

# Reenacting the Route to Interpretation: Enhanced Perceptual Identification Without Prior Perception

Michael E. J. Masson  
University of Victoria  
Victoria, British Columbia, Canada

Colin M. MacLeod  
Division of Life Sciences, University of Toronto,  
Scarborough Campus  
Scarborough, Ontario, Canada

Memory for processing a stimulus event may be expressed indirectly through more fluent processing of that stimulus on a later occasion. In 11 experiments, enhanced identification of words presented under visual masking was measured following events that involved reading target words or generating them from semantic cues. Amount of enhancement was related not to whether a word was actually seen on its first presentation, but to the degree to which it was integrated with its encoding context—integration led to less enhancement. It is proposed that 2 sets of operations are carried out during encoding. *Interpretive* encoding operations construct a context-sensitive interpretation of the stimulus and are optionally followed by *elaborative* encoding operations. Enhanced word identification due to memory for a prior episode is determined by the fluent reenactment of interpretive encoding operations applied during that episode.

In their everyday use of the word, people usually think of *remembering* as a single act. This is evident in the frequent analogy to locating a book on a library shelf: The routine is done essentially the same way every time. But cognitive psychologists have shown over and over that, as appealing as the library analogy may be, it is not appropriate for describing memory. Remembering is not a single routine; it is a family of skills that we learn to use alone or in combination to meet the demands placed on us by our contexts.

To understand memory, then, a key step will involve categorizing different types of remembering, finding commonalities among superficially different acts of remembering. In the past decade, this enterprise has focused particularly on a distinction between two ways of remembering—the deliberate recollection of specific episodes and the fluent application of memory for past experience to current task performance. Situations in which we deliberately attempt to remember have been called *direct* or *explicit* tests of memory (Richardson-

Klavehn & Bjork, 1988; Schacter, 1987) precisely because we directly examine and reflect upon what we are able to remember. On the other hand, to function on a day-to-day basis we must also be able to make use of relevant memories even when we are not intentionally remembering, as when engaging in skilled performance. Tasks designed to reveal the influence of memory without intentional recollection are referred to as *indirect* or *implicit* tests of memory. Enhancement on these tests stemming from a specific prior episode is generally called *priming*.<sup>1</sup>

Although direct and indirect uses of memory share certain characteristics (e.g., both are sensitive to a single prior occurrence of a stimulus), various forms of these tests have been experimentally *dissociated*: They respond differently and even in opposite ways under particular circumstances. For example, generating a target word from a cue such as its definition or its antonym produces reliably better performance on direct memory tests such as recognition than does simply reading the target in isolation, but the opposite result has been found for priming on indirect memory tests such as perceptual identification, which involves the identification of briefly presented words (Jacoby, 1983b; Winnick & Daniel, 1970). Similarly, an encoding of a word that emphasizes aspects of its meaning rather than its surface features enhances performance on direct tests of memory, but this manipulation often has no reliable effect on indirect tests such as word-fragment completion and perceptual identification (Jacoby & Dallas, 1981; Roediger, Weldon, & Challis, 1989).

The original purpose of the experiments we report here was to explore the role context plays in the actuation of memory

---

This research was supported by Natural Sciences and Engineering Research Council of Canada Operating Grant A7910 and International Collaborative Research Grant IC-R0044518 to Michael E. J. Masson and Operating Grant A7459 to Colin M. MacLeod.

For their assistance in collecting the data, we thank Guy Gondor, Angela Micco, Lisa Pantuso, Nadine Plotnikoff, and Megan Terepocki at the University of Victoria and Natasa Arbutina at the University of Toronto. Thanks also to Martin for the tow. We also wish to acknowledge helpful discussions with Larry Jacoby, Walter Kintsch, and Endel Tulving and comments provided on an earlier version of this article by Larry Jacoby, Henry Roediger, and an anonymous reviewer.

Preliminary reports of this work were presented at the 1989 and 1990 meetings of the Psychonomic Society.

Correspondence concerning this article should be addressed to Michael E. J. Masson, Department of Psychology, University of Victoria, P.O. Box 3050, Victoria, British Columbia, Canada V8W 3P5, or Colin M. MacLeod, Division of Life Sciences, University of Toronto, Scarborough, Ontario, Canada M1C 1A4.

