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Rice University

Specificity of Operations in Generating Words on Implicit and Explicit Memory Tests

by

Todd C. Jones

A thesis submitted in partial fulfillment of the requirements for the degree Doctor of Philosophy

Houston, Texas

May, 1995
Abstract

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Research has shown that generating words in a study phase (e.g. “shoe” from foot - s _ _ e) usually yields better memory performance compared to reading words (e.g. foot - shoe), and this advantage for generated words relative to read words is called the generation effect. One particularly interesting version of the generation effect was studied by Jacoby (1978). In two conditions of his study, subjects generated a word once (e.g. foot - s _ _ e) or generated a word immediately after reading it (e.g. foot - s _ _ e preceded by foot - shoe). Jacoby (1978) found that generating a word once produced better cued recall (e.g. foot - ?? ??) than reading a word, then generating it. One purpose of the present experiments was to investigate if Jacoby’s (1978) results would generalize to other memory tests. The experiments reported manipulated the number of study presentations, the modality of study presentation, the difficulty of generating a word, and the match between perceptual cues (e.g. s _ _ e) presented at study and test, and examined performance on four tests (associative cued recall, recognition, word fragment cued recall, and word fragment
completion). Jacoby's (1978) results were replicated for associative cued recall, but other patterns of data were obtained on the other tests.

A new finding for a word fragment cued recall test occurred based on the match of perceptual cues between study and test. Presenting the same word fragment (e.g. s _ _ e) at study and test resulted in better memory performance than did presenting different word fragments at study and test cue (e.g. s _ _ e at study but s _ o _ at test). Dissociations between word fragment cued recall and the word fragment completion ruled out the possibility that generation effects obtained for the word fragment completion test were due to subjects using intentional retrieval strategies. Most of the results were explainable with the transfer appropriate processing framework, which states that the greater the overlap in mental processes engaged at study and test, the better test performance will be.
Acknowledgments

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I thank my family, Mac, Corrine, Lisa, and Bryce Jones, and my friends, Amy Hammond, Katie Jones, Kathleen McDermott, Olga Watkins, and Karin Winters, for their encouragement and emotional support. The generous gift of a new computer from my parents, Mac and Corrine Jones, greatly facilitated this whole endeavor and made it possible to travel to and from New York City and still work on my dissertation. Finally, I especially thank my fiancee, Pamela Caird, for her understanding and for her devotion to me and this dissertation. There were times when I wondered if would finish in time for a May, 1995 graduation, but she always believed in me and helped me to believe in myself.
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Introduction

There are two general types of tests that researchers employ to assess memory performance: explicit memory tests and implicit memory tests (Graf & Schacter, 1985). Explicit memory tests are characterized by subjects intentionally thinking back to items encountered in a study episode and attempting to retrieve those items at test. Examples of explicit memory tests are free recall, cued recall, and recognition tests.

Implicit memory tests, by contrast, do not require subjects to think back to the study episode. For example, various implicit memory tasks include identifying briefly presented words (word identification), deciding whether a string of letters forms a word (lexical decision), naming pictures, identifying fragmented pictures, and completing word stems or word fragments to with the first word that comes to mind. The instructions for most implicit memory tests do not inform subjects of the study-test relationship. Nevertheless, subjects often demonstrate better performance (faster or more accurate identification) for studied items than for new items, and this advantage for old items relative to new items is called priming.

One line of evidence that shows that implicit memory is indeed different than explicit memory from studies using amnesic subjects. In a study by Graf, Shimamura, and Squire (1985), amnesic subjects and normal (control) subjects were presented words visually for two lists in a study phase. One of the lists was tested using free recall, a traditional explicit memory test, and the other was
tested using word stem completion, an implicit memory test. On the free recall test, the amnesic subjects performed well below normal subjects. This result was not surprising since, by definition, amnesics’ memory is severely impaired relative to normals. For the word stem completion test subjects were told to complete the word stems with first word that came to mind. The results showed that both amnesic subjects and normal subjects completed more word stems with studied words than with new words, and the amnesic subjects performed as well as the normal subjects. Thus despite the amnesic subjects’ inability to consciously recollect the words seen in the study phase, they demonstrated intact priming.

For explicit memory tests, generating items from conceptual cues (e.g. antonyms: hot - ?????) at study produces better memory performance compared to reading items (hot - cold) at study and is called the generation effect (Slamecka & Graf, 1978). A generation effect was demonstrated on a free recall test by Winnick and Daniel (1970), and Slameck and Graf (1978) obtained a generation effect for free recall, cued recall, and recognition tests and labeled the effect as the generation effect.

In the Winnick and Daniel (1970) study, visual word identification thresholds, now considered to be an implicit memory measure, were also employed. In a study phase, subjects read words or generated words to sentence cues. After the study phase, studied words and new words were presented one at a time very briefly, with the duration of presentation increasing
until a subject could correctly identify each word. In contrast to their findings for the free recall data, Winnick and Daniel (1970) found greater priming from prior reading than from generating on visual word identification thresholds. Thus, a generation effect occurred for the explicit memory test (free recall), but a reverse generation effect occurred for the implicit test (word identification).

Jacoby (1983) also had subjects generate a target word to a conceptual clue or read the target word with (or without) a conceptual clue and gave subjects an implicit or an explicit memory test. In Jacoby's (1983) study, the implicit test was word identification, but, unlike the Winnick and Daniel (1970) study, the measure was not the threshold of identification, but rather the accuracy of identifying briefly presented words. The results showed a reverse generation effect, an advantage for read words relative to generated words, for the implicit test, while the generation effect was preserved on the explicit memory test, recognition. The finding of a reverse generation effect has been reproduced on a variety of implicit memory tests including word identification, word stem completion, and word fragment completion (see Roediger & McDermott, 1993, for a review, for exceptions, see Schwartz, 1989; Masson & McLeod, 1992).

That a single manipulation can have opposite effects on explicit and implicit memory tests is indeed impressive. However, implicit memory tests that have yielded a reverse generation effect have employed perceptually impoverished stimuli. These types of implicit memory tests are generally referred to as data-driven or perceptual implicit memory tests because they are
more affected by variations in the surface information of stimuli than are other tests (Jacoby, 1983; Roediger & Blaxton, 1987; Tulving & Schacter, 1990). On the other hand, implicit memory tests that rely more on the conceptual nature of stimuli (e.g. answering general knowledge questions, producing category instances) have produced positive generation effects (Blaxton, 1989; 1992; Srinivas & Roediger, 1990). Presumably, a positive generation effect is obtained on conceptual implicit memory tests because they rely on conceptual information in a manner similar to explicit memory tests.

The present investigation, which examined the specificity of the generation effect, had subjects generate words using word fragments. For example, in the word pair white - b _ a _ k, “white” would be an associative cue and “b _ a _ k” would be the word fragment cue for the word black. Thus, subjects used both the associative cue and the word fragment to generate the word black, so generation was guided by both perceptual and conceptual cues.

An experiment using these type of materials was first reported by Jacoby (1978), who used an explicit memory test. In his Experiment 1, subjects read or generated the second word of a word pair (foot-shoe or foot-s _ e, respectively) in a study phase. Immediately after the study phase, subjects performed a cued recall test, for which the left word of each word pair was presented and subjects were to recall the right word (the target). Generating the target at study yielded better cued recall performance compared to reading it (.57 vs..27; estimated
from Fig. 1, p. 653; The rate of successful generation at study was .77, but the
data reported were not conditionalized on successful generation).

Two other study conditions that were included in Jacoby's (1978)
Experiment 1, which will be important to the present experiments (reported
below), involved two massed study presentations. In one condition, the word
pair was Read twice in immediate succession (foot-shoe:foot-shoe). In another
condition the word pair was first read, then generated (foot-shoe:foot-s _ _ e).
Jacoby was interested in 1) the effect of repetitions, and 2) the potential to
trivialize or short-circuit the generation process. Jacoby thought that the
generation effect could be trivialized or short-circuited by giving subjects the
opportunity to remember the target from the immediately preceding read
presentation, presumably from primary memory, rather than more effortfully
generating the target. He supposed that if the generation process were made
relatively effortless, no benefit from generating would accrue.

Jacoby found cued recall performance to be only slightly greater in the
Read:generate condition (.42) than in the Read twice condition (.38). This
difference was not significant. Both of the repetition conditions produced
significantly greater recall than did the Read once condition (.27; noted above),
but significantly poorer performance than the Generate (once) condition (.58;
noted above).

So while repetition was found to be beneficial relative to reading the
word-pair once, generating the target word from the associative cue once
yielded better performance than two study trials. Apparently, Jacoby's (1978) attempt to trivialize the generation process in the Read:generate condition was successful. If the same generation process occurred for the Read:generate condition as for the generate only condition, then performance for these two conditions would not be much different. If one were to make a prediction based solely on number of study presentations, one would predict that the Read:generate condition should have yielded better recall than the Generate once condition. Although the two conditions did differ, the advantage occurred for the Generate once condition.

In his Experiment 2, Jacoby (1978) manipulated the difficulty of generating the target words by varying the number of absent letters (one or two) in the perceptual cue seen at study (e.g. foot - s _ o e, foot - s _ _ e). He found little difference between words that were difficult to generate relative to words that were easy to generate on an associative cued recall test (foot - ? ? ? ?). A recognition test has also failed to yield a difference of generation difficulty by varying the number of absent letters in the study fragment (Peynircioğlu & Mungan, 1993).

**Generation Specificity in Verbal Tasks**

Donaldson and Bass (1980) suggested that the generation effects obtained by Jacoby (1978) were due to the strengthening of the cue-target relationship, and this idea was examined by Rabinowitz and Craik (1986). In their study, Rabinowitz and Craik (1986, Experiment 2) presented pairs of words, a cue word
and a target word, to subjects. The cue words were either semantically related to the targets or rhymed with the targets, and the target words were either presented as whole words or word fragments. Thus, at study, subjects either read or generated a word in the presence of an associative cue (e.g. avenue-STREET or avenue-S_R_ET) or in the presence of a rhyme cue (e.g. feet-STREET or feet-S_R_ET). In the test phase, subjects were given three types of retrieval cues. The retrieval cue was either the identical cue word used at study, similar to the type of study cue in terms of associative or rhyming status, or different from the type of study cue. So if the associative word pair “avenue-STREET” (or avenue-S_R_ET) was presented to a subject in the study phase, the three possible retrieval cues were “avenue” (Identical), “road” (Similar), or “feet” (Different). On the other hand, if the rhyming word pair “feet-STREET” (or feet-S_R_ET) was presented to a subject at study, then the three possible retrieval cues were “feet” (Identical), “meet” (Similar), or “road” (Different).

First, Rabinowitz and Craik (1986) found main effects of generating versus reading study words and using semantic associates compared to rhyme associates at study. More important though was their finding that the generation effect was dependent on the type of retrieval cue. No generation effects were obtained for the Different retrieval cue condition (generate minus read condition = .03). However, a generation effect occurred for the Similar cue condition and Identical cue condition, with the Identical cue condition yielding a larger generation effect (.17) than the Similar cue condition (.10). This result
demonstrated that a general relationship (semantic or rhyme) between the study cue and the target word produces a generation effect, as evidenced by the fact that a generation effect was obtained for the Similar cue condition. Furthermore, the specific relationship between the study cue and the target word was enhanced such that a larger generation effect occurred for the Identical cue condition relative to the Similar cue condition.

In another experiment Rabinowitz and Craik (1986, Experiment 3) showed that items had to be pre-experimentally associated to produce an enhanced generation effect. In that experiment, an enhanced generation effect was obtained for word pair associations that were pre-experimentally related but not for new word pair associations. Rabinowitz and Craik (1986) concluded that "[t]he information enhanced by generation on a particular occasion is the specific information used to guide the generation process. To the degree that a particular type of information is used to guide the generation process, the memory representation for that information will be enhanced" (p. 236).

In a related study by Glisky and Rabinowitz (1985; Experiment 1) the focus was the type of word fragment used to generate the target word at study and test rather than the type of associative cue or its relationship with the target word. In fact, in their first experiment no associative cues were present at study or test, but subjects rarely failed to generate a word because the word fragments were constrained to produce only one word. At study, subjects either read target words (e.g. ALCOHOL) or generated target words from a word fragment
(e.g. A L _ O H O _). Their were two types of test in the experiment. One test was a straightforward yes/no recognition test. The whole words were presented with new items (distractors), and subjects made a recognition judgment for each item. Glisky and Rabinowitz (1985) referred to this test as the read recognition test. For another recognition test, words were presented as fragments (e.g. A _ A _ I N; A L _ O H O _ ) along with new word fragments as distractors. Subjects first filled in the missing letters, then judged whether the word was old or new. The authors called this a generate recognition test.

The recognition hit rate revealed greater performance for items that had been generated compared to items that had been read at study, for both types of recognition test (read test: .76 vs. .60; generate test: .86 vs. .59; see Table 1). There was a significant interaction such that recognition performance was best when the target words were generated at both study and test. In other words, the difference between the generate study:read test and generate study:generate test conditions was greater than the difference between the read study:read test and read study:generate test. It is important to note that in the Glisky and Rabinowitz (1985) experiment the study and test fragments for the generate items were identical (e.g. A L _ O H O _ was presented at study and test). Thus the result was an enhanced generation effect, with items generated at both study and at test yielding better recognition than items generated at study but read at test. Experiment 5 (Glisky & Rabinowitz, 1985) manipulated whether the study fragment was presented alone (e.g. _ U G L E for BUGLE) or with an associative
Table 1. Recognition hit rates from Glisky and Rabinowitz (1985) as a function of study and test condition and whether the target word was presented alone or paired with an associative cue at study.

<table>
<thead>
<tr>
<th></th>
<th>Alone</th>
<th>Test</th>
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<tbody>
<tr>
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</tr>
<tr>
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<td>Read</td>
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<tr>
<td></td>
<td>Generate</td>
<td>.76</td>
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<table>
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<th>Test</th>
<th>Read</th>
<th>Generate</th>
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<td>.59</td>
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<tr>
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<td>Generate</td>
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<td>.83</td>
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<table>
<thead>
<tr>
<th></th>
<th>Paired</th>
<th>Test</th>
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<td>Study</td>
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<td>.63</td>
</tr>
<tr>
<td></td>
<td>Generate</td>
<td>.78</td>
</tr>
</tbody>
</table>
cue (e.g. trumpet - _ U G L E). One group of subjects saw the study fragment alone as in Experiment 1 (and produced the same pattern of results (see Table 1). A second group of subjects saw the study fragment with an associative cue but produced slightly different results. Like the results for Experiment 1 and the study-fragment-alone group of subjects in Experiment 5, recognition was better for studied generate items than for studied read items for both types of recognition test (read and generate). Thus the usual generation effect was obtained for both tests. Unlike the results for the study-fragment alone subjects, there was no enhanced generation effect. There was no difference between studied generate items on the two different types of test (read: .78 and generate: .81). Thus, an enhanced generation effect occurred from the matching of the study fragment when the fragment was studied alone but not when it was studied with an associative cue.

In another experiment by Glisky and Rabinowitz (1985, Experiment 2), the word fragments at study and test were manipulated such that the test fragments were either the same as the study fragment (e.g. A L _ O H O _; A L _ O H O _ ; as in Experiment 1) or different from the study fragment (e.g. A _ C O H _ L; A L _ O H O _ ). Their results showed a slight but significant advantage for fragments that matched at study and test over fragments that did not match at study and test on a generate recognition test (.88 vs. .84 hit rate). These results show that the perceptual match between the study and test cues is an important factor in producing the effect, not just the act of
generation per se. This result was replicated in their Experiment 3 (hit rates .92 for same fragments versus .85 for different fragments). Therefore, while the Rabinowitz and Craik (1986) found an enhanced or specific generation effect based on the specific associative cue - target word relationship, Glisky and Rabinowitz (1985) obtained an enhanced generation effect based on the perceptual study-test fragment match.

For the present study, a benefit of generating a word at study when the study and test cues do not match compared to reading the word at study is considered a nonspecific generation effect. Also, an advantage for a generate condition presenting the same cues from study to test relative to a read condition and a generate condition presenting different cues from study to test is referred to as a specific generation effect.

As stated above, generation effects generally have been observed for tests of explicit memory (see Schmidt & Cherry 1989, for an exception) but not for tests of perceptual implicit memory. However, recent work by Gardiner and his colleagues (Gardiner, 1988, 1989; Gardiner, Dawson, & Sutton, 1989) has shown a type of generation effect, at least under some study and test conditions, on what has been considered to be a perceptual implicit memory test, word fragment completion. As was the case with Glisky and Rabinowitz (1985), Gardiner (1988, 1989; Gardiner et al., 1989) concentrated on the match between word fragments presented at study and test. In all of Gardiner's (1988, 1989) experiments, subjects read or generated words in a study phase; later they were
given a word fragment completion test. For the test, subjects were instructed to complete the word fragments with the first word that came to mind and were not informed of the study-test relationship. In fact, to disguise the study-test relationship the test was presented to subjects as a new and unrelated task.

