as a whole.

The issue of whether implicit memory for new associations reflects memory for the integral processing of sensory/perceptual information was examined by including test contexts that consisted of cues that were orthographically or semantically similar to the study cues, and cues that were both conceptually and perceptually different from the study cues. If implicit memory for new associations reflects the reprocessing of visual information, then completion performance in the orthographically similar context condition should significantly differ from the different context conditions because the pattern

analyzing procedures applied at test are more likely to be recruited when the test cues are visually similar to the study cue than when they are visually dissimilar. Similarly, if priming reflects the recruitment of the conceptually driven processes applied at study, then the proportion of study words completed in the semantically similar context should be higher than in contexts where the conceptual interpretation does not match that of study. However, another possibility that exists is that data driven and conceptually driven processes do not contribute independently to context sensitive priming. Instead, priming may be mediated by the retrieval of the conceptual interpretation of the visual pattern. If this is the case, then completion performance will be higher than the different context condition only for the same context condition where the conceptual interpretation of the visual pattern matches that of study (i.e. when the identical cue is used).

Method

Subjects. Subjects were 72 University of Victoria undergraduates who participated without benefit of payment. In all of the experiments in this study, English was the subject's native language. Both males and females participated in the experiments, but participation was limited to subjects whose ages ranged between 18 and 30 years of age.

Design and Materials. Experiment 1a was a 2 x 2 x 6 mixed factor design. Retrieval task (word stem completion vs. letter-cued recall) and encoding instructions (copying vs. relational elaboration) were between subject factors, and the within subject factor was test context (same, re-paired, new, semantically similar, orthographically similar, and baseline context).

The critical test items were 60 cue-target pairs constructed according to the following criteria. The targets were medium frequency concrete nouns selected from the Kucera and Francis (1967) norms. Each target was between 4 and 12 letters in length, and the first three letters (word stems) of each of the target words were represented by at least 10

common English words in a pocket dictionary. The test cues were 60 concrete nouns that were selected from the Whitten, Suter, and Frank (1979) synonym ratings, the Wilding and Mohinder (1983) preferred synonym norms, or Roget's thesaurus (1985). The cues and targets were randomly paired forming new associates. In addition, forty-four fillers were constructed. These items consisted of medium frequency concrete nouns each paired with a three letter stem that was represented by at least 10 common English words in a pocket dictionary.

In this experiment changes in context were achieved by manipulating the study context within subjects, and keeping the test context constant across subjects. In order to do this five types of study list cues were required. An orthographically similar version of each test cue was derived by changing one of the test cue's interior letters so that the result was a legal English word that was semantically dissimilar to the test cue. The semantically similar but orthographically dissimilar study cue consisted of the test cue's normative synonym. Each synonym was selected from the same source as the test cue. For the new context condition sixty medium frequency words were selected from Kucera and Francis (1967) norms and randomly paired with a target word. The words that were used as test cues were used as cues for the same and re-paired context conditions (See Appendix A).

For counterbalancing purposes, the 60 critical pairs were divided into six blocks each consisting of 10 cue-target pairs. One of the six blocks was not presented at study and was used to assess the baseline probability of completing the stems with the target item. At study for any one subject, one block of target items was paired with the same cue word that was its partner at test (same context), one block was paired with a cue word from the same block that was not its partner at test (re-paired context), one block was paired with a cue that was never paired with a target at test (new context), one block was paired with a cue that was semantically similar to the test cue, and one block was paired with a cue that was

orthographically similar to the test cue. All the word pairs were typed on index cards in upper case lettering. The critical items were counterbalanced such that each of the six sets of items appeared equally often in each of the combinations of test context.

Forty fillers were selected and randomly distributed through the test list in order to disguise the fact that the critical pairs were seen at study. This was to prevent subjects from becoming aware that the word stem completion task was assessing memory for the item's prior occurrence as this knowledge may result in the subject's adoption of an explicit retrieval orientation. The remaining four filler cues were paired with a medium frequency, concrete noun, and acted as practice items at the beginning of the study phase and did not appear on the test. The first three letters of all the fillers, study cues, and critical cues and targets were unique.

The test form consisted of 100 words typed next to a three -letter stem (e.g. MOTHER-WIN____). The same test form was used for both the word stem completion and the letter-cued recall tasks. In order to induce the proper mental set for the word stem completion task, a distractor task that required subjects to generate the names of cities in response to stimuli consisting of the initial letter of the city (e.g. H_____), was interpolated between study list presentation and the test. This test consisted of 20 first letter cues typed on one sheet of paper.

Procedure. Subjects were tested individually. At study, the word pairs were presented at a rate of 6 s per pair. Subjects were either asked to copy the words side by side on a separate sheet of paper for each pair of words, or to generate and say aloud a sentence that would meaningfully relate the word pair together (e.g. SHIRT-CALENDAR: the child's SHIRT had a picture of a CALENDAR on it). Subjects were not informed that their memory for the word pairs would be tested.

After the critical pairs had been studied, all subjects were presented with the distractor task and were allowed 3 minutes to complete the task. Half the subjects were then given the word stem completion task and the other half were given the letter-cued recall task. In the word stem completion task, subjects were instructed to complete the word stem with the first word that came to mind that would fit the stem. Subjects were also told that the context word next to the stem was present to serve as an aid in helping them to think of a completion, but that it was not necessary that the completion be related in any way to the context word. Subjects were told not to complete the fragments with proper names, and informed that beyond this restriction there was no correct or incorrect response. Subjects were encouraged to perform this test as quickly as possible and not to leave any stems incomplete.

Subjects in the letter-cued recall task were instructed that the task was a cued recall test, and that they were to think back to the study list and complete the word stems with the study list targets. Subjects were informed that some of the stems appeared in the context of their original study partner, some appeared with a word that was paired with another context word on the study list, some appeared in the context of words that had not appeared in the study list, and that some word pairs had never been presented before. Subjects were encouraged to work as quickly as possible and instructed to complete all the stems, even if they felt that they had to guess.

Results and Discussion

In all the analyses reported in this paper, the Type I error rate was set at the .05 level. All planned comparisons were carried out using the Bonferroni correction for familywise error, which was set at the .05 level. The dependent measure was the proportion of target words produced as word stem completions, or the proportion of targets recalled on the

letter -cued recall task. In scoring each test, a response was counted only if it was its exact study list or plural form. Misspellings were not counted.

The mean proportion of targets completed and recalled under each of the experimental conditions is displayed in Table 1.

Table 1

Letter-Cued recall and Word Stem Completion Performance as a Function of Study Task and Test Context in Experiment 1.

	Test Context				
Same	Ortho	Semantic	Re-paired	New	Baseline
Study Task					
Letter-cued recall					
Sentence generation task					
.43	.28	.27	.27	.21	.10
Copying task					
.24	.17	.21	.24	.28	.13
M					
.34	.23	.24	.25	.24	.11
Word stem completion					
Sentence generation task					
.30	.17	.20	.23	.25	.11
Copying task					
.27	.19	.21	.23	.20	.10
M					
.28	.18	.21	.23	.22	.11

Letter-cued recall. A separate analysis of variance (ANOVA) performed on the letter-cued recall data revealed a reliable effect of test context $F(5,170)=8.10$, $MSe=0.023$, and a significant test context X encoding task interaction, $F(5,170)=3.73$, $MSe=0.023$. The main effect of encoding task was only marginally significant, $F(1,34)=$, $p<.07$, $Mse=0.041$.