---

<sup>1</sup> The use of this term should not be confused with the concept of *semantic priming*, which denotes enhanced identification of a stimulus that is immediately preceded by a semantically related item. Although the term *priming* suggests the theoretical view that such effects result from persistent semantic activation, we wish to point out that for the most part the views described here do not subscribe to such a notion.

for prior experience during an indirect test of memory. As so often happens in research, though, this exploration led us to an alternative view of the direct–indirect distinction. Before introducing this alternative view, we provide a description of the framework from which we began.

### Transfer-Appropriate Processing

The concept of transfer-appropriate processing (Morris, Bransford, & Franks, 1977) has been proposed as a possible framework for explaining the direct–indirect memory distinction. The principal tenet of this view is that memory performance will vary directly as a function of the similarity between processing operations demanded by a memory test and the encoding operations applied during original processing. In their instantiation of this framework, Roediger and his colleagues (Blaxton, 1989; Roediger & Blaxton, 1987; Roediger, Weldon, & Challis 1989) have emphasized the notion that cognitive operations can be divided into two classes: conceptually driven and data-driven processes. Data-driven processes are those that emphasize sensory and perceptual processing of a stimulus; conceptually driven processes are those responsible for developing plausible interpretations of the stimulus.

This processing dichotomy does not claim that direct memory tests are based only on conceptually driven processes whereas indirect tests are based only on data-driven processes. Rather, the claim is that either type of test may be constructed to rely primarily on either type of process (Blaxton, 1989; Roediger & Blaxton, 1987). Still, the most prevalent indirect memory tests—such as word-stem completion (e.g., WIN\_\_\_\_\_ for WINDOW), word-fragment completion (e.g., H\_YL\_\_\_\_T for HAYLOFT), and perceptual identification—are typically assumed to rely primarily on data-driven processes, whereas direct tests of memory such as recall and recognition most commonly invoke conceptually driven processes (Roediger & Blaxton, 1987; Roediger, Srinivas, & Weldon, 1989). Dissociations between direct and indirect tests of memory (and even dissociations within these two classes of test) are attributed to differential emphasis on conceptually driven and data-driven processes (Roediger, Srinivas, & Weldon, 1989). For example, tests such as word-fragment completion have been shown to be highly sensitive to surface changes (e.g., visual, auditory; picture, word) between study and test (e.g., Roediger & Blaxton, 1987; Weldon & Roediger, 1987), whereas direct memory tests such as recognition are not as sensitive (Jacoby & Dallas, 1981; Roediger & Blaxton, 1987).

Although we accept that the general concept of transfer-appropriate processing can serve as a useful explanatory framework in understanding the relation between direct and indirect tests, we suggest that the distinction between conceptually driven and data-driven processes, despite its importance, is not adequate. A number of results—we will consider four—pose serious challenges to the version of transfer-appropriate processing that has this distinction at its core.

The first problematic result has to do with dissociations between tests of the same type. Dissociations have been established between two indirect tests of memory, word-fragment completion and perceptual identification, both of

which are presumed to be based on data-driven processing of nominally similar types of data (Schwartz, 1989; Witherspoon & Moscovitch, 1989). Furthermore, there are well-known dissociations between different direct tests, particularly recall and recognition, both of which are assumed to rely on conceptually driven processes: (a) word frequency (e.g., Gregg, 1976; MacLeod, 1989b), (b) recognition failure of recallable words (Watkins & Tulving, 1975), (c) test expectancy (Connor, 1977; Leonard & Whitten, 1983), (d) association (Bruce & Fagan, 1970; Kintsch, 1968), and (e) intention to learn (Estes & DaPolito, 1967).

Second, the construction of a conceptual interpretation of a stimulus (e.g., identifying a letter string as a specific word) during encoding enhances or is necessary for later priming on an indirect test (e.g., Graf & Schacter, 1985; Weldon, 1991; Whittlesea & Cantwell, 1987). Third, free recall and word-fragment completion are both greater for orthographically distinct target words (e.g., *khaki*; Hunt & Toth, 1990). Given that free recall is viewed as the ultimate conceptually driven memory task, it is surprising to discover that it is reliably influenced by a variable associated with data-driven processing.