In Experiments 1 and 2 (Gardiner, 1988), subjects were presented a conceptual cue and either read the target word (e.g. Hired political killer: ASSASSIN) or generated the target from a word fragment (e.g. Venetian boat: G _ N _ O L _ ). Subjects were instructed to read the conceptual cue and target word aloud, but the rate of successful generation was not recorded by the experimenter. Later, subjects were given a word fragment completion test that included both types of studied words (read and generated; e.g. A _ _ A _ _ I N; G O _ D _ _ A) as well as new words (e.g. P _ L _ Y _ O _ for P O L L Y W O G) for a baseline measure. Unlike the experiments by Glisky and Rabinowitz (1985), the word fragments presented at test for these two experiments were never the same as the word fragments presented at study. The priming scores for Gardiner's (1988) experiments, as well as other specificity experiments conducted by Gardiner and his colleagues, (Gardiner, 1989; Gardiner et al., 1989) are presented in Table 2. Both read and generated study words were completed significantly more often than were new words; thus priming was obtained. The amount of priming obtained for the read and generate conditions was approximately equal for both Experiments: Experiment 1: .21 (read) vs. .23 (generate); Experiment 2: .38 (read) vs. .37 (generate). In addition to the groups
Table 2. **Priming scores for generation specificity experiments conducted by Gardiner and his colleagues.**

**Word Fragment Completion**

<table>
<thead>
<tr>
<th>Study</th>
<th>Exp.</th>
<th>Read</th>
<th>Gen. - diff</th>
<th>Gen. - same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardiner, 1988</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>.21</td>
<td>.23</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.38</td>
<td>.37</td>
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<td>.42</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.33</td>
<td>----</td>
<td>.44</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>.33</td>
<td>.31</td>
<td>.45</td>
</tr>
<tr>
<td>Gardiner, 1989</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>.18</td>
<td>----</td>
<td>.30</td>
</tr>
<tr>
<td>Gardiner, Dawson, &amp; Sutton, 1989</td>
<td>1</td>
<td>.28</td>
<td>.29, .33¹</td>
<td>.41</td>
</tr>
</tbody>
</table>

**Anagram Solution**

<table>
<thead>
<tr>
<th>Study</th>
<th>Exp.</th>
<th>Read</th>
<th>Solve - diff</th>
<th>Solve - same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardiner, Dawson, &amp; Sutton, 1989</td>
<td>2</td>
<td>.23</td>
<td>.24</td>
<td>.36</td>
</tr>
</tbody>
</table>

Note: Gen. - diff = Generate to different fragment than that presented at test; Gen. - same = Generate to same fragment presented at test; Solve - diff = Solve different anagram than that presented at test; Solve - same = Solve same anagram as that presented at test.
receiving implicit tests in Experiments 1 and 2, Gardiner (1988) administered a recognition test to separate groups of subjects. Subjects were given a yes/no recognition test on whole words for the studied items and new words (distractors). The hit rate for generated words (.66 and .76 for Experiments 1 & 2, respectively) was significantly greater than the hit rate for read words (.51 and .59 for Experiments 1 & 2, respectively). So while no generation effect was found for the implicit memory test, a robust generation effect was obtained for the recognition test in both Experiments 1 and 2.

As in Experiments 1 and 2, Experiments 3 and 4 (Gardiner, 1988) used conceptual generation cues with either a whole word (e.g. Hired political killer: ASSASSIN) or a word fragment (e.g. Venetian boat: G _ N _ O L _ ) at study. However, in these two experiments the test fragments for generated items were always the same as the word fragments presented at study (e.g. G _ N _ O L _ ). Recall that this sort of design was employed by Glisky and Rabinowitz (1985) but for tests of recognition. One other difference between Experiments 3 and 4 compared to Experiments 1 and 2 is that, in Experiments 3 and 4, when subjects failed to generate an item at study, the experimenter said the target word aloud. Only in Experiment 4 was the generation success rate recorded. Again, the implicit memory test instructions were to complete each word fragment with the first word that came to mind, and to help prevent subjects from intentionally retrieving studied items, subjects were not informed of the study-test relationship.
Significant priming was found for both the read and generate conditions. However, the priming obtained for the generate condition was significantly greater than that for the read condition in both Experiments 3 and 4 (.43 vs. .33, respectively, as an average; also see Table 2). For Experiment 4, the data reported were conditionalized on successful generation of the study words. Although subjects were only able to generate the target word 81% of the time, analyses on the unconditionalized data did not change the amount of priming obtained or the results in general.

Finally, Experiment 5 (Gardiner, 1988) included three study conditions: read, generate to the same fragment to-be-presented at test, and generate to a fragment different from the fragment to-be-presented at test. Thus, Experiment 5 was a replication of Experiments 1 and 2 and Experiments 3 and 4 in a single experiment. Based on the previous experiments, the results were as one would expect. Significant priming was observed for all three study conditions. The generate-same condition yielded significantly more priming (.45) than the read (.33) and generate-different conditions (.31), while the read and generate-different conditions did not differ. Again, the data reported were conditionalized on successful generation of the study words (82%), but analysis of the unconditionalized data did not change the results or the amount of priming obtained. Therefore, Gardiner (1988) replicated the findings of Glisky and Rabinowitz (1985) but for an implicit memory test, word fragment completion.
One way to measure the generation effect in implicit tests, like explicit tests, is to subtract performance for the read condition from performance in the generate condition. For Experiments 3, 4, and 5, in which the exact fragment was presented at study and test, there was a positive difference between the generate and read conditions of .10, .11, and .12 respectively (see Table 2). If the generation effect in Experiments 3 - 5 was based on some general advantage from the act of generation, one would expect the same benefit to manifest itself if the study and test fragments differed. However, no difference was observed when the study and test fragments differed in Experiments 1, 2, and 5 (.02, -.01, and -.02, respectively; see Table 1). In other words, there was no generation effect. Therefore, the generation effect obtained in Experiments 3 - 5 was not due to generation per se but a match in study and test cues.

An experiment by Gardiner et al., (1989, Experiment 2) was a conceptual replication of Gardiner's (1988) Experiment 5, with anagram solution substituted as the implicit test. At study, subjects read the target words (e.g. American whiskey: BOURBON) or generated the targets from an anagram (e.g. Deadly poison: IDEYNAC, for CYANIDE). In the test phase, subjects attempted to solve anagrams for read words, generated words, and new words. Test anagrams were either the same as or different from those presented in the generate study condition. Significant priming was obtained for all three study conditions, read, generate-same, generate-different, but significantly more priming was produced for the generate-same condition compared to the priming
produced for the read and generate-different conditions, which did not differ (see Table 2).

This pattern of results leads to the same conclusion as Glisky and Rabinowitz (1985) drew for recognition memory, and Gardiner (1988; 1989; Gardiner et al. 1989) made for word fragment completion: the generation enhancement is not due to the general act of generation per se, but also depends on a match between the cognitive operations required during the study and test phases. Thus the enhancement is specific to the match between study and test operations.

A study by Gardiner et al., (1989; Experiment 1) that used a word fragment completion test explored the exact nature of generation specificity by varying the study fragments. The study fragments were varied by adding or subtracting just one letter relative to an exact fragment condition. As in Gardiner (1988), a conceptual cue was presented on each study trial (e.g. Single unmarried man). In addition to the clue, subjects read the target word (BACHELOR) or generated the target using the conceptual clue and a word fragment. Subjects saw one of three types of word fragment on each study trial: the exact word fragment to be presented during the test (B _ _ _ _ E _ O R), the exact fragment plus one letter (B A _ _ E _ O R), or the exact fragment minus one letter (B _ _ _ _ E _ _ R). Again, when a subject failed to generate the target word at study the experiment said the word aloud.
After subtracting out baseline performance, the priming obtained for the read (.28), minus one letter (.29), and plus one letter conditions (.33) was statistically equivalent, but the priming for the identical fragment condition (.41) was significantly greater than each of the other conditions (see Table 2; the data reported are not conditionalized for generation success rate, 99%, at study). This result showed that the effect was specific to the display of the exact fragment at study and test. A change of only one letter between the study and test fragment produced priming no greater than priming produced by presenting the whole word. Gardiner et al. (1989) called this finding an hyperspecificity effect. This result reinforces the findings of Gardiner (1988; 1989): If generation based on the conceptual clue were critical to obtaining the effect, then the plus one letter and minus one letter conditions should have produced greater priming than the read condition, but they did not. Once again, the act of generation at study was not the critical factor but rather generation to the specific word fragment used during test.

**Specificity in Nonverbal Priming**

The results for experiments investigating specificity in nonverbal implicit memory tasks is somewhat mixed. Theoretically, changing the scale (size) or orientation of the stimuli from study to test should affect performance relative to maintaining the scale or orientation from study to test. Manipulations of size between study and test displays (Biederman & Cooper, 1992) and transformation in the form of rotation (180° about a central y-axis; reflection; or left-right
orientation; Biederman & Cooper, 1991a) have failed to produce specificity effects in priming for pictures. Size and reflection transformations have not produced effects of specificity for making decisions about 3-dimensional objects (Cooper, Schacter, Ballesteros, & Moore, 1992). On the other hand, specificity effects have been found in the form of decreased naming times for objects appearing in the same degree of rotation (about the x-axis) compared to a different degree of rotation from study to test (Jolicœur, 1985; Jolicœur & Milliken, 1987) and for naming objects seen in the same viewing angle versus different angle from study to test (Bartram, 1974).

Evidence for specificity in priming for picture fragments also has been mixed. Snodgrass and Feenan (1990) presented picture fragments at different levels of completion at study and test. The more complete fragments included the same information provided at lower levels plus new information. After each study item subjects were given the name of the picture. Snodgrass and Feenan (1990) reported that an intermediate level of fragmentation (Level 4) produced the greatest amount of priming for all test levels. Biederman and Cooper (1992) showed that two different fragments that contained the vertices of pictures (called recoverable fragments) primed each other equally on a later picture fragment identification test. Also, Hirshman and Snodgrass (1994) compared priming for two complementary picture fragments (that appear to have been recoverable fragments) and found no difference in the amount of priming for same versus different tests fragments. However, picture fragments that
excluded whole parts of a picture (and vertices; called nonrecoverable fragments) did not produce as much priming as a recoverable fragment when the test used recoverable fragments (Biederman & Cooper, 1991b).

In a series of experiments that are conceptually akin to Gardiner’s (1988), evidence was gathered in support of specificity with picture fragments (Srinivas, 1993). In Srinivas’s (1993) Experiments 1 and 2, recoverable and nonrecoverable fragments were made for each picture. In the study phase of the experiments, subjects studied pictures in three different forms: intact pictures, recoverable picture fragments, and nonrecoverable picture fragments. The name of the item was presented with the picture or picture fragment on each trial. In the test phase, subjects were given both recoverable and nonrecoverable picture fragments to solve and identify. Thus the study conditions were crossed with the test conditions. New items were given in the form of both recoverable and nonrecoverable picture fragments to obtain the appropriate baseline measures.

The results showed that significantly more priming occurred when the study and test fragments were the same. That is, studying recoverable fragments (with their names) produced more priming than did studying the intact picture or the nonrecoverable picture fragment when the test items were recoverable fragments. Studying nonrecoverable fragments (with their names) produced more priming than did studying intact pictures or recoverable fragments when the the test items were nonrecoverable fragments. Therefore, to some extent Srinivas (1993) failed to replicate Beiderman and Cooper (1991b).
On the other hand, her work using a picture fragment identification test did replicate Gardiner's (1988) results of specificity with a word fragment completion test.

One additional note concerns the Hirshman and Snodgrass (1994) study. Subjects were not always able to identify (or generate) a picture fragment correctly at study. When the Hirshman and Snodgrass (1994) data were conditionalized for successful identification at study, specificity effects were revealed, such that identifying the same picture fragment at study and test resulted in more priming than did identifying different fragments (Snodgrass, 1995, personal communication). Therefore, in some sense, Hirshman and Snodgrass (1994) replicated the work of Srinivas (1993) and Gardiner (1988).

Explicit Memory Contamination

In Gardiner and his colleagues' (Gardiner, 1988, 1989; Gardiner et al., 1989) work with word fragments, there are two elements that are common among the experiments that have demonstrated a boost in priming or an enhanced generation effect: 1) Subjects always generated the target word; and 2) The study fragment that subjects used to aid in generation of the target was identical to the word fragment given at test. The relative increase in priming was probably not due to the act of generation based on the conceptual cue, so the specific generation effect does not seem to be based on conceptual factors. In all of the specificity experiments conducted by Gardiner and his colleagues
(Gardiner, 1988, 1989; Gardiner et al. 1989), a conceptual cue was always presented in the study phase (e.g. Venetian boat: in Venetian boat: G N O A). Although specificity effects do not appear to be conceptual, the effect of removing the conceptual cue at study remains uncertain. Only one study (Olafsson & Nilsson, 1992) has included a control condition for an implicit test of specificity effects in which the sentence or associative word cue is absent at study. However, problems with the Olafsson and Nilsson (1992) study will be discussed below in detail, so no firm conclusions can be drawn. Finally, recall that Glisky and Rabinowitz (1985) did have subjects generate items without sentence or associative word cues for tests of recognition and still obtained effects of specificity. What appears to be critical to obtaining specificity effects is the visual presentation of the perceptual cue, the specific word fragment.

One possible reason why Gardiner and his colleagues (Gardiner, 1988, 1989; Gardiner et al., 1989) have obtained a specific generation effect in their experiments is that subjects may have used an explicit memory strategy in completing the test fragments. The generation effect is well documented for explicit memory tests, so if subjects treated the fragment completion test as an explicit memory test by intentionally thinking back to the study list and trying to complete the fragments with words they had read and generated, one would expect performance to be better in the generate than in the read condition. One reason a subject might engage in an intentional retrieval strategy is that the subject has become aware of using studied words to complete some of the test
fragments; then he/she adopts an intentional retrieval strategy under the belief that adopting such a strategy will improve test performance. This explanation is referred to as explicit memory contamination of the implicit memory measure.

One approach to this problem has been to design studies in which subjects are given both an implicit and an explicit test for some or all of the same items. Generally, an explicit memory test is given first followed by an implicit test. The logic is that if subjects engage in explicit strategies on the implicit memory test, then a relationship of dependence ought to be observed for items occurring on both tests. However, if a relationship of independence is found for overlapping items, then one can argue strongly that the implicit test was not affected by the explicit test, and hence, that explicit strategies were not used on the implicit memory test. One study that addressed this issue found that priming on an implicit word fragment completion test was uninfluenced by performance on a preceding recognition test (Tulving, Schacter, and Stark, 1982). Thus performance on the two tests was found to be stochastically independent.

Another way of assessing the level of dependence for performance on successive tests is to use a measure called Yule’s $Q$. Yule’s $Q$ is equal to Goodman and Kruskal’s $\gamma$ in a $2 \times 2$ contingency table. Hayman and Tulving (1989a; 1989b) have advocated the use of this measure. In four experiments (1989b), a group of subjects was given two successive word fragment completion tests that used complementary fragments for the same item
(e.g. for the target ASSASSIN, A _ _ A _ _ IN was presented in Test 1 but
_S S _ S S _ _ was presented in Test 2). Another group of subjects received a
word fragment completion test that used the same fragment in both tests. Two
other groups of subjects were given successive word fragment cued recall tests,
one with the same fragments for the two tests and one with different fragments
for the two tests.

The results showed that if the tested fragment was identical for two
successive implicit word fragment completion tests, then performance on the
two tests was found to be highly dependent (Qs .88 to .92). On successive tests
of word fragment cued recall that employed different fragments performance
was moderately dependent (Qs .38 to .53), while on successive tests of word
fragment completion using different fragments, performance was fairly
independent (Qs .05 to .23). These last results demonstrate that subjects respond
differentially based on test instructions, and that awareness of using study
words to complete the word fragments does not necessarily entail explicit
retrieval strategies.

In another paper, Hayman and Tulving (1989a) showed that the level of
dependence between a recognition test (Test 1) and a subsequent word fragment
cued recall test (Test 2; Qs .38 and .39 for low constraint fragments and Qs .55
and .57 for high constraint fragments) was much greater than the level of
dependence between a recognition test (Test 1) and a subsequent word fragment
completion test (Test 2; Qs -.167 and .004 for low constraint fragments and Qs
.182 and .389 for high constraint fragments). Again, the relationship of
performance on the recognition test and word fragment completion test was
largely independent as measured by Yule's $Q$. Once again, this demonstrates the
dependent relationship between two explicit memory tests, recognition and
word fragment cued recall, and the independent relationship between an explicit
memory test, recognition, and an implicit memory test, word fragment
completion.

A study by Olofsson and Nilsson (1992) attempted to replicate the work
of Gardiner (1988; 1989) but preceded the word fragment completion test with
an explicit memory test -- recognition of word fragments in Experiment 1 and
free recall in Experiment 2. As Olofsson and Nilsson pointed out, the amount of
priming yielded in Gardiner's (1988) experiments was unusually high. One
possible reason for the unusually large amount of priming could have been that
subjects used explicit retrieval strategies. Although Gardiner (1988)
administered a recognition test in Experiments 1 and 2, no explicit test was
administered in Experiments 3, 4, and 5, the experiments in which generation
specificity was produced. Therefore, Olofsson and Nilsson (1992) included
explicit memory tests and measured the dependence between the successive
explicit and implicit memory tests where the implicit test was always word
fragment completion.

The design was similar to that used by Gardiner (1988; Experiment 5).
Subjects read cues (e.g. Naval commander) at study followed by either the whole
word (CAPTAIN), a word fragment the same as the test fragment (e.g. C_P_A__ at study; C_P_A__ at test), or a word fragment different from the test fragment (e.g. _A_T_I_ at study; C_P_A__ at test). However, half of the old and new items used in the word fragment completion test were presented in an immediately preceding recognition test. The instructions for the word fragment completion test were the standard instructions -- complete the word fragments with the first word that comes to mind. The recognition instructions, however, directed subjects to identify the word fragments that were identical to the word fragments seen at study.