Planned comparisons performed on the data from the elaborative encoding condition found a significant difference in means for the same vs. re-paired contexts, $F(1,17)=8.33$, $MSe=0.060$, and for the same vs. new contexts, $F(1,17)=12.06$, $MSe=0.077$. Associative memory was not observed in the nonelaborative condition, as planned comparisons indicated that the difference in the means for the same vs. repaired and the same vs. new contexts was not significant, $F<1$.

Word stem completion. The mean proportion of items completed under each of the experimental context conditions for the nonelaborative and elaborative task are also displayed in Table 1. A separate ANOVA conducted for the word stem completion data revealed a reliable effect of context, $F(5,170)=7.28$, $MSe=0.017$. The main effect of encoding task and the context X encoding task were nonsignificant, $F<1$.

An issue addressed in this experiment was whether context sensitive priming reflects the retrieval of only the data driven or only the conceptually driven operations that were applied at study. Planned comparisons were performed on the completion data from the elaborative and nonelaborative conditions in order to observe whether repeating only the sensory/perceptual analysis or only the conceptual analysis carried out at study would facilitate priming relative to the re-paired condition where neither the conceptual nor the perceptual analysis were repeated. As seen in Table 1, completion performance in the re-paired condition was actually higher than performance in the orthographic and semantic context conditions. For the both nonelaborative and the elaborative encoding condition all

of the following comparisons were nonsignificant: same vs. re-paired ; orthographic vs. re-paired ; and semantic vs. re-paired .

Although it would appear that repeating only the sensory/perceptual analysis or only the conceptual analysis does not facilitate priming relative to the re-paired context, priming in the same context condition where both the data driven and conceptually driven processes of study were repeated also did not reliably differ from the re-paired context condition. Consequently, any conclusions as to whether data driven or conceptually driven processes contribute independently to context sensitive priming could not be reached in Experiment 1a.

Experiment 1b

Experiment 1a found the typical effect that cued recall benefits from semantic relational processing. Although the probability of completing the stems with the target word was greater than the baseline probability, a context effect did not emerge in either the elaborative or nonelaborative condition on the word stem completion task. The lack of a context effect may be attributed to the experiment's lack of power to detect such effects. In order to increase power, in the next experiment the number of items and the number of subjects per condition were increased. It did not seem necessary to included the letter-cued recall task as Experiment 1a did not produce any findings that would have been unexpected on an explicit associative memory test. Therefore, in order to economize on the use of subjects, only the word stem completion task was used.

Method

Subjects. Subjects were 56 University of Victoria undergraduates who did not receive any form of payment for their participation. Each subject was randomly assigned to one of eight counterbalancing conditions and tested individually.

Design. The experiment consisted of a 2 x 4 mixed factorial design. Type of encoding task (word generation vs. copying) was the between subjects factor, while test context (same, re-paired, orthographic, semantic) was manipulated within subjects. In this experiment changes in context were achieved by manipulating the study context within subjects, keeping the test context constant across subjects.

Materials and Procedure. The materials used were identical to those used in Experiment 1. In this experiment, only the same, re-paired, orthographically similar and semantically similar context conditions from Experiment 1 were used. The new and the baseline context conditions were excluded. There did not appear to be a need for a baseline condition as the items were identical to those used in previous experiment, which found that studied targets primed above baseline. The 60 cue-target pairs from Experiment 1 were randomly assigned to the four context conditions.

The procedure was identical to that of Experiment 2, with the exception of the elaborative encoding task. Here, subjects were instructed to generate a single word that would describe a way in which the cue and the target word were related. As with the sentence generation task used in the previous experiment, subjects were allotted 6 s per pair to generate a response.

Results

The proportion of targets produced as word stem completions was the dependent measure, and the mean proportion of items completed in each of the context conditions is displayed in Table 2.

Table 2

Word Stem completion Performance as a Function of Encoding Task and Test Context in Experiment 1b.

Study Task	Test Context			
	Same	Re-paired	Ortho	Semantic
Word generation	.30	.17	.20	.20
Word copying	.27	.19	.23	.21
M	.28	.18	.22	.20

An ANOVA revealed a significant main effect of test context $F(3,45)=8.023$, $MSe=.015$ However, there was no significant interaction of test context X encoding task, $F<1$, contrary to what would have been expected if context sensitive priming is observed only following semantic relational processing. A main effect of encoding task also failed to reach significance, $F<1$.

In order to examine the contribution of data driven and conceptually driven processes to context sensitive priming, separate sets of planned comparisons were conducted on the data from the semantic and the non-semantic study conditions.

Word generation task. Planned comparisons found that the difference in means for the same vs. re-paired contexts was significant, $F(1,27)=16.34$, $MSe=0.029$. However, nonsignificant differences emerged when comparing the means of the orthographic vs re-paired contexts, and the semantic vs. re-paired contexts.

Copying task. The question of interest was whether context sensitive priming would be observed following non-semantic elaboration. Planned comparisons found that the difference between means for the same vs. re-paired contexts was significant, $F(1,27)=8.00$, $MSe=0.020$. However, no reliable difference in means was found when

comparing the orthographic vs. re-paired contexts, nor when comparing the semantic vs. re-paired contexts.

Discussion

In this experiment, implicit memory for new associations was observed following a non-semantic copying task. This finding calls into question the claim that implicit memory for new associations is observed only following semantic relational processing (Schacter & Graf, 1986; Schacter & McGlynn, 1989). Although the individual meaning of the words may have been processed during the copying task, a joint interpretation of the words pairs probably was not elaborated. If an association had been elaborated during the copying taska context effect would have been expected to emerge in the explicit memory condition in Experiment 1a, as associative memory benefits from relational processing at study. Consequently, the occurrence of context sensitive priming following the copying task does not support the unitization/redintegration claim that the context effect is mediated by the redintegration of associative information that was encoded at study via semantic relational processing.

However, the results do support the component process view of context sensitive priming. In this framework, the contribution of semantic relational processing does not consist of the elaboration and storage of semantic associative information. Instead, both the word generation task and the copying task required the subject to process the two words as a single, integrated unit. Therefore, unless the original unit was reinstated at test, the collection of procedures originally applied at study could not be optimally re-applied at test and re-processing fluency would be diminished. Consequently, under integral processing conditions, completion performance in the different context condition would be lower than completion performance in the same context condition. Similarly, the failure to find a context effect following a nonelaborative vowel comparison task (Graf and Schacter,

1985) does not mean that context sensitive priming is contingent upon encoding a semantic association. Instead, unlike the copying task, the vowel comparison task did not process the words in the pair as a integral unit and as a consequence, the original study procedures could be reapplied at test regardless of whether the component was re-presented with its original context word. Consequently, completion performance would not differ for the same and different context conditions.