Fourth, Levy and Kirsner (1989) demonstrated that reading a text failed to produce reliable priming on a later perceptual identification test of individual words taken from the text. This lack of priming could not, however, be attributed to the lack of data-driven processing during text reading because the amount of priming obtained on a text rereading task was greater if the original presentation of the text was visual rather than auditory. Memorable data-driven operations must have been applied during the first reading, yet they were of no apparent value for words presented in isolation.

### A Modified Framework: Context-Sensitive Interpretation

Although the distinction between conceptually driven and data-driven processes appears insufficient to explain the relation between direct and indirect tests of memory, we maintain that the general principle of transfer-appropriate processing has a critical role to play. Our approach has been to develop the notion put forward by Kolers (1979; Kolers & Roediger, 1984) that encoding operations applied to a stimulus form the memory for that event. Such operations include both data-driven and conceptually driven processes working together to produce a context-dependent interpretation of a stimulus. In this view, the interpretation of a stimulus is not restricted to semantic classification, but can also be based on judgments regarding functional applications of an object or whether the object adheres to some arbitrary set of constraints.

Memory for an encoding episode consists of the processing operations that were followed in developing an interpretation of a stimulus. This memory can then express itself when opportunities arise to reenact the original encoding operations. Such remembering is most successfully (and in some cases only) accomplished when task conditions permit the entire collection of encoding operations to be recruited. It is not surprising, then, to find dissociations between indirect tests or between direct tests, nor to find indirect tests sensitive

to changes in context and direct tests sensitive to surface characteristics of stimuli. We assert that although data-driven processes seem particularly important for many indirect tests of memory (e.g., Roediger, Weldon, & Challis, 1989), both data-driven and conceptually driven operations make critical contributions to direct and indirect tests and an additional processing distinction between these two classes of tests is warranted.

In this regard, a fundamental distinction can be made between two classes of encoding processes: those that contribute to the construction of an initial interpretation of an item, and those that elaborate on the interpretation (see also Graf & Mandler, 1984; Graf & Ryan, 1990; Hirshman, Snodgrass, Mindes, & Feenan, 1990; Micco & Masson, 1991). Processes that construct the initial interpretation are assumed to be context-sensitive. For example, the particular nuance of a word's meaning may vary as a function of the sentence in which it is embedded (e.g., Kintsch, 1988). Interpretive encoding processes are also assumed to be sensitive to the physical nature of the stimulus, such as its presentation modality. Although the final interpretation of a word presented in isolation may be the same with visual and auditory input, conceptual processes that identify the input will vary systematically with modality. For example, in a connectionist word identification system such as the one developed by J. L. McClelland and Rumelhart (1981), visual presentation of the letter string *heard* will activate the word node HEARD in addition to visually similar neighbors like HEART that eventually must be inhibited. Auditory presentation of the same item would generate activation among a different set of neighbors. If we assume that memory for an encoding episode is captured in part by changes in connection weights between activated word nodes, it is clear that different sets of changes are implied by different input modalities.

Once an interpretation has been constructed, processing may be continued in the form of elaboration of any of a host of features, including surface and semantic attributes ( Craik & Lockhart, 1972; Morris et al., 1977). Elaborative processing uses the established interpretation of the stimulus and serves to relate it to existing knowledge, perhaps revising the interpretation if an anomaly is discovered, as might happen with homographs in garden path sentences (Carpenter & Daneman, 1981). The nature of these elaborative processing operations has a strong influence on the recollection of targets when direct tests of memory are used (Anderson & Reder, 1979; Craik & Tulving, 1975).

The value of distinguishing between interpretive and elaborative encoding lies in the leverage it provides in explaining the relation between direct and indirect memory tests. We suggest that indirect memory tests that involve only the initial identification or regeneration of a stimulus reenact those processes used in the interpretive encoding of the item. Processing of the information provided in the retrieval cue (e.g., a word-stem or a briefly flashed word) enables redintegration of the original encoding operations applied during the initial encounter (Horowitz & Manelis, 1972; Horowitz & Prytulak, 1969). In many instances, interpretive encoding operations do not require conscious deliberation regarding candidate interpretations. Their automatic reenactment on an indirect

test may therefore fail to invoke a powerful sense of prior occurrence, producing the characteristic memory without awareness.