First of all, the effect of the prior recognition test on word fragment completion performance was not significant, nor were there any interactions across the various study conditions. For the word fragment completion test, significant priming was produced in all three study conditions (read, generate-same, and generate-different). Priming for the generate-same condition was significantly greater than priming for the read condition (.30 vs. .19, respectively; estimated from Figure 1, p. 106). The priming for the generate-different condition fell somewhere in between (.24, estimated from Figure 1) and was not significantly different than the priming for either the generate-same condition or the read condition.

In the recognition test, subjects were able to identify word fragments that had been previously presented significantly above chance. Though not cited, this replicated similar work by Glisky and Rabinowitz (1985, Experiment 5). A
high degree of dependence was found between the recognition test and the word fragment completion test using Yule's $Q$. However, this result is not very surprising given that Olafsson and Nilsson (1990) confounded the type of test instructions. Instead of instructing subjects to identify all studied words on the word fragment recognition test, subjects were instructed to identify only those word fragments that were presented in the exact same form in the study phase. Thus the design of the experiment was arranged to produce a high degree of dependence between the two tests.

In the study phase of Olafsson and Nilsson's (1992) Experiment 2, sentence cues (e.g. Naval commander:) were presented to one group of subjects, but the corresponding words (e.g. CAPTAIN) were presented to a second group of subjects. For both groups, the sentence cue or whole word was followed by a word fragment for the target word (e.g. C _ P _ A _ _), and the fragment was either the same as (e.g. C _ P _ A _ _) or different from (e.g. _ A _ T _ I N) the fragment to be presented in the test phase (e.g. C _ P _ A _ _). A free recall test immediately preceded the word fragment completion test.

The results for the free recall test showed that significantly more generated words were recalled than read words. The results for word fragment completion test yielded mixed results. First, the results of the generation group replicated the work of Gardiner (1988; 1989). Significantly more priming was produced in the generate-same condition than in the generate-different condition. However, for the read group there was not a significant difference in
the amount of priming produced for the same and different fragment conditions. Using Yule's Q, there was no significant dependence between performance on the free recall test and the word fragment completion test for the generation group, but performance between the free recall test and the word fragment completion test for the read group was found to be highly dependent.

Although comparisons between the groups were made in the study, statistically these comparisons should not have been made. The intention of the authors was to employ a condition “without reference to generation” (p. 106) -- the read group. But in their attempt to employ conditions that did not require generation, Olafsson and Nilsson (1992) confounded the type of cue (sentence vs. word) which preceded the study fragments as well as the number of presentations of the stimulus word (1 presentation in the generate group vs. 2 presentations in the read group). Therefore, comparisons cannot be made between the two groups.

One methodology intended to identify explicit contamination on tests of implicit memory is called the retrieval intentionality criterion (Schacter, Bowers, & Booker, 1989). The retrieval intentionality criterion proposes that implicit memory tests should be accompanied by explicit memory tests with all conditions held constant except for the test instructions. If an effect (or opposite effects) of a variable is observed for an implicit memory test and not for an explicit memory test or vice versa, then explicit contamination may be ruled out as a significant problem. Unfortunately, this methodology leaves ambiguous the
interpretation of parallel effects of a given manipulation on explicit and implicit memory tests. The effects observed could either occur on tests of both types, or the implicit test performance could be contaminated by intentional remembering (explicit memory contamination), or the explicit test could be contaminated by automatic processes (implicit memory contamination).

Bowers and Schacter (1990) found that on an implicit test of word stem completion for single word priming, subjects aware of the study-test relationship did not produce any greater priming than subjects who were unaware of the study-test relationship. However, associative priming effects were obtained for "aware" subjects only. In the present experiments the implicit test was always single word priming.

Gardiner (1988, 1989), Gardiner et al. (1989), and Olafsson and Nilsson (1992) did not employ the retrieval intentionality criterion in their experiments. Although Olafsson and Nilsson (1992) presented the same retrieval cues for the explicit and implicit tests, the explicit test involved discrimination of old items rather than identification of all old items. Subjects were to identify as old only those items that were presented in the same form from study to test rather than to identify all old items. In fact to my knowledge, a word fragment cued recall test which presents the same retrieval cues as those for the implicit memory test has never been administered in one inclusive experiment investigating specific generation effects. In order to more firmly demonstrate that the very specific priming obtained by Gardiner and his colleagues (Gardiner, 1988, 1989;
Gardiner et al., 1989) and Olafsson and Nilsson (1992) is indeed an implicit memory phenomenon, the retrieval intentionality criterion needs to be met.

The specificity effects in generating words obtained by Gardiner and his colleagues (1988, 1989; Gardiner et al., 1989) in implicit memory parallel specificity effects found in prior work on explicit memory (Glisky & Rabinowitz, 1985; Rabinowitz & Craik, 1986). Because these parallel effects have not been obtained while a simultaneous dissociation is obtained between the implicit and explicit tests, explicit contamination of implicit memory performance in the Gardiner (1988, 1989; Gardiner et al., 1989) experiments cannot be ruled out.

On the other hand, in Gardiner's (1988, 1989; Gardiner et al., 1989) experiments there were no differences between the read conditions and the conditions in which subjects were tested with fragments different from the fragments used to generate the target word at study. Generation is known to benefit explicit memory, so if subjects were adopting an explicit memory strategy in these experiments, one would expect a difference between the generate-different and read conditions, and perhaps no difference between the generate-different and generate-same conditions. Again, since recognition is generally regarded as an explicit memory test, and the recognition data revealed a positive generation effect while the word fragment completion test yielded no generation effect, one can argue that there was no explicit contamination of the implicit test (Gardiner, 1988, Experiments 1 & 2). Of course, the type of test was
confounded with the form of the test stimuli so no definitive conclusion can be drawn.

No recognition test was administered in Experiments 3, 4, or 5 of Gardiner's study (1988) or in Experiment 1 of Gardiner et al.'s (1989) study, but the pattern of priming is not particularly different from the comparable conditions of Experiments 1 and 2 (Gardiner, 1988; see Table 1). Since the data are similar to experiments where a recognition test was given, and different results were obtained on the recognition test than on the implicit test, one could cautiously assume that explicit contamination of the implicit test did not occur in these other experiments. Finally, in Gardiner (1989), subjects were interviewed but reported no awareness of the study-test relationship. Since subjects were not aware of the study-test relationship, they probably were not using explicit strategies on the word fragment completion test. As will be detailed below, the present experiments will all meet the retrieval intentionality criterion.

Although one study has compared generation effects for implicit and explicit memory tests while meeting the retrieval intentionality criterion, presentation time of words at study was not controlled but was subject-paced (Flory & Pring, 1994). Since study time has been shown to affect an explicit test, recognition, but not an implicit test, word fragment completion, (Neill, Beck, Botullico, & Molloy, 1990) interactions between the study conditions and the type of test in the Flory and Pring (1994) study could have been an actual interaction between the different study conditions and the type of test or an
interaction between the presentation rate and the type of test. Therefore, no firm conclusions can be drawn from the test comparisons in the Flory and Pring (1994) study, and the details of the study will not be described.

**Massed Repetition**

One variable that was used in all of the present experiments is number of study presentations. Items were presented once or twice massed. One presentation versus two massed presentations has produced no significant difference in priming (Jacoby & Dallas, 1981; Perruchet, 1989, Greene, 1990; Roediger & Challis, 1992). In fact, in a comparison of 1 versus 4 versus 16 study presentations, Challis & Sidhu (1993) found no difference in priming on a word fragment completion test but did find a significant difference for a conceptual implicit test and for a word fragment cued recall test. Massed repetition has produced significant effects on other explicit memory tests, namely cued recall (Jacoby, 1978), recognition and free recall tests (Roediger & Challis, 1992).

Challis and Sidhu (1993) stated:

"In our study, the finding that massed repetition has a large effect on word fragment cued recall but no effect on word fragment completion satisfies the retrieval intentionality criterion for an implicit test. In future studies, massed repetition could serve as a study variable for assessing whether performance on an implicit perceptual test was contaminated by explicit retrieval (cf. Roediger, 1992)."

However, following the retrieval intentionality criterion, Greene (1990, Experiment 2) failed to obtain an effect of massed repetition on both word fragment completion and word fragment cued recall tests. The comparison was
one versus two massed study presentations. Therefore, massed repetition may be a manipulation which dissociates word fragment completion and word fragment cued recall only after more than two massed presentations. The exact number of massed study presentations needed to produce an effect on a test of word fragment cued recall remains in question. Since Challis and Sidhu (1993) revealed a repetition effect using four presentations, but Greene (1990) did not find an effect using two presentations, the range of possibilities has been limited considerably. Interestingly, other explicit memory tests, free recall, cued recall, and recognition, are sensitive to massed repetition effects using only two presentations. This fact appears to represent a difference between word fragment cued recall and other explicit memory tests. Word fragment cued recall may be less sensitive to study repetitions because the test relies more on perceptual processes than other explicit tests.

**Theoretical Background**

Glisky and Rabinowitz (1985) have suggested that there are two components that produce generation effects. One component is conceptually driven and accounts for generation effects in general. The other component depends on surface features, or is data-driven, and accounts for enhanced generation effects like those revealed by Glisky and Rabinowitz (1985) in recognition memory and Gardiner and his colleagues (Gardiner, 1988; 1989; Gardiner et al., 1989) in implicit word fragment completion and anagram solution tests. Gardiner et al. (1989) state that they found "... further evidence
of generation effects that are very different from those found in explicit memory. These implicit effects in primed fragment completion and anagram solution are data-driven rather than conceptually driven . . .” (p. 303).

Two related theories, repetition of operations (Kolers, 1975; Kolers & Roediger, 1984) and transfer appropriate processing (Morris, Bransford, & Franks, 1977; Roediger & Blaxton, 1987; Roediger & Weldon, 1987; Roediger, Weldon, & Challis, 1989; Weldon, Roediger, & Challis, 1989) offer an explanation of these results. Kolers and Roediger's (1984) repetition of operations proposal is that performance on a given test will be enhanced relative to other conditions if the mental procedures at test repeat or recapitulate the mental procedures at study. Roediger's (1990) transfer appropriate processing view advances the idea of repetition of operations but proposes that there are two general types of memory processes which have already been discussed in this paper:
conceptually-driven and data-driven processes. While most explicit memory tests to date have emphasized conceptual processing and most implicit memory tests to date have emphasized data-driven processing, conceptual processing is not unique to explicit memory tests and data-driven processing is not unique to implicit memory tests.

Appealing to two types of memory processes, conceptually-driven and data-driven (perceptual), transfer appropriate processing theory provides a good explanation of why generation effects have been obtained on explicit memory tests but reverse generation effects have been produced on implicit memory
tests. The explicit tests have relied on conceptually-driven processes, but the implicit tests have depended on data-driven processes. Thus for explicit tests, the enhanced conceptual processing at study for a generate condition has benefited memory performance compared to reading a word a study. Oppositely, since their is a greater overlap in the surface features of a read word (e.g. assassin) and a word fragment (e.g. a__a__in; overlap of 4 letters) relative to a generated word (Hired political killer: a_____) and the test fragment (a__a__in; overlap of 1 letter), read words have been produced more priming than generated words.

The finding of superior performance for a generate condition compared to a read condition on a recognition test, where subjects read the test words, could pose a problem for a repetition of operations explanation. One might assume that reading a word (alone) at test is more like reading a word at study than generating a word at study. If associative cues are presented at study, however, one does not know what relational processing occurs between the associative cue and the target in the read and generate conditions. Thus, the relational processing between a cue and a generated word may be richer in nature than the relational processing between a cue and a read word, and this richer processing may be repeated at test despite the fact that the test word is read (Donaldson & Bass, 1980). Evidence supporting this idea was obtained in the Rabinowitz and Craik (1986) study.
Furthermore, a specific generation effect based on the specific associative cue - target word relationship was obtained in the Rabinowitz and Craik (1986). Though the authors did not say whether this specific generation effect was conceptually-driven or data-driven or both, since the specificity effect was based on the relationship between the associative cue and the target word, the effect was arguably due to conceptually-driven processes.

Although Rabinowitz and Craik (1986) showed a specific generation effect based on the associative - cue target relationship, Glisky and Rabinowitz (1985) obtained generation specificity without presenting associative cues. Instead, the specific generation effect was produced by presenting matching perceptual cues, word fragments, at study and test. Again, Glisky and Rabinowitz (1985), argued that the specific generation effects in that study depended on data-driven rather than conceptually-driven processing. Thus conceptual factors and perceptual factors may separately be able to produce specific generation effects based on whether conceptually-driven processes or data-driven processes are emphasized at test.

Some researchers have opted to explain the generation effect by proposing that self-generation makes target words more distinctive and hence more memorable (e.g. Begg, Snider, Foley, & Goddard, 1989; Gardiner & Hampton, 1988). This idea might apply to generation specificity as well, though no one has advanced this explanation. Unfortunately, repetition of operations does not address the issue of distinctiveness.
As described above, Glisky and Rabinowitz (1985, Experiment 5) manipulated whether the target word was read or generated, alone or with an associative cue at study, and manipulated whether the test word was read or generated (in the absence of the associative cue; see Table 1). As was shown in a prior experiment (Experiment 1), the performance in the generate-generate condition was better than the read-read, read-generate, and generate-read conditions for the items that were studied without an associative cue. However, for the items that were studied with an associative cue, performance in the generate-generate condition was superior to the read-read and read-generate conditions, but no different than the generate-read condition.

These results support the repetition of operations hypothesis, too. In the test phase, all items were presented without the associative cues. In the associative cue condition, since the cue was present at study but not at test, the study and test operations should have been different. Therefore, according to the repetition of operations hypothesis, no specificity effect should have occurred, and, in fact, none did occur. On the other hand, a specificity effect did occur in the alone condition, where the study and test presentations and the mental operations should have been relatively similar.
The Present Experiments

The repetition of operations and transfer appropriate processing accounts of memory are supported by the generation specificity results from both explicit memory tests (Glisky & Rabinowitz, 1985) and implicit memory tests (Gardiner, 1988; 1989; Gardiner et al., 1989). The purpose of the present series of experiments is (1) to show how different tests vary in terms of their reliance on perceptual and conceptual processing by replicating and extending Jacoby's (1978) Experiment 1; (2) to demonstrate, once again, the crucial nature of the exact match between the study and test fragment in obtaining specificity effects; and (3) to use the theory of transfer appropriate processing to help predict when similarities and dissimilarities of the various tests will occur. In each of the three proposed experiments the type of test and the form of the retrieval cues were manipulated. Note that what was important for the predicted results was not whether a test was an implicit or an explicit memory test. What was important was the relative reliance on the types of processing (perceptual and conceptual) that were engaged in a particular test and how this processing matched the processing engaged in the study phase.
Experiment 1

Recently researchers have shown that different memory tests can yield very different patterns of results (e.g. Jacoby, 1983; Weldon & Roediger, 1987). Therefore, one purpose of this experiment was to replicate and extend the results of Jacoby (1978) to other tests while also showing differences between outcomes for the test that he used, associative cued recall, and other tests. Based on this intention, the experiment was modeled after Jacoby’s (1978) Experiment 1. Like Jacoby’s (1978) experiment, there was a Read once condition, a Generate once condition, a Read twice condition, and a Read:generate condition. In addition, two other study conditions, a Generate twice condition and a Nonstudied condition were employed (See Table 3). To replicate and extend Jacoby’s (1978) results, one of four types of test were administered to four different groups of subjects: associative cued recall to replicate Jacoby’s (1978) results, and recognition, word fragment cued recall, and word fragment completion to extend his results.

Another goal was to replicate the work of Gardiner (1988; 1989) and Glisky and Rabinowitz (1985) in a single experiment. Gardiner and his colleagues (1988, Experiments 3-5, 1989;) never included an explicit memory test to compare to results for the word fragment completion test, so one group of subjects in the present experiment was given a word fragment completion test while another group was given a word fragment cued recall test. Administering
Table 3. **Study conditions and example stimuli for Experiment 1.**

<table>
<thead>
<tr>
<th>Item type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonstudied</td>
<td>----</td>
</tr>
<tr>
<td>1 presentation</td>
<td></td>
</tr>
<tr>
<td>Read once</td>
<td>river-stream</td>
</tr>
<tr>
<td>Generate once</td>
<td>river-s_re_m</td>
</tr>
<tr>
<td>2 presentations</td>
<td></td>
</tr>
<tr>
<td>Read twice</td>
<td>river-stream:river-stream</td>
</tr>
<tr>
<td>Generate twice</td>
<td>river-s_re_m:river-s_re_m</td>
</tr>
<tr>
<td>Read:Generate</td>
<td>river-stream:river-s_re_m</td>
</tr>
</tbody>
</table>
the word fragment cued recall test satisfied the retrieval intentionality criterion advocated by Schacter et al. (1989).

A third purpose of this experiment was to show a generation effect for all four tests. This objective was attempted by having subjects generate words at study using both a conceptual and a perceptual cue. As was done by Jacoby (1978), the conceptual cue was an associate of the target word, and the perceptual cue was a fragment of the target word itself. Different retrieval cues were employed for the various tests. The conceptual cue presented at study was re-presented for the associative cued recall test, the entire target word was presented for the recognition test, and the perceptual cue presented at study was re-presented for the word fragment cued recall and word fragment completion tests. The predicted generation effect for the associative cued recall and recognition tests was expected to be driven primarily by conceptual processes. On the other hand, the predicted generation effect for the word fragment cued recall and word fragment completion tests was expected to be guided by data-driven processes. That is, the match in perceptual features between the study and test fragment was expected to drive the generation effect. Since word fragment cued recall is affected by conceptual manipulations (e.g. level of processing; Roediger, Weldon, Stadler, & Riegler, 1992), conceptual processes also were expected to contribute to a generation effect for this test.