As was the case in Experiment 1a, data driven and conceptually driven processes did not appear to contribute independently to context sensitive priming. Completion performance in the orthographic and semantic context conditions did not reliably differ from completion performance in the re-paired condition where neither the data driven nor the conceptually driven processes matched that of study. Instead, priming was facilitated only when both the visual and the conceptually driven processes matched that of study. This result is consistent with the component process view that an interactive relationship between data driven and conceptually driven processes exists; when the context word, and consequently the original interpretation of the visual pattern was altered, the original collection of study operations cannot be retrieved from episodic memory.

Transfer appropriate processing did not appear to contribute to context sensitive priming in the manner described by the unitization/redintegration framework. If access to relational information is contingent upon repeating the sensory/perceptual analysis conducted at study, then following word generation, completion performance would have been expected to be higher in the orthographic than in the re-paired context condition because the visual analysis applied at study was more likely to be recruited from memory when the test context was visually similar to the study context than when the test context was visually dissimilar. However, no significant difference between the re-paired and orthographically similar context emerged. Experiment 3 investigates this issue further.

A question that arises is whether or not subjects adopted an explicit retrieval orientation during the word stem completion task. The results do not suggest such an occurrence. First, explicit memory benefits more from deep semantic processing than from the shallow surface level processing emphasized in the copying task. If subjects were explicitly remembering the target items, then the effect of encoding task should have approached significance as it did in Experiment 1a. It did not. Second, for letter-cued recall performance in Experiment 1a an associative effect emerged only following processing that emphasized a conceptual relationship between the word pairs. In this experiment, the lack of a reliable context X encoding task interaction indicated that performance in the same context condition, which reflects associative memory, did not reliably differ for the word generation and the copying task. While the hallmarks of explicit memory were demonstrated on the letter-cued recall task in Experiment 1a, none were observed on the completion tasks in either Experiments 1a or 1b.

Finally, it is possible that a context effect did not emerge in Experiment 1a because of the design of the experiment. Past work on implicit memory for new associations has been conducted under limited experimental conditions where only two context conditions (same vs. different) were compared, and more important, the cue-target pairs always consisted of concrete, medium frequency nouns. In Experiments 1a and 1b, not all of the cues were concrete, medium frequency nouns. Prior work by Graf and Schacter (1989, Experiment 3) found that when the cue word consisted of a concrete noun, a context effect emerged. However, a context effect failed to emerge when the cues consisted of abstract nouns. It is possible that the context effect was diminished in Experiment 1a because of the nature of some of the cues. The reliable difference in completion performance between the same and re-paired context conditions in Experiment 1b may have emerged due to the increase in the experiment's power to detect the difference.

Experiment 2

Experiment 1b found that implicit memory for new associations can be observed following an integral non-semantic study task. As such, the work that has shown context sensitive priming only following semantic relational processing might be reinterpreted as evidence that context sensitive priming is observed following integral processing, as opposed to being contingent upon encoding semantic associative information.

The context effect that emerged in Experiment 1b could be interpreted as reflecting memory for both the visual pattern and the conceptual interpretation that was recruited from the pattern at study. However, a possibility that exists is that both the semantic relational processing task and the copying task integrally processed only the word pair's sensory/perceptual pattern (e.g. Whittlesea & Cantwell, 1987). Consequently, the context effect in Experiment 1b may have been mediated solely by the recruitment of the perceptual processes that were applied to the word pair at study. The purpose of Experiment 2 was to examine whether implicit memory for new associations reflects the recruitment of memory for newly integrated visual patterns.

Experiment 2 consisted of a conceptual replication of work that examined the influence of contextual details on memory for perceptual experiences (Whittlesea & Brooks, 1988). When a target and its context had been integrally processed at study, perceptual identification performance was optimally facilitated if the target was reinstated in its original context at test. However, perceptual identification performance was degraded if the context was altered. The order of context conditions in terms of increasing decrement was as follows: no context, new context, and re-paired context. While the reinstatement of the original perceptual context optimally facilitated the target's identification, performance in the re-paired condition indicated that presenting a target in a context that had been originally

associated with a different target item at study actually interfered with the target's perception.

Two different context conditions had been included in Experiment 1a; one that was established by re-pairing the targets with a word originally seen with another target at study, and one that was established by pairing the target with an unrelated context word that was new to the experiment. Following semantic relational processing, completion performance in the new context condition was higher than performance in the re-paired context condition. This result suggested that following integral processing, re-pairing contexts may have interfered with the perception of the target. Experiment 1a, however, lacked the power to detect any context effects. Therefore, it can only be speculated that context sensitive priming may be mediated solely by the recruitment of the perceptual processes applied to the word pair at study.

Experiment 2 included a same, new, and re-paired context condition. On the basis of previous work, priming performance in the re-paired context condition would be expected to be reliably lower than the new context condition because re-pairing contexts would interfere with the perception of the target. If such an interference effect emerges, then it may be reasonable to suggest that semantic relational processing only served to integrate a word pair's sensory/perceptual pattern, and context sensitive priming reflects the recruitment of memory for the integrated visual pattern. Consequently, from the transfer appropriate processing framework, context sensitive priming would be expected to be modality specific as priming would be contingent upon reprocessing the sensory/perceptual information that was experienced at study.

This experiment used cue-target pairs that were constructed exactly according to the criteria established by prior implicit associative memory work (Schacter & Graf, 1986). The shift in materials was prompted by a failure to find a context effect in an earlier version

of Experiment 2 that used the materials from Experiment 1a and 1b. The decision to change the materials was prompted by the fact that the only major difference between the present study and previous work that found a context effect was our use of cue words that were not always concrete, medium frequency nouns.

Method

Subjects. Twenty undergraduates at the University of Victoria participated in the experiment without benefit of payment. Each subject was randomly assigned to one of four counterbalancing conditions and tested individually.

Design and Materials. The experiment consisted of a repeated measures design where test context (same, new, re-paired, and baseline) was the within subjects factor. As in Experiment 1a and 1b a change in context was achieved by manipulating study context within subjects and keeping the test context constant across subjects.

The critical study items were 40 cue-target pairs constructed according to the following criteria. The targets were medium frequency concrete nouns selected from the Kucera and Francis (1967) norms. Each target was between 4 and 9 letters in length, and the three letter stem of each of the target words was represented by at least 10 common English words in a pocket dictionary. The test cues were 40 medium frequency concrete nouns selected from the Kucera and Francis (1967) norms. The 40 critical targets and the test cues were randomly paired forming new associates. In addition, thirty test fillers were constructed. These items consisted of medium frequency concrete nouns each paired with a three letter retrieval cue that was represented by at least 10 common English words in a pocket dictionary. The three-letter stems of all the words used in the experiment were unique.

As in Experiment 1a and 1b a change in context was achieved by manipulating study context within subjects and keeping the test context constant across subjects. In order to do

this, three study list cues were constructed. Forty medium frequency concrete nouns were selected from the Kucera and Francis (1967) norms and served as cues in the new context condition. The words that were used as test cues were used as cues for the same and re-paired conditions (See Appendix B).