We further assume that elaborative processes used during study are not recruited when generating potential responses on indirect tests, although they may be involved in decisions about whether to overtly produce those responses. For example, if a subject were to be instructed that correct responses consisted of items that had been presented during a study phase, memory for elaborative processing could be used to determine that a candidate item had appeared during study and was therefore an appropriate response.

Performance on direct memory tests is assumed to be supported by both types of encoding operations. For example, in a recall task it is necessary both to generate potential targets from available cues (as on indirect tests) and to decide whether there is enough evidence to claim that a candidate is a target item (Jacoby & Hollingshead, 1990). Although this decision often is based on reconstruction of details of the original elaborative encoding, it may also be influenced by the fluency with which a candidate is generated on a recall test or encoded on a recognition test (Jacoby, Kelley, & Dywan, 1989; Jacoby & Whitehouse, 1989). This fluency is assumed to be determined by the same recruitment processes as those that drive indirect memory performance (Jacoby & Hollingshead, 1990).

An important implication of this proposal is that indirect memory tests, like direct tests, should exhibit sensitivity to aspects of the conceptual context in which an item is encoded. This is because the initial interpretive encoding of a stimulus is context-dependent. Recent studies have provided strong support for this idea by showing that priming in an indirect memory test is stronger when aspects of the initial encoding context are reinstated at test (Allen & Jacoby, 1990; Masson & Freedman, 1990; Smith, MacLeod, Bain, & Hoppe, 1989).

This view also provides an alternative explanation for a related result widely treated as evidence that indirect memory tests are based on data-driven processes (e.g., Blaxton, 1989; Hintzman, 1990; Richardson-Klavehn & Bjork, 1988; Roediger & Blaxton, 1987; Schwartz, 1989). Jacoby (1983b) found that words generated from their antonyms produced little or no priming on a subsequent perceptual identification test, whereas words read in isolation showed reliable priming. On the other hand, generated words were much more likely than words read in isolation to be correctly recognized. The absence of data-driven processing of generated targets has been assumed to be responsible for the failure to obtain priming on the perceptual identification test. In contrast, we view the lack of priming among generated items as a consequence of the difference between the original encoding context and the test context. During encoding, generated items were processed and interpreted in the context of a generation cue. When presented on the perceptual identification test, however, all items appeared in isolation. The processes involved in constructing the interpretation of a generated item would, therefore, be very different at study and test because of differences in context. By testing a generated item in isolation, the interpretive encoding operations applied during study would not be redintegrated and little or no priming would be found. Words read in isolation during study, however, would be

appropriately encoded for testing in isolation and would show priming.

We have carried out a series of experiments to explore the validity of this account and, more generally, the usefulness of the modified version of transfer-appropriate processing proposed here. A major goal was to specify those aspects of interpretive encoding that are sensitive to the change between study and test contexts and that play a central role in determining whether priming on indirect memory tests will occur. Our initial strategy was to reinstate the original encoding context at the time of test in an effort to produce priming in a perceptual identification task for generated items. The surprising results of our first attempt at this approach led us to explore in more detail the nature of encoding operations and their influence on indirect memory as exemplified by the perceptual identification test.

### Experiment 1

Most previous research that has compared indirect memory of words generated from a cue with indirect memory of words read in isolation has done so in the absence of any item-specific contextual information on the test. An important exception is a study by Toth and Hunt (1990) in which a semantic associate was used as the encoding cue for each target. Toth and Hunt found that perceptual identification performance on generated, but not on read, targets was enhanced by providing the associate at test. The generation task could be classified as incorporating a major data-driven component, however, because targets were presented with only one or two letters missing during generation. Indeed, even when a different or no cue was presented during test, Toth and Hunt found that identification performance on generated items was at least as high as on read items.

Our objective was to explore priming where performance on read items was superior to that on generated items when the original encoding context was not reinstated. We reasoned that under such circumstances, providing context in the form of the generation cues at test might have two consequences. First, it could enhance performance for the generated words because the study-test relation would now be more similar, making recruitment of the original encoding operations more likely at the time of test. Second, and reciprocally, it could diminish performance for words originally read in isolation because the study and test formats would now be less similar, with context present only at test. Both predictions follow directly from the modified version of the transfer-appropriate processing framework just presented. Jacoby's (1983b) perceptual identification results were expected to replicate when there was no context at test. The version of transfer-appropriate processing proposed by Roediger and his colleagues (e.g., Roediger, Weldon, & Challis, 1989) would make similar predictions, based on the claim that presence of a context word at test would induce conceptually driven processing operations. Thus, the first experiment was not intended to directly contrast these two versions of transfer-appropriate processing.