The second manipulation that was built in by using Jacoby’s (1978) design was number of study presentations. In Jacoby’s (1978) study, reading a word
twice in immediate succession resulted in better memory performance than reading a word once. Recognition has also shown an effect of massed repetition (Wells, 1974). As described earlier, Greene (1990) failed to find a difference between reading a word once versus reading a word twice massed on a word fragment cued recall test. Challis and Sidhu (1993) did find an effect of massed repetition on word fragment cued recall, with 4 and 16 massed study presentations producing more completions than one study presentation. The question here was whether Greene’s (1990) work would be replicated. No one has observed an effect of massed repetition on a word fragment completion test so an effect was not expected in the present experiment (Challis & Sidhu, 1993; Greene, 1990; Roediger & Challis, 1992). Therefore, an effect of massed repetition was predicted to occur for the associative cued recall, recognition, and possibly word fragment cued recall test but not for the word fragment completion test. Obtaining this result would demonstrate a dissociation between the explicit memory tests and the implicit memory test.

Usually effort is thought to be important for explicit memory tests, with more effortful study processing resulting in better test performance (e.g. Auble & Franks, 1978; Griffith, 1976; Tyler, Hertel, McCallum, & Ellis, 1979; but see Zacks, Hasher, Sanft, & Rose, 1983). Based on Jacoby’s (1978) results for an associative cued recall test, a generate condition ought to produce better performance than a read:generate condition because more effort ought to be involved in generating the target in the generate condition. Since subjects have
just seen the target word in the read:generate condition, not as much effort should be required to generate the same target word to the immediately subsequent word fragment (see Table 3 for examples).

Thus, another aim was to extend Jacoby’s (1978) effect of generation difficulty for associative cued recall to the other tests. Using Jacoby’s (1978) idea of presenting a read trial immediately before a generate trial (for the same target word) to short-circuit the generation process provided the opportunity to replicate his result for associative cued recall. If this procedure disrupts conceptual processes, then tests that depend primarily on conceptual processes should be affected by this manipulation. In the present experiment, three tests were thought to depend on conceptual processing: associative cued recall, recognition, and word fragment cued recall. The logic was that if only conceptual processing were disrupted by the read:generate manipulation then an effect of generation difficulty (better performance for Generate once than for Read:generate) would occur for associative cued recall, recognition, and word fragment cued recall but not for word fragment completion. On the other hand, if both conceptual and perceptual processes for generation are disrupted by a read:generate procedure, then tests that depend on conceptual and/or perceptual processing should be affected by this manipulation. In this case, performance on all four of the tests would be affected.

Manipulations that have attempted to short-circuit the generation process have not used word fragment cues at test. Using word fragments as study and
test cues provided a perceptual match in fragments, which was a constant between the Generate once and Read:generate conditions. Explicit memory tests usually rely more on conceptual-driven processes, but word fragment cued recall test probably relies more on data-driven processing than most explicit memory tests (Weldon et al., 1989). Also implicit word fragment completion is thought to rely more on data-driven processing (Roediger et al., 1989).

The relative strength of an effect of a perceptual match between study and test cues compared to an effect of generation difficulty was unknown for a word fragment cued recall test. A beneficial effect of a perceptual match between study and test stimuli could be a stronger determinant for performance than generation difficulty, such that an effect of generation difficulty on the word fragment cued recall test might not be observed. On the other hand, an effect of generation difficulty might be so robust that an effect of the perceptual manipulation might go unobserved. So predictions about the effect of trivializing the generation process on a word fragment cued recall test were ambiguous. The same ambiguity occurred in predictions for the implicit word fragment completion test as well.

One question was: Would the Read:generate condition produce as much priming as the Generate once conditions? If generation specificity effects are due to perceptual processes, as Gardiner et al. (1989) have proposed, then there would be no difference in the amount of priming obtained for the Generate once and Read:generate conditions. This assumed that the critical factor in these two
conditions was seeing the same word fragment in the study phase as that to be presented in the test phase. Of course, the proper comparison to show an effect of seeing the word fragment in the Read:generate condition was between the Read:generate condition and the Read twice condition, because a comparison of the Read:generate condition to the Generate once condition would confound the number and type of presentations. Thus a generation effect for the repetition conditions would support the idea that generation specificity is due to data-driven processes. If conceptual processing were involved in producing effects of generation specificity, then there would be a difference in the amount of priming obtained, favoring the Generate once over the Read:generate condition.

Experiment 2 of Olafsson and Nilsson (1992) suggests that perhaps reading a target word immediately prior to seeing the word fragment does not entail processing sufficient enough to produce an effect of specificity. However, free recall and word fragment completion performance were found to be highly dependent in their experiment, so explicit contamination possibly could have resulted in the null effect that was obtained for the read group.

Unfortunately, neither the theory of transfer appropriate processing nor any other theory has been developed to the point of being able to make specific predictions for the generation difficulty manipulation. Whether the generation difficulty procedure used in the present experiment would disrupt conceptual processes, or both conceptual and perceptual process involved in generating the target word, the results were not crucial for evaluation of the transfer
appropriate processing account since the theory makes no specific predictions about these conditions.

The a priori hypothesis was that reading the target immediately prior to generating it would disrupt only conceptual processes. Thus the Generate once condition was expected to yield better performance than that for the Read:generate condition for the associative cued recall, recognition, and possibly word fragment cued recall tests but not for the word fragment completion test.

Method

Subjects. One hundred fifty U.S. Air Force recruits were tested at Lackland Air Force Base in San Antonio, TX.

Materials. The critical items were 66 word pair associates drawn from the associative norms listed in Postman and Keppel (1970). All target words were 5-9 letters in length, and word fragments were constructed for each target word. Ten additional word pairs were used as primacy and recency buffers at study. Finally, 50 additional word fragments for names of concrete objects were drawn from the Snodgrass and Vanderwart (1980) norms and used as filler items at test. IBM compatible Zenith computers at Armstrong Laboratories at San Antonio, TX, were used to run the experiments (utilizing MEL software; Schneider, 1988) and collect the data.

Design. The experiment was a 4 (Test: Associative cued recall, Recognition, Word fragment cued recall, Word fragment completion) x 6 (Item type: Read once, Generate once, Read twice, Generate twice, Read:generate,
Nonstudied) mixed design, with Type of test as a between subjects factor and Item type as a within subjects factor.

**Procedure.** The stimuli were randomly assigned to 6 different lists, with 11 pairs per list. The 6 lists were rotated through the various study conditions such that each list served in each item type condition an equal number of times (see Table 3).

One of the 6 lists was not presented at study to provide a baseline measure. The other 5 lists (55 word pairs) were presented in 88 study trials. The items of 2 lists were presented once, and the items of 3 lists were presented twice in immediate succession. The word pairs were preceded by 5 primacy buffer items and followed by 5 recency buffer items. All trials were presented on a computer screen at a rate of 6 seconds per item with an additional 200 msec interval between trials. The different study conditions were presented randomly across trials, and the items within each condition were drawn randomly without replacement. The study phase took a total of 8-10 minutes.

Following the study phase, a 15-20 minute retention interval was filled with an unrelated object decision task. Unless otherwise specified, all experiments included a 15-20 minute retention interval, during which subjects made decisions about 3-dimensional objects presented as line drawings.

For the associative cued recall test, the left word of each word pair seen at study was presented with a series of question marks presented to the right (e.g. sleep - ???????). The Nonstudied list again was included at test as a baseline
measure. Subjects were instructed: "The following task is a memory test for the second word (the word on the right) of each word pair that was presented to you earlier. To help you, the first word (the word on the left) of each word pair will be presented as a cue. Some of the cues that you are about to see are words you read earlier, and some of the cues are words you have not seen. If the cue is one you saw earlier, write the word that was paired with it (on the right-hand side). Write down a word only if you remember it from earlier in the experiment." The order of the items for the test was the same predetermined random order for each subject.

The recognition test presented the target words and fillers as whole words and maintained the order of critical items from the associative cued recall test. Each word was presented to the subject he/she judged whether the word was old (studied) or new (Nonstudied). Subjects were instructed: "The following task is a recognition test for the second word (the word on the right) of each word pair that was presented to you earlier. Some of the words you are about to see are words that you read or generated earlier, and some of the words are new (words that were not presented to you earlier). For each word, you should decide if the word is old or new. Press 'O' if the word is old and 'N' if the word is new."

The word fragment cued recall and implicit word fragment completion tests were identical except for the instructions. Subjects who received the word fragment cued recall test were told: "The following task is a memory test for the
second word (the word on the right) of each word pair that was presented to you earlier. To help you remember the words you will be given some of the letters as a cue (a word fragment). Some of the cues will be for old words and some of the cues will be for new words. Complete the word fragments only with words that were presented to you earlier. If you think the word is one you did not see (you think the word is new), write 'new.' Also, if you cannot remember a word that will fit a fragment, leave the item blank or write the word 'new.' Do not write the completion for a word that is new -- only write down a word if you are sure it is old." The subjects in the implicit test group were instructed: "The following task assesses your ability to complete word fragments (incomplete words). You should complete each word fragment with the first word that comes to mind." In addition to the 55 studied words and the 11 critical new words, 44 filler word fragments were included on the test. Thus the test was composed of half old and half new items. The order of items on the fragment completion test was the same randomly predetermined order as for the recognition test. Subjects saw each test fragment for 10 seconds, then were given an additional 10 seconds to write an answer on each trial. The test phase took about 20-25 minutes.

In order to measure the rate of successful generation for the study fragments, after the test phase the generate lists were re-presented. (Prior to this experiment, testing established a high generation success rate for the materials, .90) Subjects were instructed write the word they generated in the study phase
so that the data could be conditionalized on their ability to generate the targets. Subjects were given 15 seconds to write each word.

After the generation check program subjects answered three survey questions (see Appendix B). This questionnaire was intended to help identify explicit contamination of the implicit test by simply asking subjects if they used intentional retrieval strategies to complete the word fragments. Anecdotally, from prior research at Rice University, most subjects in an implicit test group are aware that some of the first words that come to mind are words that were presented to them earlier in the experiment. The expectation here was that subjects would be aware of this occurrence but that they would not engage in an intentional retrieval strategy. After filling out the questionnaire subjects were debriefed. The entire experimental session took about 50 minutes.

Results

The data for each test group -- associative cued recall, recognition, word fragment cued recall, and word fragment completion -- were subjected to a repeated measures ANOVA. All follow-up comparisons were tested using Fisher's LSD test. The alpha was set at .05 for all analyses. This approach also was used for the analyses of Experiments 2 and 3. The mean rate for each Test group in Experiment 1 is presented by Item type in Table 4, with the critical difference obtained from the LSD test reported in the last row of the table. The corrected scores (hits - intrusions) are presented in Table 5. The data presented are not conditionalized for successful generation at study because of two
Table 4. **Experiment 1: Mean proportions as a function of test and item type** (ACR = Associative cued recall; RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th>Item type</th>
<th>ACR</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read once</td>
<td>.41</td>
<td>.59</td>
<td>.44</td>
<td>.68</td>
</tr>
<tr>
<td>Generate once</td>
<td>.62</td>
<td>.83</td>
<td>.63</td>
<td>.71</td>
</tr>
<tr>
<td>Read twice</td>
<td>.46</td>
<td>.73</td>
<td>.52</td>
<td>.70</td>
</tr>
<tr>
<td>Generate twice</td>
<td>.70</td>
<td>.87</td>
<td>.67</td>
<td>.76</td>
</tr>
<tr>
<td>Read:generate</td>
<td>.52</td>
<td>.85</td>
<td>.67</td>
<td>.79</td>
</tr>
<tr>
<td>Nonstudied</td>
<td>.07</td>
<td>.15</td>
<td>.22</td>
<td>.56</td>
</tr>
<tr>
<td>LSD</td>
<td>.08</td>
<td>.07</td>
<td>.08</td>
<td>.07</td>
</tr>
</tbody>
</table>

Table 5. **Experiment 1: Mean corrected rates (hits - intrusions) as a function of test and item type** (ACR = Associative cued recall; RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th>Item type</th>
<th>ACR</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read once</td>
<td>.35</td>
<td>.44</td>
<td>.22</td>
<td>.12</td>
</tr>
<tr>
<td>Generate once</td>
<td>.55</td>
<td>.68</td>
<td>.41</td>
<td>.15</td>
</tr>
<tr>
<td>Read twice</td>
<td>.39</td>
<td>.58</td>
<td>.30</td>
<td>.14</td>
</tr>
<tr>
<td>Generate twice</td>
<td>.63</td>
<td>.72</td>
<td>.45</td>
<td>.20</td>
</tr>
<tr>
<td>Read:generate</td>
<td>.44</td>
<td>.70</td>
<td>.45</td>
<td>.23</td>
</tr>
</tbody>
</table>
separate problems. One problem was a programming error and the other was the failure of many subjects to write down their answers in the generation check. Together these problems resulted in generation check data for only one-third of the subjects. Therefore, any generation effects obtained in Experiment 1 represent a conservative estimate of the real effects of generation.

**Associative Cued Recall.** The repeated measures ANOVA was significant, $F(5, 145) = 58.22$, $MSe = .03$, and the Critical difference for Fisher’s LSD was .08. As expected, recall for the five study conditions was well above that for Nonstudied items (false recall). Focusing on the study conditions, the data replicated Jacoby (1978) nicely. First there was a significant generation effect with the Generate once (.62) condition yielding significantly better recall than the Read once (.41) condition. The comparison between the Read twice condition (.46) and Read:generate condition (.52) also yielded an advantage of generation, though this difference was not significant. For the repetition variable, there was an advantage for the Read twice (.46) over the Read once condition (.41) and an advantage for the Generate twice condition (.70) over the Generate once condition (.62). However, only the difference between the Generate once and Generate twice conditions was significant. The attempt to short-circuit the generation process was successful, with the Generate once condition (.62) producing significantly better recall than the Read:generate condition (.52). This situation occurred again with the Generate once condition (.62) also showing an advantage over the Read twice condition (.46). Thus, one
generate study trial produced better cued recall performance than two study
trials (Read twice as well as Read:generate). The difference between the
Generate twice condition (.70) and the Read:generate condition (.52) was
significant.

Overall, the associative cued recall data replicated Jacoby’s (1978)
findings. Generation effects, repetition effects, and a generation difficulty effect
were all obtained. The Generate once condition produced better recall than the
Read once condition and the Read:generate condition produced better recall than
the Read twice condition. While the repetition effect for the read conditions
(Read once compared to Read twice) was not significant, the trend favored the
Read twice condition. Making the generation process less effortful (Read:
generate condition) attenuated performance relative to the more effortful
situation of generating a word once (or twice). Thus, the Generate once
condition produced better recall than two conditions that used two study trials
rather than one study trial: the Read twice condition and the Read:generate
condition. The new finding was a massed repetition effect for the generate
conditions, with the Generate twice condition yielding greater cued recall than
the Generate once condition.

Recognition. The repeated measures ANOVA was significant, \( F(5, 145) =
114.60, \text{MSE} = .02 \), and the critical difference for Fisher’s LSD was .07. First,
words from the five study conditions were identified as “old” significantly more
often than words from the Nonstudied condition, demonstrating that recognition
was above chance for all study conditions. As was the case with the associative cued recall data, there was a significant generation effect, with the Generate once condition (.83) producing significantly better recognition than the Read once condition (.59). Also, recognition for the Read:generate condition (.85) was significantly better than recognition for the Read twice condition (.73), showing another generation effect. A significant massed repetition effect was obtained for the read conditions, with the Read twice condition (.73) producing better performance than the Read once condition (.59), but no repetition effect was obtained for the generate conditions, with only a small advantage being present for the Generate twice condition (.87) over the Generate once condition (.83). Unlike the associative cued recall results, the Generate once condition (.83) was no different than the Read:generate condition (.85). Thus, the generation difficulty manipulation failed to produce an effect for the recognition test. However, the Generate once condition (.83) did yield significantly better recognition performance when compared to the Read twice condition (.73). Finally, recognition for the Generate twice condition (.87) was not significantly better than recognition for the Read:generate condition (.85).

Most of the expectations for the recognition data were borne out, extending Jacoby’s (1978) results for associative cued recall to recognition. As with the associative cued recall data, generation effects and repetition effects were obtained. The comparison of the Generate once condition to the Read once condition and the comparison of the Read:generate condition to the Read twice
condition both yielded generation effects. Importantly, the finding that the Generate once condition produced better recognition than the Read once condition replicated the observations of Glisky and Rabinowitz (1985). The repetition effect for the read conditions was significant, and although the repetition effect for the generate conditions was not significant the trend showed an advantage for the Generate twice condition. One possibility is that performance for the generation conditions may have been constrained by a ceiling effect.

Unlike the results for associative cued recall, the recognition test showed no effect for the generation difficulty manipulation. That is, the Generate once condition did not yield better recall than the Read:generate condition. Perhaps the best explanation for this difference in results between the two tests centers on the type of retrieval cue given at test.