For counterbalancing purposes, the 40 critical cue-target pairs were divided into four blocks each consisting of 10 cue-target pairs. One of the four blocks was not presented at study and was used to assess the baseline probability of completing the stem with the target item. At study, for any one subject, one block of target items was paired with the same cue that was its partner at test (same context), one block with a cue that was new to the experiment (new context), and one block was paired with a cue from the same block that had been paired with another target on the test list (re -paired). Each study list pair was typed on an index cards in upper case lettering. The critical items were counterbalanced such that each of the three sets of items appear equally often in each of the combinations of test context.

One test form was constructed, and consisted of the 40 critical cues and 30 filler cues next to a three letter stem. All items were randomly distributed through the test list, and typed in uppercase lettering.

Procedure. The encoding task and the procedure used was the same as that in Experiment 1b.

Results and Discussion

The mean proportion of items completed under each of the experimental context conditions is presented in Table 3. The baseline probability of completing a word stem with the target increased above baseline following exposure on the study list.

Table 3

Word Stem Completion Performance as a Function of Test Context in Experiment 2.

Test Context			
Same	New	Re-paired	Baseline
.39	.28	.27	.13

An ANOVA revealed a main effect of context, $F(3,57)=11.89$, $MSe=0.018$. Planned comparisons with the Bonferroni method found the difference between the means for the same vs. re-paired contexts was marginally significant, $F(1,19)=5.80$, $MSe=0.045$, $p < .026$. If implicit memory for new associations was mediated by the reprocessing of perceptual information, then according to the rationale of the experiment, completion performance in the re-paired context would have been significantly lower than completion in the new context. However, no significant different emerged when comparing the new vs. re-paired contexts, $F<1$. This experiment did not suggest that implicit memory for new associations reflected memory for the perceptual integration of the word pairs. The issue of whether the failure to observe a context effect in Experiment 1b when comparing the orthographically similar and the re-paired context condition was due to the orthographically similar items' failure to recruit the sensory/perceptual analysis of study is discussed in Experiment 3.

Experiment 3

Experiment 3 tested the hypothesis that implicit memory for new associations is modality specific because priming is contingent upon reinstating both the perceptual pattern and the conceptual interpretation that was recruited from the pattern at study. Experiments

1b and 2 found a context effect only when comparing completion performance between the same and the re-paired context condition. Although this finding suggests that context sensitive priming is contingent upon reinstating both the visual pattern and its interpretation at test, Experiment 3 was designed to rule out the possibility that context sensitive priming is contingent upon reinstating only the perceptual pattern seen at study.

In this experiment, the context word's visual pattern was held constant at study and test by using homographs, and the interpretation of the visual pattern was manipulated at test by presenting the homograph with a word that would bias its meaning. The paradigm used in this experiment required the subject to study two different interpretations of a homograph (e.g. the word BAT was interpreted as an animal and a as stick). Each interpretation was paired with a different target word, each of which shared the same three-letter stem (e.g. DRUM; DRUG). In this way, when the three-letter word stem was presented at test the two targets would compete as possible responses.

At test, the homograph was biased towards one of the two interpretations seen at study (e.g. cave BAT-DRU___; baseball BAT-DRU___). If context sensitive priming reflects the recruitment of the conceptual interpretation of a visual pattern, then the likelihood that a word stem would be completed with the target that was studied with the particular interpretation of the homograph biased at test would be greater than the probability of completing the word stem with the target associated with the alternate interpretation of the homograph. Alternatively, if context sensitive priming is modality specific because access to the relational information is contingent upon recruiting the visual analysis carried out at study (Schacter & Graf, 1989), then each target would have the same probability of being offered as a completion because the sensory/perceptual analysis of study was always reinstated at test by using homographs.

Method

Subjects. Sixteen undergraduates at the University of Victoria participated and did not receive any form of payment.

Design and materials. The experiment consisted of a repeated measures design where the factor test context (same, different, and baseline) was manipulated within subjects.

Seventy-two cue-target pairs were constructed. Two sets of targets were selected. Set A consisted of 36 medium frequency concrete nouns selected from the Kucera and Francis (1967) norms. Each target was between 4 and 9 letters in length, and the three letter stem of each of the targets was represented by at least 10 common English words in a pocket dictionary. Set B consisted of 36 nouns, each of which was matched to a target in Set A such that they shared the same three letter stem, and were approximately the same frequency and letter length (e.g. CHAIR-CHAIN). Twenty additional medium frequency concrete nouns were selected from the Kucera and Francis (1967) norms to serve as study list filler items.

Thirty six homographs were selected from various sources (Gorfein, Viviani, & Leddo, 1982; Holley-Wilcox & Blank, 1980; Nelson, McEvoy, Walling & Wheeler, 1980; Schvanveldt, Meyer, & Becker, 1976; Wollen, Cox, Cochran, Shea, & Kirby, 1980; Yates, 1978) with the restriction that both the dominant and the subordinate interpretation of the homograph was a concrete noun (e.g. cave BAT - baseball BAT). An additional 34 homographs were selected to serve as test filler items. Each filler homograph was paired with a biasing word that would result in the homograph being interpreted as a concrete noun. A three-letter retrieval cue that was represented by at least 10 common English words in a pocket dictionary was randomly assigned to each of the 34 filler homographs. The three-letter stem of all the filler stems, critical target pairs, homograph cues and biasing words were unique.

Two lists of words that biased the interpretation of the critical homographs were constructed. List 1 consisted of 36 words that biased the homographs towards the subordinate interpretation, while List 2 consisted of words that biased the homographs towards the dominant interpretation.

Four sets of cue-target pairs were constructed. Set A1 was constructed by randomly pairing the targets from Set A with a homograph cue. The homograph cue was then paired with the word from List 1 that biased the subordinate interpretation (e.g. oasis PALM - DRUM). Set A2 consisted of the homograph cue-target pairs that composed Set A1 but the homograph cues were paired with the words from List 2 that biased the homographs towards the dominant interpretation (e.g. hand PALM-DRUM). The targets from Set B were paired with the same homograph cue that their matched Set A target had been paired with. For Set B1, the homograph cues were paired with the words from List 1 that biased the subordinate interpretation (e.g. oasis PALM-DRUG), while the homograph cues in Set B2 were paired with the List 2 words that biased the dominant interpretation (e.g. hand PALM-DRUM).

The study items were constructed by embedding the cue-target pair from each of the four sets in a sentence that emphasized the appropriate interpretation of the homograph. The biasing word was not embedded in the sentence. Each sentence was approximately equal in length, and typed on an index card with the critical cue and target typed in uppercase letters (e.g., He sat under a desert PALM and hit on a DRUM). The 20 study filler items divided into two sets of 10 items and randomly paired. The 10 cue-target pairs were then embedded in sentences. The critical cue-target items appear in Appendix C.

In order for each target to appear equally often in the context of a homograph biased towards its subordinate or dominant interpretation, two study lists were constructed. Study List 1 was consisted of the sentences relating the meanings of the cue-target pairs from Set

A1 and Set B2, while Study List 2 consisted of the sentences relating the meanings of the cue-target pairs from Set A2 and Set B1. Each subject, therefore, studied both interpretations of the homograph, each of which was paired with a different target that shared the same stem (e.g. The first class LETTER was placed on the COUCH; The spelling error included a LETTER in the word COUGH). The 10 filler sentences were included in each study list.

Two test forms were constructed, each of which consisted of the 36 critical items and the 24 fillers. The homograph cue and the three letter stem were typed in uppercase lettering. In order to induce the subordinate or dominant interpretation of the homograph, the word that biased the interpretation was typed beside the homograph in lowercase lettering (e.g. hay STRAW - GRA____). None of the biasing words were ever seen at study.

On one test form, half of the homographs were biased towards their dominant interpretation, while the other half were biased towards their subordinate interpretation. On the second test form, the bias was reversed such that the interpretation of the homograph was the opposite of that encountered on the other test form. Each test form consisted of a different random arrangement of items.

The 36 matched cue-target pairs from each of the study lists were divided into six blocks each containing six critical cue-target pairs. Two of the six blocks would not be presented at study, and served to assess the baseline probability of completing the targets in the context of a dominant interpretation homograph and in the context of a subordinate interpretation homograph. The same context and different context conditions were achieved as follows: At test, if the homograph cue was biased towards its subordinate interpretation, a target was scored as "same" when the stem was completed with the target that had been studied with the homograph biased towards its subordinate interpretation. If

the stem had been completed with the target studied with the dominant interpretation homograph, then it was scored as "different". Similarly, if the homograph cue was biased towards its dominant interpretation at test, then a completion was scored as "same" when the target offered was the word that had been studied in the context of the homograph biased towards its dominant interpretation. The completion was scored as "different" when target offered had originally been studied with the homograph biased towards its subordinate interpretation.

Procedure. Each subject was tested individually. For each subject, the 48 critical cue-target pairs and the 10 fillers were presented in a different random order. Subjects were instructed to read the sentence on the card, and then generate a word that would relate the two capitalized words together. Subjects were allotted 8 s per sentence. The rest of the procedure was identical to that of the other experiments in the series.

Results and Discussion

An ANOVA revealed a significant effect of test context, $F(3,45)=10.36$, $MSe=0.007$. Planned comparisons found that completion performance in the different context condition (.18) significantly exceeded the baseline level (.11), $F(1,15)=9.572$, $MSe=0.1229$. This result is consistent with earlier findings that the presentation of a target word increases completion performance even when the word is tested in a different context from the one in which it was studied. The critical result is that the difference in means for the same (.25) vs. different (.18) contexts was significant, $F(1,15)=6.80$, $MSe=0.012$ indicating that completion performance was optimally facilitated when the interpretation of the test context matched the interpretation seen at study.

When word stems were completed in the context of a homograph biased towards a specific interpretation, the probability that the target offered had originally been studied with the homograph emphasizing the test interpretation was greater than the probability of

completing the stem with the target paired with the interpretation that did not match that of test. If priming reflected the retrieval of only the data driven processes carried out at study, then either of the two targets would have been equally likely to be offered as completions because the sensory/perceptual pattern was always reinstated at test by using homographs. Experiment 3, therefore, suggests that context sensitive priming is mediated by the retrieval of the conceptual interpretation that was recruited from the visual pattern at study.

Additional evidence that memory for the original visual analysis alone did not mediate priming can be found by examining the nature of the test contexts in this study. The context used in Experiment 3 consisted of two words--a homograph and a word that biased its interpretation. The biasing word was never presented at study. As such, the argument that the target studied with a different interpretation of the homograph was unlikely to be recruited from memory because of a failure to reinstate the biasing word's visual pattern is not tenable, because a context effect did emerge when the interpretation was reinstated at test even though the biasing word's visual pattern was not repeated. Similarly, the finding that word stems were more likely to be completed with the target that had originally been paired with the particular interpretation of the homograph cannot be attributed to memory for the sensory/perceptual processes applied at study because the visual pattern of the biasing word had never been seen at study. Therefore, it appears that priming was contingent upon recruiting the original interpretation of the homograph cue-target pair from memory.

These results can be extended to explain why completion performance did not differ between the orthographically similar and the re-paired context condition in Experiment 1b. The cue in the orthographically similar condition differed from the study cue by one letter. It could be argued that changing one letter disrupted the recruitment of the original pattern analyzing operations, thus eliminating the context effect. Experiment 3, however, found

that the reinstatement of the interpretation of the homograph, and not the reinstatement of perceptual pattern of the biasing word affected priming. If presenting a new biasing word did not eliminate context sensitive priming, then it is unlikely that the visual consequences of changing one letter in a word eliminated the context effect in Experiment 1b. A more reasonable explanation is that in changing the orthographic structure, the interpretation of the visual pattern also changed. Consequently, the conceptual interpretation originally recruited from the visual pattern at study could not be reprocessed at test and the context effect was eliminated. This argument is supported by work (Murrell and Morton, 1974) that reported that the prior presentation of a word primed morphologically related items where the visual pattern and the meaning of the studied item was reprocessed at test (e.g. card primed cards), but did not prime orthographically related items where only the studied item's visual pattern was reprocessed at test (e.g. card did not prime cars).

The results of Experiment 3 are consistent with the component process view that priming involves the unconscious retrieval of the original interpretation recruited from the visual pattern at study. The unaware nature of retrieval in this experiment is an issue, in that a condition that dissociated implicit and explicit memory was not included in the design. We are prompted to believe that the subjects did not use explicit retrieval strategies for the following reasons: First, Bowers and Schacter (1990), claim that implicit memory for new associations is not a product of explicit retrieval strategies because previous work (Graf & Schacter, 1985, 1987, 1989; Schacter & Graf, 1986, 1989) has demonstrated that associative effects on a cued recall task have dissociated from associative effects on a word stem completion task. The conditions of our experiment closely followed those used in the previous work (e.g. Graf & Schacter, 1987) that found word stem completion to dissociate from letter-cued recall, so there is little reason to suspect that our subjects treated the completion task differently from the subjects in previous studies. In addition, unlike the

work conducted by Schacter and his associates (Graf & Schacter, 1989; Schacter & Graf, 1986, 1989, Schacter & McGlynn, 1989), subjects in our study were not informed at the beginning of the experiment that their memory for the study items would be tested. If a memory test was not expected, then the probability of approaching the test with an explicit retrieval orientation would be expected to be lower than in the previous work. Second, post-experimental interviews indicated that the subjects were following the test instructions to complete the fragment with the first word that came to mind. Many subjects reported that they did not realize that a relationship between the test and study items existed, while others indicated that they recognized the cue-target pairs as being from the study list only after they had completed the stem. Of course, the issue of whether an explicit retrieval orientation was used during the word stem completion task in the present study can be properly addressed only through further experimentation which dissociates the two types of tasks. Such an experiment is planned.

General Discussion

In summary, the main results obtained in this study were: (a) in contrast to past claims that implicit memory for new associations is contingent upon semantic relational processing (Schacter & Graf, 1986; Schacter & McGlynn, 1989), a context effect was observed following a non-semantic copying task; (b) the proportion of word stems completed with the target in the orthographically similar context condition did not significantly differ from performance in the different context condition; and (c) completion performance was optimally facilitated when both the visual pattern and the conceptual interpretation of the visual pattern was reinstated at test. These results are not consistent with the conceptualization of implicit memory for new associations recently advanced by Graf and Schacter (1989), nor with the transfer appropriate processing view that data driven and

conceptually driven processes contribute independently to priming. Each of these issues are discussed in turn.