For the associative cued recall test, the associative cue helps a subject retrieve a target word based on the associative cue - target word relationship (Donaldson & Bass, 1980; Rabinowitz & Craik, 1986). A generate trial is thought to strengthen the associative cue - target relationship, but when the associative cue - target word relationship is not strengthened on a generate trial by presenting a read trial immediately beforehand, the associative cued recall test is then affected. For the recognition test, the presentation of the whole target word may influence a subject to rely more on processing of the individual (target) word rather than referring to the associative cue - target relationship. If the
recognition test does not depend so heavily on the associative cue - target word relationship, then a failure to strengthen this relationship on the generate trial in the Read:generate condition would not influence recognition test performance.

**Word Fragment Cued Recall.** The data for the group showed a false alarm rate of .38. Based on this unusually high rate of completing Nonstudied items, the possibility existed that subjects did not understand the instructions to not write down new words. Thus, another group of subjects was given a word fragment cued recall test with test instructions that emphasized the importance of writing down a word only when the subject was sure the item was old. Also, the instructions stressed that the subject was not sure an item was old, he/she should write the word “new” in the answer space provided. While the false alarm rate for the second group of subjects was still somewhat high (.22) this group was used as the comparison group for the three other test groups.

The repeated measures ANOVA was significant, $F (5, 145) = 40.38$, $MSe = .02$, and the critical difference for Fisher’s LSD was .08. A significant generation effect was obtained, with the Generate once condition (.63) producing more completions than the Read once condition (.44). Also, the Read:generate condition (.67) showed an advantage of generation over the Read twice condition (.52). With regard to the repetition manipulations, the Read twice condition (.52) yielded better performance than the Read once condition (.44), showing a significant repetition effect. However, the Generate twice condition
(.67) yielded only a small but nonsignificant benefit compared to the Generate once condition (.63). The generation difficulty manipulation did not influence the completion rate. The Read:generate condition actually yielded more correct completions than the Generate once condition, though this difference was not significant. Finally, there was no difference in the completion rates for the Read:generate (.67) and Generate twice (.67) conditions, but generating a word once (.63) produced significantly better cued recall than reading a word twice (.52).

The results for the word fragment completion test showed the same pattern of results as the recognition data, extending some of Jacoby’s (1978) results while limiting others. First, the findings for Jacoby’s (1978) generation and repetition manipulations were extended. Generation effects were obtained for the two comparisons aimed at the generation effect: the Generate once condition versus Read once condition and the Read:generate condition versus the Read twice condition. As with the recognition data, a significant repetition effect (Read twice advantage over Read once) was observed for the read conditions and the trend for the generate conditions was in the expected direction (Generate twice advantage over Generate once). Greene (1990, Experiment 1) failed to obtain a repetition effect for 2 massed study presentations versus 1 study presentation on a word fragment cued recall test, yet Challis and Sidhu (1993) observed a massed repetition effect for 4 and 16 presentations versus 1 presentation using a word fragment completion cued
recall test. Thus, the occurrence of a repetition effect for the read conditions marked a failure to replicate the work of Greene (1990), but in a sense replicated the work of Challis and Sidhu (1993).

Like the results for recognition, the results for word fragment cued recall failed to demonstrate an effect of generation difficulty. Unlike associative cued recall, word fragment cued recall is thought to be influenced, at least to some degree, by perceptual manipulations. Since the same word fragment that was presented at study was presented again during the test as a retrieval cue, the retrieval was guided by perceptual cues. This dependence on the perceptual features of the stimuli may have resulted in decreasing the dependence on conceptually-driven processes, such that, similar to the results for the recognition test, there was no effect of the (conceptual) generation difficulty manipulation. This outcome shows an unexpected similarity between recognition and word fragment cued recall, but a difference between these two tests and associative cued recall: Neither recognition nor word fragment cued recall was affected by the generation difficulty manipulation, but the associative cued recall was affected by this manipulation.

**Word Fragment Completion.** The repeated measures ANOVA was significant, $F (5, 145) = 8.48, MSE = .02$, and the Fisher’s LSD was .07. First, items from the study conditions were completed more often than new items (Nonstudied condition) showing significant priming for all study conditions. Suprisingly, there was no generation effect. The Generate once condition (.71)
yielded only a slight, nonsignificant advantage over the Read once condition (.68). On the other hand, the Read:generate condition (.79) produced more completions than the Read twice condition (.70). As predicted, there was no repetition effect for the read condition, with the Read twice condition (.70) providing little, if any, benefit relative to the Read once condition (.68). The Generate twice condition (.76) showed a small advantage compared to the Generate once condition (.71), but this difference also was not significant. Since the Read:generate condition (.79) produced more correct completions than the Generate once condition (.71), the generation difficulty manipulation did not affect this test. In addition, there was no difference between the Read:generate condition (.79) and the Generate twice condition (.76).

Thus the word fragment completion test produced results that were very different than the results for the three explicit tests. First, there was no generation effect for the Generate once versus Read once comparison, but there was a robust generation effect between these two conditions for the three explicit tests. This outcome was not predicted. One reason why this result may have occurred is that subjects may not have been able to generate items successfully in the study phase. Since the average (specific) generation effect obtained by Gardiner and his colleagues (1988; 1989; Gardiner et al., 1989) for implicit memory was relatively small (.10), perhaps an inability to generate the study items in the present study resulted in obtaining no effect for the unconditionalized data. Subjects in Gardiner’s (1988; 1989) studies were given
the target word (aurally) if they failed to generate it at study in most of the experiments, so subjects always knew what the target word that fit the word fragment was. The testing procedure in the present study prevented this possibility.

Unfortunately, as noted above, the data could be conditionalized for only one-third of the subjects in the implicit test group. The generation success rate for these 10 subjects was the same as that obtained for subjects in the pilot study, .90. When the conditionalized data for these 10 subjects were examined, there was a .10 advantage for the Generate once condition relative to the Read once condition. Therefore, the possibility exists that a generation effect would have been observed for the implicit test group if all of the data for the generation check had been collected. However, this aim was not accomplished, and the result must be left inconclusive.

There was a generation effect for the word fragment completion data for the Read:generate and Read twice conditions, marking a similarity between the four tests. Unlike the three explicit memory tests, however, here was little hint of a repetition effect for the read conditions. In contrast, a small, nonsignificant repetition effect was observed for the Generate twice versus Generate once condition, but the fact that this difference was not significant could possibly be due to more generation failures in the Generate once condition than in the Generate twice condition. Note that this difference was significant for the associative cued recall group but not for the recognition or word fragment cued
recall groups. Finally, like the results for recognition and word fragment cued recall, there was no effect of the generation difficulty manipulation. Again, this outcome is probably due to the emphasis of word fragment completion on data-driven processing for the individual target word rather than conceptually-driven processing for the associative cue - target word relationship.

Explicit Contamination. With regard to the question of explicit contamination of the implicit test, a post-experiment questionnaire asked three questions of subjects in the implicit memory group as an attempt to identify intentional retrieval strategies (see Appendix A). Almost all subjects reported that they were aware that sometimes the first word that came to mind was a word they had been presented earlier. Also, most subjects reported that they did adopt a strategy of intentionally thinking back to the study list to help complete the word fragments.

Correlations were computed for the percentage of times that subjects reported using an intentional retrieval strategy and the priming obtained for each of the study conditions. While all of the correlation were positive (range \( r = .12 \) to \( r = .23 \)), none reached significance all \( ps > .30 \). Thus, although subjects reported that they used intentional retrieval strategies on the implicit test, there is no evidence that what they reported significantly influenced the amount of priming obtained. Subjects may have reported using an intentional retrieval strategy due to demand characteristics, or they may have grossly overestimated the percentage of the time that they adopt such a strategy.
Another possibility is that subjects did not engage in an intentional strategy but did not understand the meaning of "intentionally thinking back" to the words presented earlier. Subjects may have treated the second question as a subtle differentiation from the first question regarding awareness (see Appendix A). That is, subjects may have understood the first question correctly, responding that they were aware that some of the words that first came to mind were words that were presented earlier in the experiment but may have misunderstood the second question, thinking that the question asked whether they simply used words presented earlier in the experiment, not whether they intentionally used words presented earlier in the experiment.

Stronger evidence that explicit contamination of the implicit test did not occur is that there was a repetition effect for the word fragment cued recall test but none for the word fragment completion test. And although the question of a generation effect (Generate once compared to Read once) for the implicit test group remains ambiguous, a large generation effect was obtained for the word fragment cued recall group. If subjects in the implicit memory test group were engaging in an intentional retrieval strategy, one would expect that the results for word fragment completion would appear much like the results for the word fragment cued recall group. Since a repetition effect and a generation effect were obtained for the word fragment cued recall group but not the word fragment completion group, explicit contamination of the implicit test does not seem to have been a problem in the present experiment.
Discussion

Overall, the generation and repetition effects obtained by Jacoby (1978) for associative cued recall were replicated and extended to recognition and word fragment cued recall. Robust generation effects (Generate once compared to Read once) were obtained for all three explicit tests as predicted, and the generation effect obtained for the recognition group replicated the findings of Glisky and Rabinowitz (1985). Unfortunately, the predicted generation effect for the word fragment completion test did not occur for the unconditionalized data, and the data could not be conditionalized on successful generation for all subjects. The lack of a generation effect for the word fragment completion group failed to replicate the findings of Gardiner (1988; 1989), but there was a suggestion of an effect for the conditionalized data of the 10 subjects that could be analyzed. Thus, whether there may have been a generation effect for the implicit test remains equivocal.

Jacoby (1978) failed to obtain a generation effect for the repetition conditions, Read:generate versus Read twice. The present experiment also failed to produce a significant generation effect for the Read:generate versus Read twice comparison for associative cued recall. There was an advantage for the Read:generate condition relative to the Read twice condition on this measure for both Jacoby’s (1978) experiment and the present experiment, though. In contrast, the other three tests in the present experiment showed a generation effect when the Read:generate condition was compared to the Read twice
condition. This difference in outcomes again appears to be related to the finding that the generation difficulty manipulation attenuated performance for the Read:generate condition relative to the Generate once condition for the associative cued recall test but not for the other three tests.

Effects of massed repetition occurred for the associative cued recall test for both the read and generate conditions. The recognition test and word fragment cued recall test yielded a repetition effect for the read conditions, and a nonsignificant advantage for the Generate twice condition relative to the Generate once condition. Again, the result for the word fragment cued recall test marked a failure to replicate Greene (1990) but was in agreement with Challis and Sidhu (1993). By comparison, for the word fragment completion test, there was no massed repetition effect for the read conditions, replicating the work of prior research (Challis & Sidhu, 1993; Greene, 1990; Roediger & Challis, 1992). The fact that there was a repetition effect for the recognition and word fragment cued recall test, and a trend in the right direction for the associative cued recall test, showed a parallel between these three explicit memory tests, while the absence of a massed repetition effect for the implicit test demonstrated a dissociation between the implicit and explicit tests.

On the other hand, for the implicit test there was a nonsignificant advantage for the Generate twice condition over the Generate once condition that was about the same magnitude as that observed for the recognition and word fragment cued recall tests. Further research is needed to determine if the
advantage obtained for the Generate twice condition compared to the Generate once condition for recognition, word fragment cued recall, and word fragment completion is, in fact, a real effect. If a repetition effect for generate conditions were found for these three tests, then an additional parallel would be obtained between these three tests and associative cued recall. However, if no effect were found for these three tests, then a dissociation between these tests and associative cued recall would be obtained.

Reading the target word first followed by generating the target (Read:generate) produced results very similar to the results of Jacoby (1978) for the associative cued recall test only. Jacoby (1978) employed the Read:generate condition with the idea that reading the target word first would give subjects the opportunity to remember the target when required to generate it, thus making the generation process less effortful. He found that generating words once produced better recall than reading, then generating words. The data from the present experiment replicated his finding for associative cued recall, but this result was not obtained for the recognition, word fragment cued recall, and word fragment completion tests. Thus there was an unexpected dissociation between associative cued recall and the other three tests.

This result can be explained by the difference in retrieval cues. When the retrieval cue primarily demanded the use of conceptually-driven processes based on the associative cue - target word established at study, as in associative cued recall, an effect of generation difficulty was obtained. However, when the
retrieval cue displayed part or all of the surface features of the target without
the associative cue, as in recognition, word fragment cued recall, and word
fragment completion, processing of the individual target word (and possibly
more data-driven processing as a consequence) was emphasized. Because the
processes instantiated by these tests did not rely upon the associative cue - target
word relationship quite so heavily, no effect of generation difficulty was
obtained.
Experiment 2

The results of Experiment 1 produced two surprises. First, there was no effect of generation (the Generate once compared to the Read once condition) on the unconditioned data for the word fragment completion test. Second, the generation difficulty manipulation affected only the associative cued recall test. Therefore, the present experiment was designed to replicate and add to the findings of Experiment 1.

In Gardiner’s (1988) Experiment 5, generating the target word in the study phase to a conceptual cue and a word fragment different from the test fragment yielded no more priming than for reading the (whole) target word at study with the conceptual cue (see Table 2). However, generating the target word at study to the same word fragment to be shown during the test phase produced significantly more priming than the Read and Generate-different fragment conditions. While generating to a different at study from that to be presented at test has not produced any more priming that in a read condition for word fragment completion, the effortful act of generation should produce better memory performance in a generate-different condition relative to a read condition on a test that “taps” conceptually-driven processing.

Glisky and Rabinowitz (1985, Experiment 3) had subjects use word fragments to generate target words in a study phase. The study fragments were either the same as or different from word fragments that were presented in the test phase. In their experiment a test procedure was used whereby subjects
either completed a word fragment, then judged whether the word was old or new, or read the whole word and judged whether the word was old or new. Using this test procedure, Glisky and Rabinowitz (1985) observed a small, but nonsignificant, recognition advantage for a generate-different test condition fragment condition over a read test condition. Whereas Glisky and Rabinowitz (1985) used a sort of generate/recognize task that combined word fragment completion and recognition (with recognition being the dependent measure), the present study employed a word fragment cued recall task for one group of subjects and a recognition test for another group of subjects.

The general purpose of Experiment 2 was to show functional similarities between word fragment completion and word fragment cued recall, and to dissociate these two word fragment tests from associative cued recall and recognition tests. In addition, an attempt was made to dissociate word fragment completion from all three explicit tests, word fragment cued recall, associative cued recall, and recognition. The method was the same general method used in Experiment 1.

As in Experiment 1, there were read and generate conditions. The study conditions were: Read once, generate to the same fragment to be presented at test (Generate-same fragment), generate to a different fragment than the fragment to-be-presented at test (Generate-different fragment), Read twice, read followed by generate to the same fragment as that to be given at test (Read:generate-same fragment), read followed by generate to a different
fragment from that to be given at test (Read:generate-different fragment) and Nonstudied (see Table 6). Note that the Read once, Generate-same fragment, Read twice, and Read:generate-same fragment conditions provided a partial replication of Experiment 1.

Again, a central aim was to show a generation effect for all four tests. However, the generation effect for the associative cued recall and recognition tests were expected to show equivalent generation effects for the Generate-different fragment condition and Generate-same condition producing better memory performance than the Read once condition. Since word fragments were not used as retrieval cues, it is a misnomer to refer to the study fragment conditions as “same” or “different” for these two tests. However, based on the findings of Glisky and Rabinowitz (1985) for explicit memory and Gardiner (1988; 1989) for implicit memory, a nonspecific generation effect (e.g. the Generate-different fragment condition would produce better cued recall than the Read condition) as well as a specific generation effect (e.g. the Generate-same fragment condition would yield better performance than the Generate-different fragment condition) was expected for the cued recall test, but only a specific generation effect was expected for the word fragment completion test. Thus a parallel effect of specificity would be obtained for the implicit word fragment completion and word fragment cued recall test conditions. In contrast, these effects of specificity were not expected to be produced on the associative cued recall and recognition test, thus yielding a dissociation between the tests using
Table 6. Study conditions and example materials for Experiment 2.

Nonstudied

1 Presentation
   Read once
   Generate-same
   Generate-different

2 presentations
   Read twice
   Read:Generate-same
   Read:Generate-different

**Example of Materials**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Study</th>
<th>WFC/WFCR Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>river-stream</td>
<td>s_re_m</td>
</tr>
<tr>
<td>Generate-same</td>
<td>river-s_re_m</td>
<td>s_re_m</td>
</tr>
<tr>
<td>Generate-different</td>
<td>river-st_ea_</td>
<td>s_re_m</td>
</tr>
</tbody>
</table>
word fragments as retrieval cues and those not using word fragments as retrieval cues. This finding would reiterate that it is not whether the test is an implicit or an explicit memory test that is important, but the nature of the test cue -- as has been argued previously (Weldon et al., 1989).

Based on the results of Experiment 1, massed repetition (Read twice compared to Read once) should have no effect on the word fragment completion and word fragment cued recall tests but should have an effect on the associative cued recall and recognition tests. The results for associative cued recall and recognition should be similar.

Again, generation difficulty was manipulated in the presenting the target word for a read trial immediately before presenting a generate trial. This procedure was used for study fragments that matched the test fragments (Read:generate-same fragment condition for the Generate-same fragment condition) as well as for study fragments that did not match the test fragments (Read:generate-different fragment condition for the Generate-different fragment condition). If the results for the associative cued recall and recognition test for Experiment 1 were replicated, the generation difficulty manipulation would affect associative cued recall performance but not recognition performance. For the word fragment completion and word fragment cued recall tests, an effect of generation difficulty would not be expected based on the results of Experiment 1, at least for the conditions that used the same word fragment at
study and test. However, the potential existed to replicate and extend this prior finding to the different-fragment conditions.