Experiment 1 examined the issue of whether the context effect was contingent upon semantic relational processing at study. This was an important issue as encoding processes play different roles in structural and functional views of memory. Graf and Schacter (1989) advance a structural view of memory, claiming that implicit and explicit memory for new associations engage different processes and representations. Implicit memory relies on "unitization" or processing that bonds the components of a stimulus to form a single cohesive unit. In the case of implicit memory for new associations, unitization is contingent upon semantic relational elaboration (Schacter & McGlynn, 1989), and the resulting unit consists of a single interpretation of the word pair. In turn, implicit memory for new associations reflected the successful access to the associative information. In the present study, implicit memory for new associations was observed following both semantic relational processing and a non-semantic copying task. According to the Schacter and Graf's (1989) conceptualization, a context effect should not have emerged following the copying task as context sensitive priming is contingent upon accessing a representation of the word pair's joint interpretation--this information was unlikely to have been processed during the copying task.

In contrast, the functionalist view of memory maintains that memory does not reflect the successful access to the byproducts of the encoding processes, but rather as the fluent reprocessing of the actual procedures that were applied to the stimulus at study. The occurrence of a context effect following the copying task can be conceptualized from the component process framework, in that during the word generation and the copying tasks, conceptual and perceptual processes were applied to the word pair components as an

integral unit. Consequently, the original pairing of the words had to be reinstated at test (same context) in order for the original study processes to be optimally reapplied at test.

The unitization/redintegration framework and the component process framework both share the idea that context sensitive priming is contingent upon reprocessing the data driven and the conceptually driven processes that were applied to the stimulus at study. The two frameworks, however, differ in their view of how data driven and conceptually driven processes contribute to priming.

Graf and Schacter (1986) describe the role of conceptually driven processes as confined to establishing a memorial component that represents the integration of the word pair. A visual component also becomes part and parcel of the unitized representation as a function of the data driven processes that operated upon the stimuli's visual pattern at study. In turn, the modality specificity of context sensitive priming is characterized as reflecting the requirement that the visual component of a unitized representation be reprocessed in order for the conceptual component to be accessed. Here, data driven and conceptually driven processes are characterized as independent processes that operate upon different aspects of the stimulus at encoding, and upon different components of a representation at retrieval.

Experiment 3, however, found that the reinstatement of the visual pattern did not contribute to the context effect in the manner described by Graf and Schacter (1989; Schacter & Graf, 1989). More targets were produced when both the visual pattern and the interpretation of the visual pattern matched that of study, relative to when only the visual pattern was reinstated at test. This context effect is consistent with the view that implicit memory for new associations is mediated by the recruitment of a conceptual interpretation of the visual pattern--if priming was contingent upon reprocessing a visual pattern alone, then the differences in completion performance in the same and different interpretation conditions should not have emerged because the visual pattern was always reinstated at test

by using homographs. Consequently, context sensitive priming is modality specific because reinstating the visual pattern enabled the re-enactment of the original processes used to recruit a conceptual interpretation from the visual pattern.

Support for the claim that memory for the interpretation of the visual pattern mediates context sensitive priming was also found in Experiment 1b where a context effect emerged only in the same context condition, but not in the orthographically similar context. If context sensitive priming reflected memory for the integral processing of perceptual information, then a context effect would have been expected to emerge in the orthographically similar context condition because the perceptual analysis carried out at study should have been recruited by the visually similar context.

It could be argued that the associative priming effect for the orthographically similar context condition failed to emerge because the orthographically similar items did not recruit memory for the perceptual processing conducted at study. However, there are reasons to believe that priming was not mediated by memory for perceptual operations alone: First, on the basis of prior work (Whittlesea & Brooks, 1988), it was hypothesized that context sensitive priming was an example of the finding that the perception of a target that was integrated with its context at study would be optimally facilitated when the target was re-presented in its original study context at test. If context sensitive priming reflected memory for the perceptual experience of an item, then more targets would have been expected to be produced in the context of a word that was new to the experiment, than in the context of a word from the study list that had originally been paired with a different target. This result was not found. Thus, according to the rationale of the experiment, context sensitive memory did not reflect memory for the perceptual integration of the word pairs. Second, Experiment 3 found that reinstating the visual pattern alone at test did not result in an optimal context effect. Instead, completion performance was optimally facilitated when

both the visual pattern and the conceptual interpretation of the visual pattern were reinstated at test.

Implicit memory for new associations is a phenomenon that is difficult to conceptualize from many of the current theories of memory. Recent review articles (Richardson-Klavehn & Bjork, 1988; Masson, 1989) have cited priming of newly established associations as support against the utility of the activation framework in favour of theoretical perspectives that posit an unitary view of memory. Still, the results of this study and the modality specific nature of implicit memory for new associations are difficult to reconcile with the transfer appropriate processing view that priming reflects episodic memory for either the data driven or the conceptually driven processes that were carried out at study. The present study, however, suggests that the modality specificity of the phenomenon can be conceptualized from the component process framework where implicit memory for new associations reflects episodic memory for the interaction of the conceptually driven and data driven processes that operated upon the stimulus at study. It may be possible that the results of this study may only apply to the particular implicit memory phenomenon we have examined. Therefore, an important question to address in further research is whether memory for the interaction of data driven and conceptually driven processes mediates priming on other implicit memory tasks.

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Appendix A

Context words and targets used in Experiments 1a and 1b.

Same	Orthographic	Conceptual	New	Re-paired	Target
DAWN	DARN	SUNRISE	POWDER	DISK	ELEVATOR
FLAME	FRAME	FIRE	FABRIC	WOOD	WHEAT
WOOD	WORD	LUMBER	HAWK	FLAME	COSTUME
HURDLE	HUDDLE	FENCE	FARMER	MARCHER	GENTLEMAN
ROCKETS	RICKETS	MISSILES	ROBE	COVE	THREAD
COVE	COME	HARBOUR	ADULT	ROCKET	TEACHER
DISK	DESK	RECORD	VARNISH	DAWN	PEARL
MARCHERS	MATCHES	PROTESTOR	SLAUGHTER	HURDLE	TURKEY
LABEL	LIBEL	TAG	TOBACCO	FRIGHT	SHORE
FRIGHT	FLIGHT	TERROR	SOAP	LABEL	CHOCOLATE
CAFE	CAGE	RESTAURANT	LECTURE	GLOVES	BARREL
TALE	TAME	STORY	EGG	STRUCK	COUCH
FOWL	FOAL	POULTRY	JOKE	VALLEY	BASKET
DIMES	DOME	SCENTS	BISHOP	BELT	DRILL
WASHES	WISHES	CLEANSES	MAID	FELLOW	SCRIPT
GLOVES	GROVES	MITTENS	IRON	CAFE	TEMPLE
VALLEY	VOLLEY	RAVINE	HAMMER	FOWL	SALAD
FELLOW	FOLLOW	MAN	AGENT	WASHES	ARCH
TRUCK	TRACK	VAN	FACTORY	TALE	MINUTE
BELT	BOLT	SUSPENDERS	COPPER	DIMES	BLANK
PURSE	PULSE	POCKETBOOK	NEIGHBOUR	MOUSE	PERFUME

DIVING	DINING	SUBMERGING	DEER	PADDLE	ATTIC
DAGGER	DIGGER	KNIFE	NAVY	GRASS	STITCH
MOUSE	MOOSE	RODENT	ESSAY	PURSE	SPRAY
SLATES	SKATES	CHALK	BOARD	GUITAR	DAGGER
PADDLE	PUDDLE	OAR	SERVANT	DIVING	FORK
MAYOR	MAJOR	ALDERMAN	PEPPER	HOUSE	BOULDER
COLLAR	CELLAR	NECKLINE	RAZOR	MAYOR	SNAKE
GRASS	GLASS	LAWN	JAIL	COLLAR	CORPSE
HOUSE	HORSE	HOME	OWNER	SLATES	FLOWER
NETTLE	NESTLE	THORN	ART	SLIVER	CRIME
SHEEP	SLEEP	EWE	SUGAR	CRUTCH	SHADE
BROOM	BLOOM	MOP	COTTON	SKIRT	LEASH
CLOCK	CLICK	TIMEPIECE	MILK	PRINCE	SPARK
SLIVER	SILVER	SPLINTER	ONION	NETTLE	EMPLOYER
JELLY	JOLLY	JAM	FRUIT	BROOM	SOLDIER
CRUTCH	CLUTCH	CANE	FISH	SHEEP	PLANE
PRINCE	PRANCE	KING	OPERA	CLOCK	SANDWICH
SKIRT	SHIRT	DRESS	DICE	CITRUS	WEAPON
CITRUS	CIRCUS	LEMON	ARROW	JELLY	REVOLVER
LIMBS	LAMBS	ARMS	WEDDING	SISTER	EXPERT
CUBE	CURE	SQUARE	SCHEME	PANTS	FURNITURE
DOCK	DECK	WHARF	CAVALRY	BALLET	MUSIC
BALLET	BULLET	DANCE	CAKE	DOCK	CHEEK
LANE	LAKE	STREET	WORKER	CUBE	QUEEN
LUNCH	LURCH	MEAL	PARADE	NOISE	PHOTO

MURAL	MORAL	PAINTING	MOVIE	LANE	BRAIN
NOISE	NOOSE	SOUND	TIGER	LUNCH	GREASE
SISTER	SITTER	SIBLING	MAGIC	LIMBS	SPEECH
PANTS	PINTS	TROUSERS	QUARTER	MURAL	REFRIGERATOR
WITCH	WATCH	SORCERESS	FEATHER	BLEACH	INSECT
CATTLE	CASTLE	CALF	WIDOW	JUNGLE	TENNIS
JUNGLE	JINGLE	RAINFOREST	AUTUMN	CATTLE	TEAM
BLEACH	BREACH	WHITEN	ART	WITCH	CROWN
BIRD	BIND	ROBIN	TELEGRAPH	PICKET	ACCENT
PICKET	POCKET	STAKE	POEM	BIRD	THEATRE
BANKER	BUNKER	FINANCIER	INJURY	INLAND	TRAIL
SOIL	SOUL	EARTH	RIFLE	BENCH	VERSE
INLAND	ISLAND	ONSHORE	RACCOON	BANKER	POLICE
BENCH	BEACH	TABLE	MIDNIGHT	SOIL	FREAK

Appendix B

Context words and targets used in Experiment 3.

Same	Re-paired	New	Target
OFFICE	GENTLEMAN	ARTIST	SANDWICH
POLICE	CHEEK	WRIST	DRILL
CHEEK	POLICE	EGGS	FURNITURE
HORSE	AUTO	ORCHARD	MUSCLE
AUTO	HORSE	RADIO	ATTIC
CAGE	COAL	CAMEL	PRANK
BABY	FREAK	TOOTH	THEATRE
SWEATER	CAGE	HARBOUR	SOLDIER
SISTER	FISH	BULLET	PERFUME
PRINCE	CHICKEN	WAGON	ARCH
JANITOR	PEARL	GATE	SLEEVE
COAL	SISTER	PIANO	WEAPON
CHICKEN	PRINCE	MIRROR	FLOWER
COFFEE	COMPUTER	TOOL	TEACHER
PEARL	JANITOR	MILK	COSTUME
COMPUTER	COFFEE	LAWYER	CHOCOLATE
JACKET	GHOST	MOUSE	GREASE
TRAIL	BELL	BOOK	INFANT
FISH	PLANE	BOWL	STITCH
BELL	TRAIL	CURB	STEAM
REVOLVER	LEASH	WALNUT	INSECT
GHOST	JACKET	COIN	COUCH

SPARK	SUGAR	SHEEP	TENNIS
PLANE	BARREL	TOWEL	SHORE
SUGAR	SPARK	SNOW	CROWN
LEASH	REVOLVER	SLUG	CHAIR
WATER	HUSBAND	GUITAR	SPIDER
PIPE	VILLAGE	GARAGE	BREAD
VILLAGE	WATER	FOUNTAIN	THREAD
HAND	DOLLAR	HAMMER	FORK
PENCIL	TEMPLE	FATHER	WHEAT
FREAK	BABY	ANKLE	CREAM
SALAD	STONE	PEACH	SNAKE
STONE	SALAD	MEADOW	PHOTO
GENTLEMAN	OFFICE	SWAMP	FRAME
BARREL	BOULDER	SOAP	SQUARE
HUSBAND	PIPE	HOSPITAL	QUEEN
TEMPLE	PENCIL	LADDER	CORPSE
DOLLAR	HAND	JAIL	TURKEY
BOULDER	SWEATER	TENT	CLOUD

Appendix C

Critical cue-target pairs used in Experiment 3.

HOMOGRAPHS BIASED TOWARDS THEIR SUBORDINATE INTERPRETATION.

The baseball BAT was used to destroy the FURNITURE.

The baseball BAT was placed behind the FURNACE.

The charity BALL was disrupted by STEAM rising from the ground.

The charity BALL was followed by a STEAK dinner.

The fisherman on the BANK wore a DRESS.

The fisherman on the BANK had a bad DREAM.

The social CLUB met in the BARN.

The social CLUB ate the BARK off a tree.

A ton of molasses CANE crushed the man's CHEST.

A piece of molasses CANE hit his CHEEK.

The ace was a SPADE and won the gambler a pound of BUTTER.

The ace was a SPADE and won the gambler a gold BUTTON.

During the game of GIN I bet and lost a tropical PLANT.

The game of GIN lasted so long I missed my PLANE.

He sat under the desert PALM and hit on a DRUM.

He sat under the desert PALM and swallowed a DRUG.

Tighten the lug NUT that holds the PHOTO machine together.

Tighten the lug NUT the holds the PHONE receiver together.

The barbed wire PEN was built to protect the president's BRAIN.