In sum, a nonspecific generation effect was predicted for the three explicit memory tests but not the implicit test. In contrast, a specific generation effect was expected for the word fragment cued recall and word fragment completion tests but not for the associative cued recall and recognition tests. Since the experiment conformed to the retrieval intentionality criterion, if a specific generation effect was obtained for both the word fragment cued recall and word fragment completion test, but these tests were dissociated based on a separate manipulation (e.g. a nonspecific generation effect or a massed repetition effect), one would be assured that the effect of generation specificity for the implicit test was not due to explicit contamination. If the results for the massed repetition condition in Experiment 1 were replicated, then the three explicit tests would show an effect of massed repetition. On the other hand, word fragment completion would not show a massed repetition effect. Finally, if the results of Experiment 1 were replicated, an effect of generation difficulty would be observed for the associative cued recall test only.

**Method**

**Subjects.** One hundred forty U.S. Air Force Recruits were tested at Lackland Air Force Base in San Antonio, TX.

**Materials.** The materials were the same as those used in Experiment 1 with the exception that 4 of the buffer items from Experiment 1 were used as
target items in Experiment 2, and so 4 new items were used as buffers (see Appendix A).

**Design.** A 4 (Test: Associative cued recall, Recognition, Word fragment cued recall, Word fragment completion) x 7 (Item type: Read, Generate-same, Generate-different, Read twice, Read:generate-same, Read:generate-different, Nonstudied) mixed design was employed. Again Type of test was a between subjects factor, while Item type was a within subjects factor.

**Procedure.** The whole experimental list design and experimental procedure were followed the design and procedure of Experiment 1. Seven lists of 10 words were used. The 7 lists were rotated through each study condition such that each list served in each study condition an equal number of times.

**Results**

The mean rates for each test group are presented as a function of item type in Table 7, with the corrected scores (hits - intrusions) presented in Table 8. The data presented are not conditionalized for successful generation at study. With regard to the generation check, only a few subjects neglected to participate in the check. The data for subjects who did provide this information was conditionalized on successful generation, but conditionalizing the data did not change the results for any of the analyses. Unless otherwise noted, the means for the conditionalized data yielded the same means (within .01) as for the unconditionalized data.
Table 7. Experiment 2: Mean proportions as a function of test and item type (ACR = Associative cued recall; RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th>Item type</th>
<th>ACR</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read once</td>
<td>.26</td>
<td>.48</td>
<td>.49</td>
<td>.62</td>
</tr>
<tr>
<td>Generate-different</td>
<td>.43</td>
<td>.66</td>
<td>.65</td>
<td>.64</td>
</tr>
<tr>
<td>Generate-same</td>
<td>.43</td>
<td>.64</td>
<td>.73</td>
<td>.74</td>
</tr>
<tr>
<td>Read twice</td>
<td>.35</td>
<td>.56</td>
<td>.57</td>
<td>.66</td>
</tr>
<tr>
<td>Read:gen-different</td>
<td>.39</td>
<td>.66</td>
<td>.65</td>
<td>.70</td>
</tr>
<tr>
<td>Read:gen-same</td>
<td>.39</td>
<td>.70</td>
<td>.72</td>
<td>.72</td>
</tr>
<tr>
<td>Nonstudied</td>
<td>.05</td>
<td>.31</td>
<td>.18</td>
<td>.54</td>
</tr>
<tr>
<td>LSD</td>
<td>.08</td>
<td>.08</td>
<td>.08</td>
<td>.08</td>
</tr>
</tbody>
</table>

Table 8. Experiment 2: Mean corrected rates (hits - intrusions) as a function of test and item type (ACR = Associative cued recall; RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th>Item type</th>
<th>ACR</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read once</td>
<td>.21</td>
<td>.16</td>
<td>.31</td>
<td>.08</td>
</tr>
<tr>
<td>Generate-different</td>
<td>.38</td>
<td>.35</td>
<td>.47</td>
<td>.10</td>
</tr>
<tr>
<td>Generate-same</td>
<td>.38</td>
<td>.33</td>
<td>.55</td>
<td>.20</td>
</tr>
<tr>
<td>Read twice</td>
<td>.30</td>
<td>.25</td>
<td>.39</td>
<td>.12</td>
</tr>
<tr>
<td>Read:generate-different</td>
<td>.34</td>
<td>.35</td>
<td>.47</td>
<td>.16</td>
</tr>
<tr>
<td>Read:generate-same</td>
<td>.34</td>
<td>.39</td>
<td>.55</td>
<td>.18</td>
</tr>
</tbody>
</table>
**Associative Cued Recall.** The repeated measures ANOVA for the seven conditions, Read once, Generate-same fragment, Generate-different fragment, Read twice, Read:generate-same fragment, Read:generate-different fragment, and Nonstudied, was significant $F (6, 142) = 20.45$, $MSe = .03$, and the Fisher’s LSD was .08. All study conditions were produced significantly more often than chance (Nonstudied) condition. A significant generation effect was obtained, with both the Generate-same fragment (.43) and Generate-different fragment conditions (.43) producing greater recall than the Read once condition (.26).

There was no difference between the Generate-same and Generate-different fragment conditions. Similar to the results of Jacoby’s (1978) study and those of Experiment 1, the Read:generate-same fragment (.39) and Read:generate-different fragments (.39) yielded a nonsignificant advantage over the Read twice condition (.35). The Read:generate-same (.39) and Read:generate different fragment conditions (.39) did not differ from one another. Second, a significant repetition effect was obtained, with the Read twice condition (.35) producing better recall than the Read once condition (.26). Jacoby (1978) also found a massed repetition effect, although the effect (.05) favoring the Read twice condition over the Read once condition in Experiment 1 was not significant.

Also, as in Jacoby’s (1978) findings and the results for Experiment 1, the generation difficulty manipulation affected associative cued recall performance, although the outcomes in the present experiment were not significant. The Generate-same fragment (.43) condition produced greater recall than the
Read: generate-same fragment condition (.39), and the Generate-same fragment condition (.43) produced greater recall than the Read: generate-different fragment condition (.39), but neither of these differences was significant. Conditionalizing the data for successful generation at study yielded a cued recall rate of .47 for both the Generate-same fragment and Generate-different fragment conditions, but again, conditionalizing the data did not change the statistical results. Finally, generating a word once (.43 for both Generate-same fragment and Generate-different fragment conditions) led to better cued recall performance than reading a word twice successively (.35).

The same general pattern of results observed by Jacoby (1978) and in Experiment 1 was replicated in the present experiment. There were significant generation effects for Generate once conditions compared to the Read once condition but not for the Read:generate conditions compared to the Read twice condition. Also, although the repetition effect was not significant in Experiment 1, the effect was significant in the present experiment. The generation difficulty manipulation (Read:generate conditions) decreased cued recall relative to the Generate once conditions in Jacoby’s (1978) experiment, Experiment 1, and the present experiment, although the effect was not significant in the present experiment. Finally, the Generate once conditions yielded better recall than the Read twice condition, demonstrating that one study presentation can produce better cued recall performance than two study presentations.
Recognition. The repeated measures ANOVA for all seven study conditions was significant, $F (6, 162) = 24.33$, $MS_e = 0.02$, and the critical difference for the LSD test was .08. First, there was a significant generation effect, with the Generate-same (.64) and Generate-different fragment conditions (.66) yielding better recognition than the Read once condition (.48). The Generate-same (.64) and Generate-different fragment conditions (.66) were not significantly different. Unlike the results for the associative cued recall test there was a significant generation effect for the repetition conditions. That is, the Read:generate-same fragment (.70) and Read-generate different fragment conditions (.66) produced significantly better recognition memory than the Read twice condition (.56). The Read:generate-same fragment (.70) and the Read:generate-different fragment conditions (.66) were not significantly different. Like Experiment 1, there was an effect of massed repetition with the Read twice condition (.56) yielding significantly better recognition than for the Read once condition (.48). The comparisons of the Generate-same fragment (.64) to the Read:generate-same fragment (.70) and the Generate-different fragment (.66) to the Read:generate-different fragment condition (.66) yielded no significant differences. Thus, the generation difficulty manipulation did not significantly influence performance for recognition. The Generate once conditions yielded better recognition performance than the Read twice condition, also replicating Experiment 1.
Overall the recognition data replicated the recognition data for Experiment 1. Significant generation effects were obtained for the Generate once conditions relative to the Read once condition, and for the Read:generate conditions relative to the Read twice condition. There was a significant massed repetition effect. And finally, the generation difficulty manipulation did not decrease performance relative to the Generate once conditions. Again, it was shown that one study presentation can produce better recognition than two study presentations.

**Word Fragment Cued Recall.** Experiment 2 was being conducted before the data from Experiment 1 were scored. As with Experiment 1, the word fragment cued recall group produced an unusually high rate of false recall (.38). Another group of subjects was tested with the improved instructions and yielded a lower rate of false recall (.18). The data for the group of subjects that received the improved instructions and lower false recall rate is reported here.

The repeated measures ANOVA for the seven study conditions was significant, $F(6, 162) = 42.32$, $MSe = .02$, and Fisher’s LSD was .08. The Generate-same fragment (.73) and Generate-different fragment conditions (.65) produced more completions than the Read once condition (.49), showing two separate generation effects. Both the nonspecific generation effect (the Generate-different fragment condition greater than the Read once condition) and the specific generation effect (the Generate-same fragment condition greater than the Generate-same fragment condition) were significant. Also, both the
Read:generate-different fragment condition (.65) and the Read:generate-same fragment condition (.72) yielded significantly better memory performance than the Read twice condition (.57). However, the advantage for the Read:generate-same condition (.72) compared to the Read:generate-different fragment condition (.65) did not quite reach significance. The repetition effect was significant, with the Read twice condition (.57) producing more completions than the Read once condition (.49). Like Experiment 1, there were no effects of generation difficulty. The Generate-same fragment condition (.73) was not significantly different from the Read:generate-same fragment condition (.72), and the Generate-different fragment condition (.66) was not significantly different from the Read:generate-different fragment condition (.64). As was the case in Experiment 1, the generate once conditions (.73 for the Generate-same fragment and .66 for the Generate-different fragment conditions) yielded more completions than did the Read twice condition (.57).

Thus, the word fragment cued recall data replicated the results obtained in Experiment 1 and replicated similar findings by Glisky and Rabinowitz (1985). First, the pattern of data showed a nonspecific generation effect with the Generate-different fragment condition yielding more completions than the Read once condition and the Read:generate-different fragment condition yielding more completions than the Read twice condition. Moreover, evidence for a specific or enhanced generation effect was obtained with the Generate-same fragment condition and Read:generate-same fragment conditions producing
more completions than the Generate-different fragment and Read:generate-
different fragment conditions respectively. Next, a significant massed repetition
effect was obtained, replicating the finding in Experiment 1. Again, this effect of
massed repetition in word fragment cued recall represented a failure to replicate
Greene (1990). As in Experiment 1, the generation difficulty manipulation did
not decrease the number of correct completions for the Read:generate conditions
relative to the generate once conditions. Finally, again replicating the results of
Experiment 1, generating a word once at study resulted in better word fragment
cued recall performance than for reading a word twice massed.

Word Fragment Completion. The repeated measures ANOVA for the
seven study conditions was significant, $F(6, 162) = 6.41$, $MSe = .02$, and Fisher's
LSD was .08. First, fragments for all study conditions were completed
significantly more often than fragments for the Nonstudied condition, showing
significant priming for all study conditions. While there was a significant
generation effect for the Generate-same fragment (.74) compared to the Read
once condition (.62), there was no generation effect for the Generate-different
fragment condition (.64) compared to the Read once condition (.62). The
advantage for the Generate-same fragment condition (.74) over the Generate-
different fragment condition (.64) was significant, demonstrating an enhanced or
specific generation effect. The fact that a generation effect occurred only when
the study and test fragment were identical replicated the findings of Gardiner
(1988; 1989). Comparisons of the Read:generate-same fragment (.72),
Read:generate-different fragment (.70), and Read twice (.66) conditions yielded no significant differences. The finding of no difference between the Read:generate-same fragment and Read:generate different fragment conditions replicated the observation by Olafsson and Nilsson (1992). Thus there were no generation effects, nonspecific or specific, for the repetition conditions. As in Experiment 1, the massed repetition effect was not significant; the Read once (.62) and Read twice (.66) conditions produced similar completion rates. With regard to the generation difficulty manipulation, the Generate-same fragment condition (.74) was not significantly different from the Read:generate-same fragment condition (.72), and the Generate-different fragment condition (.64) was not significantly different from the Read:generate-different fragment condition (.70). Thus, replicating Experiment 1, generation difficulty did not affect priming for conditions for which the study and test fragments were identical. Furthermore, there was no effect of generation difficulty when the study and test fragment were different. Finally, the Generate-different fragment (.64) did not produce a significant advantage over the Read twice condition (.66), but the Generate-same fragment condition (.74) did yield a significant advantage compared to the Read twice condition (.66).

Although a generation effect for word fragment completion was ambiguous in Experiment 1, there was a generation effect in the present experiment. Moreover, this effect was specific to the generate condition where the word fragment matched between the study and test, replicating the work
done by Gardiner (1988, 1989). There was a trend toward a generation effect in the repetition condition with the Read:generate-same fragment producing more completions than the Read twice condition. Again, Olafsson and Nilsson’s (1992) results were replicated; there was no difference between the Read:generate-same fragment and Read:generate-different fragment conditions. Like Experiment 1 and the findings of others, there was no effect of massed repetition for the word fragment completion (Challis & Sidhu, 1993; Greene, 1990; Roediger & Challis, 1992). Also as in Experiment 1, there was no effect of generation difficulty.

**Explicit Contamination.** Almost all subjects in the implicit test group indicated that they were aware that some of the first words that came to mind were target words. Also, almost all subjects indicated that they adopted an intentional retrieval strategy. However, as was the case with Experiment 1, the correlations of the percentage of time that subjects reported using an intentional retrieval strategy with the amount of priming obtained for each study condition yielded no significant relationships (range \( r = -.21 \) to \( r = .19 \), all \( ps > .34 \)).

Stronger evidence that explicit contamination of the implicit test was not a problem was that dissociations were obtained for the word fragment cued recall and word fragment completion tests. First, there was a significant massed repetition effect for the word fragment cued recall test but not for the word fragment completion test. Second, there was a significant nonspecific generation effect (Generate-different fragment advantage over the Read once condition) and
a strong trend toward a nonspecific generation effect for the repetition conditions (Read:generate-different fragment advantage over the Read twice condition) for the word fragment cued recall test but not for the word fragment completion test. If subjects in the implicit test group adopted intentional retrieval strategies similar to those used by the explicit cued recall group, then the repetition effect and nonspecific generation effect obtained for the word fragment cued recall group should have been obtained for the word fragment completion group. Since these dissociations occurred with a design that satisfied the retrieval intentionality criterion, one can be assured that explicit memory contamination was not a problem in the present experiment.

Discussion

The results for the four tests yielded similarities and differences that replicated the work of prior researchers, while providing new direct comparisons between the tests. First, there was a nonspecific generation effect for the three explicit memory tests but not for the implicit memory test, However, a specific generation effect was obtained only for the word fragment cued recall and word fragment completion tests. Thus presenting the same fragment in the study and test phases boosted the completion rate relative to when the study and test fragments were different. This finding is important because it shows a similarity between an implicit and an explicit test, but a difference between explicit tests based on the type of retrieval cue given in the test phase. Therefore, this result cannot be explained in terms of
implicit/explicit test distinction but can be explained by the type of processing guided by the retrieval cue. When the retrieval cue instantiated specific perceptual processing demands that matched the perceptual processes engaged in the study phase, as in the word fragment cued recall and word fragment completion tests, a specific generation effect occurred. However, since the retrieval cue for the associative cued recall and recognition tests did not instantiate the same perceptual processes as those engaged in the study phase, no specific generation effect was obtained.

Next, the three explicit memory tests demonstrated an effect of massed repetition, but the implicit memory test showed no such effect. Thus a second dissociation between the implicit test, word fragment completion, and the three explicit tests, associative cued recall, recognition, and word fragment cued recall was obtained.

Turning to the generation difficulty manipulation, no test group showed a significant advantage for the Generate once conditions over the Read:generate conditions. This outcome is a failure only to replicate the results for the associative cued recall group. Both the experiment by Jacoby (1978) and Experiment 1 showed a significant advantage in cued recall for a Generate once condition over a Read:generate condition. The present experiment demonstrated an advantage for the Generate conditions over the Read:generate conditions, and though these differences increased to .07 when the data were conditionalized, the differences for the conditionalized data were not significant. Since the effect
was always in the appropriate direction, this effect may be just a subtle effect with the materials used here.

One prediction was that the Read:generate-same fragment condition would produce a significantly higher completion rate than the Read:generate-different fragment condition for the word fragment cued recall and word fragment completion tests. However, this difference was obtained only for the word fragment cued recall test. For the word fragment completion test, the thought was that if the specific generation effect is due to perceptual processes, then the Read:generate-same fragment condition would yield priming equivalent to the Generate-same fragment condition. While this result did occur, the number of presentations and the type of presentations were confounded in this comparison. So the appropriate comparison to find a specific generation effect based on perceptual processing was a comparison of the Read:generate-same fragment condition to the Read:generate-different fragment condition. This difference between these two condition was not significant. Why the Read:generate-same fragment and Read:generate-different fragment conditions produced similar completion rates is unclear. Olafsson and Nilsson (1992) suggested that the exposure to the word prior to seeing the fragment “provided enough overlap in surface features, and so it made no difference whether the subjects had been presented with the actual fragments or with their alternative form” (p.108). This possibility was examined in Experiment 3.
Experiment 3

The following experiment attempted to reproduce findings from Experiments 1 and 2 but eliminated the associative cue and the visual presentation of the target word at study. The object of this experiment was to replicate Glisky and Rabinowitz (1985) by demonstrating that subjects do not need the associative cue to obtain an effect of generation specificity on the word fragment cued recall test. Also, Olafsson and Nilsson (1992) suggested one possible reason that they did not observe a specificity effect in their read conditions (Read:generate-same versus Read:generate-different) was that the word “provided enough overlap in surface features, and so it made no difference whether the subjects had been presented with the actual fragments or with their alternative form” (p.108). Since the results of Experiment 2 replicated the findings of Olafsson and Nilsson (1992), their hypothesis was tested by presenting a word aurally rather than visually, followed by a visual presentation of a word fragment.

There were seven study conditions in this experiment: hear a word once, read a word (once), hear a word twice, hear a word:read a word, hear a word:generate a word to the same word fragment to be used at test, hear a word:generate a word to a different fragment form that to be used at test, and Nonstudied (see Table 9). Note that in all the generate conditions of this experiment, the generation process was made less difficult by presenting the target aurally immediately prior to presentation of the study fragment. Thus, in
Table 9. **Study conditions and example materials for Experiment 3.**

Nonstudied

1 presentation
- Hear word
- Read word

2 presentations
- Hear word twice
  - Hear word: Read word
  - Hear word: Generate-different fragment
  - Hear word: Generate-same fragment

**Example Materials**

<table>
<thead>
<tr>
<th>Visual conditions</th>
<th>Study</th>
<th>WFC/WFCR Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read word</td>
<td>ASSASSIN</td>
<td>A__A__IN</td>
</tr>
<tr>
<td>Generate-same fragment</td>
<td>A__A__IN</td>
<td>A__A__IN</td>
</tr>
<tr>
<td>Generate-diff fragment</td>
<td><em>SSSS</em>_</td>
<td>A__A__IN</td>
</tr>
</tbody>
</table>
the present experiment when the target word was presented in its entirety there was no visual feature overlap as in Olafsson and Nilsson (1992) and Experiment 2. Instead, the subjects heard the word, then were presented the word fragment, in either the same or different form of the test fragment. Three groups of subjects were tested either by implicit word fragment completion, word fragment cued recall, or recognition.

A nonspecific generation effect (the Hear:generate-different fragment condition would yield better performance than the Hear twice or Hear:read conditions) was expected to occur for the recognition and word fragment cued recall tests. However, no such effect was predicted for the word fragment completion test. Also, a specific generation effect was expected to occur for the word fragment cued recall test and possibly for the word fragment completion test. If a specificity effect were obtained for the word fragment completion (Hear:generate-same fragment producing more completions than the Hear:generate-different fragment), then support would be gained for Olafsson and (1992) hypothesis. On the other hand, if no specificity effect occurred, then the evidence would go against the hypothesis of Olafsson and Nilsson (1992).

Other differences between the tests were expected for the modality and repetition variables. One expectation was that there would be a large effect of modality (hear word versus read word) for the word fragment completion test, a smaller effect for the word fragment cued recall test, and little or no effect for the recognition test. Based on previous research on cross-modal priming, about half
the priming of the Read and Hear:read condition should occur in a Hear once condition (Blaxton, 1989).

Since Challis and Sidhu (1993) did not find an effect of massed auditory repetitions for 4 and 16 presentations for a word fragment completion, the Hear twice condition was predicted to be the same as the Hear once condition. However, Challis and Sidhu (1993) obtained an effect of massed auditory repetition for a word fragment cued recall test, so an effect was expected in the present experiment. And finally, a massed repetition effect was expected for the recognition test.

Obtaining the expected results would demonstrate dissociations between the explicit and the implicit test as well as dissociations between the two explicit tests. These differences should demonstrate that word fragment retrieval cues instantiate perceptual processes to a greater degree than the whole word retrieval cue. For example, due to this emphasis on data-driven processing, the word fragment cued recall and word fragment completion test should be affected by modality of study presentation but recognition should not be affected.

**Method**

**Subjects.** Ninety-one undergraduate students enrolled in psychology courses at Rice University were tested. Subjects received credit toward one of their courses in compensation for their participation in the experiment.
Materials. The critical items were 98 words and two complementary fragments for each word from Hayman and Tulving (1989b; see Appendix C).

Design and Procedure. The experiment was a 3 (Test: Recognition, Word fragment cued recall, Word fragment completion) x 7 (Item type: Hear once, Read once, Hear twice, Hear:read, Hear:generate different-fragment, Hear:generate same-fragment, Nonstudied) mixed design, with the type of test manipulated between subjects and the item type manipulated within subjects. Thirty-five subjects were assigned to the recognition test group and 28 subjects were assigned to each of the other two test groups.

There were 7 lists of 14 words. The counterbalancing of lists was done exactly as in Experiments 1 and 2. One design change was that in the current experiment the presentation of stimuli at study was in a predetermined random order.

The 98 target words and 6 primacy and 6 recency buffers were presented to subjects either aurally or visually at a 5 sec rate, with an interstimulus interval of 250 msec. Visual presentations were controlled by an IBM compatible microcomputer, and an LCD unit was used to display the computer display on a screen. Items presented in the visual modality were displayed in one of three forms: whole word, same-fragment, or different fragment.

Results

The mean rates for each test group by item type are presented in Table 10, and the corrected scores (hits - intrusions) are presented in Table 11. The critical
difference obtained for Fisher’s LSD test was .06 for all three test groups.

**Recognition.** The repeated measures ANOVA on the seven different item types was significant, $F (6, 206) = 111.22$, $MSe = .02$, and all study conditions were recognized better than chance. With regard to the generation effect, there was an advantage of generating the target word relative to hearing or reading the word. The Hear:generate conditions (.78 and .72) produced higher hit rates than the Hear twice (.67) and Hear:read (.68) conditions, though the differences were significant only for the Hear:generate-different fragment condition. In fact, the difference in hit rates between the Hear:generate-same fragment (.78) and Hear:generate-different fragment conditions was significant (.72). There was no effect of modality for the single presentation conditions, with the Hear once (.61) and Read once conditions (.63) yielding similar hit rates. There also was no effect of modality for the two presentation conditions with the Hear twice condition (.67) and Hear:read condition (.68) showing no difference in hit rates. However, there was an effect of massed auditory presentation; the Hear twice condition (.67) yielded better recognition performance than the Hear once condition (.61).

There was a significant nonspecific generation effect for the repetition conditions in Experiment 2 and in the present experiment. However, the completion rate for the Hear:generate-different fragment condition was significantly greater than the completion rate for the Hear:generate-same fragment condition. One possible reason why the words in the Hear:generate-
Table 10. Experiment 3: Mean proportions as a function of test and item type (RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th>Item type</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hear once</td>
<td>.61</td>
<td>.22</td>
<td>.24</td>
</tr>
<tr>
<td>Read</td>
<td>.63</td>
<td>.27</td>
<td>.32</td>
</tr>
<tr>
<td>Hear twice</td>
<td>.67</td>
<td>.23</td>
<td>.24</td>
</tr>
<tr>
<td>Hear:read</td>
<td>.68</td>
<td>.30</td>
<td>.33</td>
</tr>
<tr>
<td>Hear:gen-different</td>
<td>.78</td>
<td>.30</td>
<td>.29</td>
</tr>
<tr>
<td>Hear:gen-same</td>
<td>.72</td>
<td>.40</td>
<td>.33</td>
</tr>
<tr>
<td>Nonstudied</td>
<td>.11</td>
<td>.08</td>
<td>.19</td>
</tr>
<tr>
<td>LSD</td>
<td>.06</td>
<td>.06</td>
<td>.06</td>
</tr>
</tbody>
</table>

Table 11. Experiment 3: Mean corrected rates (hits - intrusions) as a function of test and item type (RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th>Item type</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hear once</td>
<td>.50</td>
<td>.14</td>
<td>.05</td>
</tr>
<tr>
<td>Read</td>
<td>.52</td>
<td>.19</td>
<td>.13</td>
</tr>
<tr>
<td>Hear twice</td>
<td>.56</td>
<td>.15</td>
<td>.05</td>
</tr>
<tr>
<td>Hear:read</td>
<td>.57</td>
<td>.22</td>
<td>.15</td>
</tr>
<tr>
<td>Hear:gen-different</td>
<td>.67</td>
<td>.21</td>
<td>.10</td>
</tr>
<tr>
<td>Hear:gen-same</td>
<td>.61</td>
<td>.32</td>
<td>.14</td>
</tr>
</tbody>
</table>
different fragment condition were recognized better than words in the
Hear:generate-same fragment condition was that the word fragments used for
the different fragment condition may have been more difficult to solve than the
"same" word fragments. So any extra effort needed to generate the target word
to the "different" fragment at study may have resulted in better recognition at
test.²

Another different way to consider the difference between the
Hear:generate-different fragment and Hear:generate-same fragment is to
question why the completion rate for the Hear:generate-same fragment was a bit
low. Unfortunately, no good explanation for this occurrence exists other than
the possibility that the relatively low completion rate occurred simply as a result
of random variation.

The lack of a modality effect for recognition replicated work by others
(e.g. Kirsner, Milech, & Standen, 1983; Roediger and Blaxton 1987). In addition,
Challis and Sidhu (1993) found an effect of massed auditory repetition for
recognition using 4 and 16 presentations, and the present experiment
demonstrated this effect using 2 massed presentations.

**Word Fragment Cued Recall.** The repeated measures ANOVA for the
seven item types was significant, $F (6, 162) = 19.22$, $MSe = .02$, and all study
conditions produced completion rates significantly above the Nonstudied
baseline rate. There was no evidence for a nonspecific generation effect, as the
Hear:read condition (.30) and Hear:generate-different fragment condition (.30)
yielded the same completion rate. On the other hand, a generation effect occurred but was specific to the Hear:generate same-fragment condition, with the Hear:generate-same fragment condition (.40) yielding significantly better performance than the Hear:read (.30) and Hear:generate-different fragment conditions (.30). Also, the Hear:generate conditions (.30, .40) produced more completions than the Hear twice condition (.23), demonstrating a type of generation effect. These differences could have been due to the difference in modality for the second study presentation rather than generation though.

There was a definite advantage for items presented in the visual modality rather than the auditory modality. While this benefit was not significant for the Read condition (.27) relative to the Hear once condition (.22), the advantage was significant for the Hear:read condition (.30) relative to the Hear twice condition (.23). Also, there was no effect of massed auditory repetition; the Hear twice condition (.68) did not produce a higher completion rate than the Hear once condition (.67).

While there was a strong trend toward a nonspecific generation effect for the repetition conditions in Experiment 2, no such trend occurred in the present experiment. This result may be due to the amount of overlap in surface features from study to test for the “different” fragment condition. In Experiment 1, there was more overlap between the study and test fragments for the “different” fragment conditions than for the “different” fragment condition of Experiment 2. Thus, the repetition of more surface features in Experiment 2 could have
produced the strong trend. Another possibility is that the difference may be due to the change in modality between Experiments 2 and 3. That is, a nonspecific generation effect may occur for visual repetition conditions but not for auditory/visual repetitions.

Differences in modality were observed, such that seeing the target word at study produced better performance than did just hearing the word. Although Challis and Sidhu (1993) found a massed repetition effect for auditory presentation on a word fragment cued recall test, they obtained the effect using 4 and 16 massed presentations. The present study used only 2 massed presentations and a slightly different procedure than the one used by Challis and Sidhu (1993). Either or both of these differences could have produce the finding of no massed auditory repetition effect in the present experiment.

**Word Fragment Completion.** The repeated measures ANOVA for the seven different itemtypes was significant, $F (6, 162) = 6.14$, $MSe = .01$. Significant priming was obtained for the visual conditions (Read, Hear:read, Hear:generate-same fragment, and Hear:generate-different fragment) as these conditions showed completion rates significantly above the Nonstudied baseline. First, no generation effect, specific or nonspecific, occurred for the visual conditions. The Hear:generate-same fragment (.33) and Hear:generate-different fragment conditions (.29) did not yield more correct completions than the Hear:read condition (.33). Because the Hear:generate-same fragment condition (.33) did not produce significantly more correct completions than the Hear:generate-
different fragment condition (.29), there was no effect of generation specificity. A different type of generation effect was occurred though, with the Hear:generate conditions (.29, .33) producing better performance than the Hear twice condition (.24). However, this effect may not have been due to generation but rather to modality with the difference being between the visual presentation of the word fragment for the hear:generate conditions compared to the auditory presentation for the Hear twice condition. Nevertheless, only the difference between the Hear:generate-same fragment (.33) and Hear twice (.24) conditions was significant. Two modality effects occurred, one for the single presentation conditions and one for the two presentation condition. The completion rate for the Read condition (.32) was significantly greater than that for the Hear once condition (.24), and the completion rate for the Hear:read condition (.33) was significantly greater than that for the Hear twice condition (.24). Since there was no difference between the Hear once (.24) and Hear twice conditions (.24) there was no effect of massed auditory repetition on primed word fragment completion.

Olafsson and Nilsson (1992) suggested that presenting the target word visually before the word fragment at study eliminated the generation specificity effect because the two visual study presentations resulted in redundancy of the visual features of the target word. For the Hear:generate conditions of the present experiment, presenting the target word aurally rather than visually, as in Experiments 1 and 2, eliminated any repetition in visual features of the target
word at study. Therefore, a difference between the Hear:generate-same fragment and Hear:generate-different fragment conditions in the present experiment, where there was no repetition of visual features at study, would support Olafsson and Nilsson's (1992) hypothesis. However, a specific generation effect did not occur for the present experiments, providing evidence against their idea. Another new finding was that hearing the target word twice at study produced the same amount of priming as hearing the target word once. This makes sense since Challis and Sidhu (1993) found no difference for 4 or 16 massed auditory presentations relative to 1 auditory presentation. The finding of a modality effect for the single study presentation conditions replicated the work of Roediger and Blaxton (1987) among others, and this effect was extended to the repetition study conditions.

**Explicit Contamination.** As was the case with Experiments 1 and 2, almost all subjects reported being aware of using old words to complete the test fragments, and the majority of subjects reported that they adopted an intentional retrieval strategy part of the time. Correlations on the percentage of times that subjects reported for using an intentional retrieval strategy with the amount of priming for each study condition were all positive (range $r = .15$ to $r = .33$) but none achieved significance.

Again, strong evidence that explicit contamination of the implicit test does not seem to have been a problem was demonstrated by a dissociation between the word fragment completion and word fragment cued recall tests. While there
was a significant specific generation effect for the word fragment cued recall
group, there was no effect for the word fragment completion group. If explicit
contamination of the word fragment completion test had been a problem, then
the word fragment completion test should also have shown this effect.
However, since the experiment met the retrieval intentionality criterion and
there was no specific generation effect for the implicit test, explicit contamination
can be ruled out as a significant problem in the present experiment.

Discussion

The results for the generate conditions on the three tests were slightly
different than those for Experiments 1 and 2. There was a significant nonspecific
generation effect for the recognition test group but not for the word fragment
cued recall group. On the other hand, a specific generation effect was obtained
for only the word fragment cued recall test, which did replicate the findings of
Experiment 2. Therefore, no support was garnered for Olafsson and Nilsson’s
(1992) hypothesis explaining the absence of specificity effect for repetition
conditions.

The word fragment cued recall test and word fragment completion tests
showed effects of modality that favored the visual conditions over the auditory
conditions, but recognition showed no effect of modality. Unexpectedly, the
word fragment cued recall test and word fragment completion tests were
dissociated from the recognition test based on the massed auditory repetition
variable. While this dissociation was expected for the recognition and word
fragment completion tests, it was not expected for the recognition and word
fragment cued recall test. Apparently, word fragment cued recall is less
sensitive to massed auditory repetition than is recognition.

This result can be explained by the emphasis of visual features on the
word fragment cued recall word fragment completion tests. Providing a
solution for the word fragments is aided primarily by visual feature of the
words. Auditory presentation, even when repeated, does not facilitate the
completion of the word fragments because there is no overlap in visual features
from study to test. This result makes sense from a transfer appropriate
processing point of view. According to Roediger's (1990) transfer appropriate
processing view, a perceptual test should show a modality effect, such that
maintaining the modality between study and test should yield better
performance than changing the modality from study to test, is indeed occurred.
General Discussion

The present study had several goals. One goal was to replicate Jacoby's (1978) findings for an associative cued recall test and to determine if his results would extend to other memory tests. Another purpose was to seek specific generation effects for word fragment cued recall, which had not been previously examined. A second reason for using a word fragment cued recall test was to be able to compare the results for word fragment cued recall and word fragment completion. By satisfying the retrieval intentionality criterion and obtaining dissociations between word fragment completion and word fragment cued recall, explicit contamination of the implicit test could be ruled out as a significant factor for any generation effect obtained for the word fragment completion test. Finally, whether specific generation effects could be obtained for repeated study trials (e.g. Read:generate-same fragment condition compared to Read:generate-different fragment condition) was investigated. The results are discussed here for each type of test across experiments.

Associative Cued Recall

The results from Experiments 1 and 2 provided a perfect replication of Jacoby (1978). The subjects' corrected scores (hits - intrusions) for these two experiments were combined and means were calculated for each item type (see Table 12). There was an obvious generation effect and a reliable repetition effect. Jacoby's (1978) finding of one generate trial producing better cued recall performance than two massed read trials or a read trial immediately
Table 12. Combined corrected scores (hits - intrusions) for study conditions employed in both Experiments 1 and 2 (ACR = Associative cued recall; RGN = Recognition; WFCR = Word fragment cued recall; WFC = Word fragment completion).