The barbed wire PEN was damaged by a falling tree BRANCH.

The person suffering from a bleeding ORGAN received a FLOWER.

The person suffering from a bleeding ORGAN fell to the FLOOR.

The starry eyed FAN waited for hours in the record STORE.

The starry eyed FAN threw a STONE at the singer.

The Greyhound COACH carried people who spoke in a WHISPER.

The Greyhound COACH carried people who drank WHISKEY.

The wool CAPE covered the CHILD.

The wool CAPE was a gift from the tribe's CHIEF.

The man's dilated PUPIL resulted from seeing the dentist's DRILL.

The man's dilated PUPIL upset the car's DRIVER.

The crystal water PITCHER was shaped like a CROSS.

The crystal water PITCHER was hurled at the CROWD.

The rush hour car JAM was noted as a BLANK on the accident report.

The rush hour car JAM was intensified by a man holding a BLADE.

Use a nail FILE to smooth the corner of the MUSIC stand.

Use a nail FILE to puncture his MUSCLE.

The tyranical RULER refused to drink coffee without CREAM.

The tyranical RULER blocked the bridge over the CREEK.

The game of SQUASH was the topic of my BOOK.

The game of SQUASH is not played wearing one BOOT.

The lady sitting in the third ROW looked up at the CLOUD.

The lady sitting in the third ROW kept looking at the CLOCK.

Dimes made at the MINT were placed on a CHAIR.

Dimes made at the MINT were strung into a CHAIN.

The upholstery SPRING was shaped like a SHELL.

The uphostery SPRING was found on a SHELF.

Numbers written in the LOG indicated I had missed the CLASS.

Numbers written in the LOG indicated the vase was made of CLAY.

The movie SCREEN was rented or out on LEASE.

The movie SCREEN was blocked by a dog on a LEASH.

The spelling error included a LETTER in the word COUCH.

The spelling error included a LETTER in the word COUGH.

Jack used the water resevoir TANK to hide the magic BEAN.

The water resevior TANK was a hiding place for a gold BEAD necklace.

A metre or YARD of steel is needed to make a spoon and FORK.

A metre or YARD of steel was used to build the FORT.

Limb specialists say CALF injuries can occur in a MOUSE.

Limb specialists say CALF injuries occur when you jump off a MOUND.

The gardener plowed with EARTH with a WEAPON.

The gardener plowed the EARTH when the WEATHER was nice.

The movie STAR tied his scarf in a KNOT.

The movie STAR hung his coat on the door KNOB.

The dastardly DEED was to injure the man's SPINE.

The dastardly DEED was to steal the gold SPIDER.

Farm grown STRAW was placed on the man's GRAVE.

Farm grown STRAW and GRAIN were sold at the market.

The medical QUACK prescribed that she eat a PEAR.

The medical QUACK prescribed the crippled man to climb a PEAK.

The Atlantic cargo VESSEL was slow as a SNAIL.

The Atlantic cargo VESSEL was used to carry the king's SNACK.

The essay on the human CELL was written by the PRINCE.

The essay on the human CELL was awarded first PRIZE.

HOMOGRAPHS BIASED TOWARDS THIER DOMINANT INTERPRETATION

The screeching BAT flew behind the FURNITURE.

The screeching BAT flew behind the FURNACE.

The rubber BALL bounced higher after being exposed to STEAM

A rubber BALL would have tasted better than the STEAK.

The manager of the BANK wore a DRESS.

The manager of the BANK helped make her DREAM a reality.

He took his CLUB and attacked the horse in the BARN.

He took his CLUB and hit the BARK off of a tree.

The wooden CANE hit the man in the CHEST.

The wooden CANE hit the man on the CHEEK.

Dig a hole with the SPADE and fill it with BUTTER.

Dig a hole with the SPADE the size of a BUTTON.

The beverage GIN is extracted from a flowering PLANT.

The beverage GIN was not served on the PLANE trip.

Lotion was placed on the PALM of the DRUM player.

Held in her PALM was an illegal DRUG.

Eat the fruit and NUT before we take the PHOTO.

Eat the fruit and NUT before you answer the PHONE.

Use the ball point PEN to draw the BRAIN.

Use the ball point PEN to draw the tree BRANCH.

A tune from the ORGAN made a FLOWER vibrate.

A tune from the ORGAN made her dance across the FLOOR.

The electric FAN was purchased at the hardware STORE.

The electric FAN was placed on a large desert STONE.

The Olympic swimming COACH drank WHISKEY.

The Olymipic swimming COACH talked in a low WHISPER.

The water from the CAPE was used to give the CHILD a bath.

The water from the CAPE was considered holy by the island CHIEF.

The elementary school PUPIL learned to use a DRILL.

The elementary school PUPIL hated the school bus DRIVER.

The big league PITCHER signed his name with a check or CROSS.

The big league PITCHER waved to the adoring CROWD.

The receipt FILE contains the cost of the MUSIC tape.

The receipt FILE indicates he went to a spa to fix his MUSCLE tone.

The label on can of fruit JAM was BLANK.

He spread the fruit JAM with a BLADE.

Use a metric RULER to measure how much CREAM is on the cake.

Use a metric RULER to measure the scar on his CHEEK.

A recipe for cooking SQUASH is in the BOOK.

Delicious SQUASH was planted by a man wearing one BOOT.

He threw the boat ROW at a CLOUD in the sky.

The boat ROW was used to smash the CLOCK.

Herbs like MINT were placed on a CHAIR.

Herbs like MINT were strung into a CHAIN.

In SPRING you can find an oyster SHELL on the beach.

In SPRING I will put the winter gear on the SHELF.

A hollow willow LOG was examined in forestry CLASS.

The hollow willow LOG was filled with CLAY.

Behind the barrier or SCREEN you will find the LEASH.

The barrier or SCREEN dividing the building was not in the LEASE.

The first class LETTER was placed on the COUCH.

The first class LETTER said the baby had a COUGH.

The military TANK rolled through the BEAN field.

Metal from a military TANK was used to make a BEAD.

The suburban YARD was gardened using a FORK.

The suburban YARD once was the site of a FORT.

This breed of CALF is as small as a MOUSE.

This breed of CALF likes to graze on a MOUND.

The astronaut circling the EARTH carried a WEAPON.

The astronaut circling the EARTH launched a WEATHER balloon.

The celestial STAR was shaped like a KNOT in a rope.

A celestial STAR was shaped like a KNOB.

The financial DEED stated he owned the gold SPIDER.

The financial DEED disclosure made his SPINE shiver.

Place the pop bottle STRAW on his GRAVE.

A pop bottle STRAW was used to pick up GRAIN.

The duck's QUACK was heard from the mountain PEAK.

The duck's QUACK was heard from the PEAR tree.

The cholesterol blocked VESSEL looked like a SNAIL on the X-ray.

The cholesterol blocked VESSEL resulted from a fatty SNACK.

A jail CELL is not an appropriate place for a PRINCE to live.

One night in a jail CELL was the PRIZE awarded in the lottery.

The label on can of fruit JAM was BLANK.

He spread the fruit JAM with a BLADE.

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