<table>
<thead>
<tr>
<th></th>
<th>ACR</th>
<th>RGN</th>
<th>WFCR</th>
<th>WFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read once</td>
<td>.29</td>
<td>.31</td>
<td>.26</td>
<td>.10</td>
</tr>
<tr>
<td>Generate (same)</td>
<td>.47</td>
<td>.51</td>
<td>.47</td>
<td>.17</td>
</tr>
<tr>
<td>Read twice</td>
<td>.36</td>
<td>.42</td>
<td>.34</td>
<td>.13</td>
</tr>
<tr>
<td>Read:Generate</td>
<td>.40</td>
<td>.55</td>
<td>.48</td>
<td>.20</td>
</tr>
</tbody>
</table>
followed by a generate trial was obtained in the present experiments. The disruption of the generation process in the read:generate trials is interpreted here as a disruption of conceptual processes evidenced by a failure to strengthen the associative cue - target word relationship on the second (generate) presentation.

Donaldson and Bass (1980) suggested that Jacoby’s (1978) generation effects were due to a strengthening of the cue - target relationship. Their basic idea was that the strengthened cue - target relationship helped to elicit the target when the same cue word was re-presented at test (as a retrieval cue). As noted above, Rabinowitz and Craik (1986) showed that a generation effect could be obtained by cueing the same general type of information (e.g. semantic or phonemic -- rhyming) involved in the cue - target relationship, but that a larger generation effect could be produced by cueing the specific relationship between the studied cue and target by re-presenting the same study cue in the test phase.

In the present experiments, reducing the effort needed to generate a word influenced how much the cue - target relationship was strengthened. For the Read:generate trials, the cue - target relationship was not strengthened much compared to the strengthening of this relationship that occurred for the Generate once trials. Therefore, at test, cued recall performance was not as great for the Read:generate condition as it was for the Generate once condition. Whether the decrease in the effort needed to generate a word in a Read:generate condition fails to increase the strength of the general informational relationship (e.g.
semantic) between the cue and target word or the strength of the specific relationship between the cue and target word cannot ascertained by the present experiments.

A new finding from Experiment 1 was the occurrence of a massed repetition effect for the generate conditions, with the Generate twice condition yielding greater cued recall performance than the Generate once condition. This makes sense from the point of view that two study presentations should yield greater memory performance than one study presentation. However, generating the word on the second generate trial for the Generate twice condition should have been relatively effortless, similar to the generate trial for the Read:generate condition. Given that the generate trial of the Read:generate condition did not appear to strengthen the cue - target relationship, one would expect that the cue - target relationship would not be strengthened by the second generate trial of the Generate twice condition. Therefore, the possibility exists that the repetition effect for the generate conditions was not due to an increase in the associative cue - target relationship but rather to some other factors. This hypothesis must await further research.

**Recognition**

Across the three experiments, the results for the recognition data showed effects of generation and repetition, but failed to show effects of modality. First, generation effects were obtained for both Experiments 1 and 2. Next, two massed visual presentations at study benefited later recognition relative to one
visual presentation at study in the first two experiments, and two massed aural presentations at study boosted recognition relative to one aural presentation at study in the final experiment. Thus repetition effects were observed for both visual and auditory presentations. Although two massed presentations helped recognition performance relative to one presentation for both the visual and auditory modalities, there were no differences between the two modalities.

A new and unexpected finding was that recognition performance was not affected by the generation difficulty manipulation in the same manner as that for the associative cued recall data. For the recognition test, the Generate once condition did not produce better memory performance than the Read:generate condition(s). An explanation of this unexpected outcome appeals to the target-cue relationship which seems to be particularly important for an associative cued recall test, but unimportant for a recognition test. For the associative cued recall test, the same associative cue was presented at study and test. Thus the test stressed the relationship of the cue word and target word. On the other hand, for the recognition test, the associative cue word was not presented in the test phase -- only the target word was presented. Therefore the recognition test did not emphasize the relationship between the cue word and target word. If the cue-target relationship was not strengthened when subjects "generated" the target on Read:generate trials, then this should affect memory performance for tests that tap into the cue-target relationship. Since performance on the
recognition test did not emphasize the associative cue - target word relationship, there was no effect of generation difficulty.

Finally, while generating an item twice did produce a higher hit rate than did generating an item once, this difference was not significant. Unfortunately, there is no good explanation of why a significant repetition effect for the generation conditions occurred for the associative cued recall test but not the recognition test.

**Word Fragment Cued Recall**

The results for the word fragment cued recall tests were in some ways like the results of the recognition tests. Generation effects and repetition effects were obtained and there were effects of generation difficulty. However, there was no effect of massed auditory repetition in Experiment 3, but there was an advantage for seeing a word compared to hearing a word (a modality effect). In contrast, Challis and Sidhu (1993) did obtain an effect of massed auditory repetition for a word fragment cued recall test using 4 and 16 massed presentations. The present study used only 2 presentations. Therefore, two dissociations between word fragment cued recall and recognition occurred. One dissociation was based on a massed auditory repetition effect for recognition but not for word fragment cued recall, and the other dissociation was based on the finding of no modality effect for recognition but a modality effect for word fragment cued recall.

In some sense, these two dissociations are related. Hearing a word does not seem to be very beneficial for the later completion of visual word fragments
(e.g. Roediger & Blaxton, 1987). Because the completion of word fragments emphasizes data-driven processing (the visual features of the target) hearing a word twice does not help one complete the fragment. Of course, at some point massed auditory repetition does aid later cued recall with word fragment cues because Challis and Sidhu (1993) demonstrated a massed auditory repetition effect using 4 presentations. Again, since data-driven processing is important for the visual word fragment cued recall task, seeing words at study produces better cued recall than for hearing words at study.

As was the case for the recognition test, the word fragment cued recall test did not produce an effect of generation difficulty. This result most likely occurred because the word fragment cued recall test, like the recognition test, relied more on processing of the individual target item at study, not the cue-target relationship that was emphasized on the associative cued recall test.

One of the main goals of the present study was to produce specific generation effects for word fragment cued recall. While specific generation effects have been obtained for associative cued recall (Rabinowitz & Craik, 1986), recognition (Glisky and Rabinowitz, 1985), and word fragment completion (Gardiner, 1988, 1989; Gardiner et al., 1989), no study has attempted to produce a specific generation effect for word fragment cued recall. This objective was accomplished in both Experiments 2 and 3 with one presentation (e.g. Generate once conditions) as well as two presentation conditions (e.g. Read:generate, Hear:generate conditions). Generating a word at study, in either a Generate
once, a Read:generate, or a Hear:generate trial, to the same word fragment to be presented in the test phase produced better cued recall performance than did generating the word to a different word fragment from that to be presented in the test phase. The conceptual processes involved in each of the generate trials (e.g. Generate-same fragment and Generate-different fragment, Read:generate-same fragment and Read:generate-different fragment) should have been the same. Only the perceptual information -- the word fragment -- was different between the same and different fragment conditions. Therefore, in agreement with previous researchers for their findings in recognition and word fragment completion (Glisky and Rabinowitz, 1985; Gardiner 1988, 1989; Gardiner et al., 1989), the specific generation effects for word fragment cued recall are interpreted as due to data-driven processes in resolving the word fragment. This finding also is in line with the theory of transfer appropriate processing. The greater overlap between the mental processes engaged at study and test for the same word fragments compared to the mental processes engaged at study and test for the different word fragments resulted in superior test performance for the same fragment conditions.

With respect to the new comparison of generating a word twice in massed fashion relative to generating a word once, the repeated generation at study produced slightly better cued recall than did a single generation trial. Like the recognition results, this difference between generating a word once and generating a word twice in immediate succession was not significant for word
fragment cued recall. This result could be a real but small effect and deserves future investigation.

**Word Fragment Completion**

The results for word fragment completion were different from those of any other test, primarily because there were no significant massed repetition effects for word fragment completion, whereas such effects occurred for the three other tests. In addition, a modality effect occurred in Experiment 3 for primed word fragment completion but not for recognition. Combining data from equivalent conditions from Experiments 1 and 2 showed a generation effect for both one and two presentation conditions (see Table 12). That is the Generate once (same fragment) condition yielded more priming than did the Read once condition, and the Read:generate (same fragment) condition produced more priming than did the Read twice condition. This outcome is comparable to Gardiner’s (1988) finding of a generation effect for word fragment completion and is in stark contrast to the usual finding of a reversed generation effect on a perceptual implicit test (e.g. Blaxton, 1989; Jacoby, 1983; Winnick & Daniel, 1970).

The theory of transfer appropriate accounts for this dramatic difference though. Usually, few of the visual features of a target word are presented in the generate condition at study, and therefore there is little overlap in the visual features of the target word from study to test. When the same visual features (e.g. word fragments) are presented at study and test, there is perfect overlap in
the visual features for the target word. Transfer appropriate processing posits that the greater the overlap between the operations from study to test, the better test performance will be. When there is little overlap in the visual features from study to test, as in the usual generation condition, not much priming is obtained on a word fragment completion test relative to a read condition (a reverse generation effect), but when there is a perfect overlap in the visual features from study to test, as in the specificity conditions (same fragment conditions), a boost in priming occurs relative to a read and different fragment condition (a specific generation effect).

Similar to the findings for recognition and word fragment cued recall, and in contrast to the finding for associative cued recall, the Generate once condition did not yield greater priming than did the Read:generate condition. Once again, a strengthened relationship between the cue word and target word at study is not important for a test that does not tap this relationship at test. The word fragment completion test, like the recognition and word fragment cued recall tests, stressed processing of the individual target item, particularly, the surface features of the target word.

One of the purposes of the present experiments was to demonstrate specificity effects in generating words for both word fragment completion and for word fragment cued recall, but to simultaneously dissociate the two tests to show that specific generation effects on the implicit memory task were not due to explicit memory contamination. The results for the attempt to obtain specific
generation effects are discussed here while the dissociations will be addressed below.

A specific generation effect was obtained for the single presentation conditions only, with the Generate-same fragment condition producing more completions than the Generate-different fragment conditions. Unlike word fragment cued recall, specific generation effects were not obtained for repeated presentation conditions (e.g. Read:generate-same fragment compared to Read:generate-different fragment; Hear:generate-same fragment compared to Hear:generate-different fragment). The fact that no specificity effects were observed for the repeated presentation conditions is curious, but Olafsson and Nilsson (1992) obtained the same result in an experiment using two visual presentations at study. Indeed, their finding was replicated in the present study (Experiment 2). However, their hypothesis that a specific generation effect did not occur because the information from the surface features for the repeated visual study presentations (read:generate) overlapped (a redundancy hypothesis) gained no support in the present study. In Experiment 3, the redundancy in visual features for the read:generate study conditions was eliminated by presenting target words aurally, rather than visually, immediately before the visual generation trial (Hear:generate-same fragment, Hear:generate-different fragment). Therefore no visual features appeared on the first presentation, but still no specific generation effect occurred on the word fragment completion test for the repeated study conditions. Why a specific
generation effect occurred for word fragment cued recall but not for word
fragment completion in the repeated conditions is unclear. According to transfer
appropriate processing theory, a specific generation effect was expected to occur
for word fragment completion in the repeated conditions. While transfer
appropriate processing failed to predict the present outcome, no other theory
seems to be able to account for this puzzling result either.

The new comparison of generating a word once compared to generating a
word twice did show a nonsignificant advantage for the repeated condition.
However, the mean for generating an item once was lower than expected,
possibly due to a failure of subjects to successfully generate the target word in
the study phase. Given more time or a second opportunity to generate the
correct target word may have resulted in a higher generation success rate for the
generate twice condition. Of course, this argument could be applied to the
Generate once and Generate twice conditions across all of the tests in Experiment
1. However, for unknown reasons the generation success rate was quite high for
the subjects who performed the generation check in each of the other test
conditions. So whether there is a difference between the Generate once and
Generate twice conditions for word fragment completion remains uncertain.

Explicit Contamination

Some researchers have expressed concern over whether subjects given
implicit memory instructions follow these instructions or engage in intentional
retrieval strategies (Schacter et al., 1989). The present experiments showed that
although a large proportion of subjects report being aware of using prior study words and adopting an intentional retrieval strategy, there were no significant correlations between the percentage of time subjects reported using an intentional retrieval strategy and the amount of priming obtained in each of the study conditions.

The strongest evidence that explicit contamination was not a problem in the present study was that comparisons of two tests, word fragment completion and word fragment cued recall, yielded dissociations in each experiment while satisfying the retrieval intentionality criterion. In Experiments 1 and 2, a massed repetition effect was obtained for word fragment cued recall but not for word fragment completion. In Experiment 2, nonspecific generation effects occurred for word fragment cued recall but not for word fragment completion. Because these dissociations between word fragment completion and word fragment cued recall were obtained, the generation effects (Generate-same fragment greater than Read once) and the specific generation effect (Generate-same fragment greater than Generate-different fragment) that occurred for word fragment completion could be ruled out as effects due to explicit contamination. If explicit contamination of the implicit test had occurred, then no dissociations should have been obtained. Although the repetition of aurally-presented words did not yield a dissociation between the word fragment completion and word fragment cued recall test in Experiment 3, the two tests were dissociated based on a specific generation effect that was obtained for the word fragment cued recall
test but not for the word fragment completion test. Thus the parallel modality effects for the word fragment completion and word fragment cued recall test in Experiment 3 were not due to explicit contamination of the implicit test.
Summary

The present study showed that not all of Jacoby’s (1978) results for an associative cued recall test generalize to other memory tests. This statement was particularly true of the comparison of associative cued recall to a perceptual implicit memory test, word fragment completion, which did not show any effects of repetition across all three experiments. Unlike the associative cued recall test, no other test produced an advantage for words generated once compared to words first read, then generated. This result was interpreted in terms of the reliance of the associative cued recall test on the associative cue-target word relationship, but an emphasis for the other tests on processing of the individual target item. Reading the target word prior to generating is thought to have undermined any strengthening of the cue-target relationship on the second (generate) presentation, thus affecting only associative cued recall performance (because it was the only test that stressed the cue-target relationship).

Second, specific generation effects were obtained on a word fragment cued recall test for the first time. This adds to the findings by Glisky and Rabinowitz (1985) that showed a specific generation effect for an explicit test based on perceptual factors. The specific effects were obtained in the present experiment by presenting the same perceptual cue (the same word fragment) at study and test.
In addition, the word fragment cued recall and word fragment completion tests were dissociated while satisfying the retrieval intentionality criterion. Thus the parallel specificity effects that occurred for single presentation conditions (the Generate-same fragment compared to the Generate-different fragment condition) for word fragment cued recall and word fragment completion ruled out the possibility that specific generation effects in word fragment completion were due to explicit contamination. Why specific generation effects were not obtained for word fragment completion was not expected and should be examined in future experiments, especially since no present theory is able to accommodate this finding.

On the whole, the present experiments showed that the results found for one memory test do not necessarily generalize to other memory tests. Thus researchers should generalize test results with extreme caution. Different tests tap into different types of memorial information, and performance on a given test should be considered in terms of the interaction of cues given in the study and test phases. This basic idea of transfer appropriate processing applies whether the test comparison is an implicit-explicit memory test comparison, or a comparison between two implicit or two explicit memory tests. At present, despite the failure of transfer appropriate processing theory to predict the lack of a specific generation effect for repeated study conditions, the theory remains a useful tool for predicting and explaining performance on different memory tests, particularly with regard to the conceptually-driven/data-driven distinction.
Footnotes

1. The study and test fragments differed by only one letter. One condition provided an extra letter on the tested word fragment relative to the study fragment. The other condition presented a test fragment with one less letter than the study fragment. All other letters provided in the fragments between study and test were the same.

2. The “different” fragments were seen only at study, instead of at both study and test. So in a sense, the experiment was not completely counterbalanced. The reason for this design was that the word fragments seemed difficult to solve in general, and there was some concern that the amount of priming, as well as the baseline, might be quite low if the “different” fragments were used during the test. Therefore, the word fragments that showed the most priming (established by Hayman & Tulving, 1989), were used for the “same” fragment condition, and the seven lists were constructed to obtain equivalent baserates across lists.
References


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storm  lightning lih_ni_  l_g_t_ng
spider insect  ns_t  i_sec
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railway train  t_a_n  tr_i

Note: a = items used only in Experiment 2.
Appendix B

Sometimes a few subjects notice that some of the words that first come to mind are words that were presented earlier in the experiment. Did you notice this?

Yes       No

Sometimes some of the subjects who become aware that they are using words that were presented earlier develop a strategy of intentionally thinking back to the prior words to come up with an answer. Did you adopt this strategy?

Yes       No

If Yes, what percentage of the time would you say that you used this strategy? (1 - 100%).
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A new finding for the word fragment-low recall test was obtained on the

Jacoby et al.'s results were replicated for associations recalled.
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spider    _pi__r      _p_d__
stigma    _t_g_a      s_i_m_
sunburn    s_n__rn     _u_bu__
teaspoon   _e__p_on    t_as_o__
toucan     t_c_n       _ou_an
travesty   t_a_e__y    _v_st_
tugboat    _ug__at     t__bo__
tukelele   _ke_e_e     u__l_l
vagabond   v__a__d      _ag_bo__
warthog    _a_t_og     w__ho__
wigwam     _i_w_m      _g_am