Although Experiment 1 was intended as a partial replication of Jacoby's results, the context manipulation required using

a generation task other than the antonym task Jacoby had used. If a target's antonym were presented as context during a perceptual identification test, subjects could easily ignore the brief presentation of the target and instead generate the target from the context word at test. To reduce this problem, we used definitional sentences as the generation cues during the study phase. The resulting two encoding conditions required subjects to say aloud a target word by either reading it in isolation (e.g., "carrot") or generating it from its definition and first letter (e.g., "The orange vegetable a rabbit eats. c?"). Then, on the perceptual identification test, a target word had to be identified in isolation or in the presence of a single content word taken from the definition and associated with the target. The availability of the context word during test was intended to reinstate the original encoding context of targets in the generate condition and to produce priming for those targets on the perceptual identification test.

### Method

*Subjects.* There were 24 participants, all undergraduate student volunteers at the University of Victoria. English was the native language of all subjects, and most were recruited from introductory psychology classes. Two additional subjects were tested but replaced because of floor or ceiling performance on the perceptual identification test. A floor effect was defined as 0% correct in two or more conditions, and a ceiling effect was defined as 100% correct in two or more conditions.

*Materials.* A set of 144 nouns and verbs was selected as target words. The words ranged in frequency of occurrence in English from 0 to 492 with a mean of 54 per million (Kučera & Francis, 1967). A definition ranging in length from 5 to 12 words was developed for each target word. Each definition was written to make it highly likely that subjects would be able to generate the desired target word from the definition and so that a word could be taken from the definition and used as a context word during the perceptual identification test. The target words, context words, and definitions are shown in Appendix A.

*Apparatus.* Testing sessions were conducted under the control of an Apple II+ microcomputer equipped with a Mountain Hardware clock for millisecond timing, a monochrome monitor, and a voice-operated relay for detecting vocal responses. Letters appeared on the monitor as bright green against a dark green background. A second monitor that displayed the target item on each trial was available to the experimenter, who sat in the testing room with the subject. The same equipment was used in Experiments 1 through 8 and in Experiment 11.

*Procedure.* The 144 target items were organized as six lists of 24 items each, and two lists were assigned to each of three study conditions: read in isolation, generate from a definition, and not studied. Target items from one list assigned to each condition were presented without a context word on the perceptual identification test, and targets from the other list were presented with the appropriate context word. Assignment of lists to the six combinations of study and test conditions was counterbalanced across subjects using a Latin square design.

In the first phase of a session, the study phase, each item in the read condition was preceded by a warning signal consisting of a row of four Xs that appeared 1,000 ms prior to the target and remained while the target was presented. The target appeared in lowercase letters below the warning signal, and subjects were to read it aloud. For items in the Generate condition, the definition was presented left-justified on the middle line of the screen, and the first letter of

the target word followed by a question mark appeared below it at the center of the screen. Subjects were to name the target word that fit the definition and began with the indicated letter. In both conditions the display remained on the screen until a response was given, at which point a row of asterisks was presented below the display for 500 ms to signal detection of the response; then the screen was erased. The experimenter, hidden from the subject's view by a partition, then pressed a key to record the accuracy of the response and to begin the next trial. Responses were considered incorrect if the subject produced a word other than the intended target in the generate condition or if the subject stumbled in saying the response in either the generate or the read condition.<sup>2</sup> The study phase began with one practice item of each type, followed by a random ordering of 48 critical trials in each of the two conditions.

The perceptual identification test phase immediately followed the study phase. Each trial began with a plus sign (+) centered on the screen as a warning signal for 250 ms. The signal was erased and 250 ms later was replaced by an uppercase string of letters consisting of either the context word for the target (for the 72 targets assigned to the context condition) or a row of four Xs (for the 72 targets assigned to the no-context condition). This display was erased after 250 ms and was followed by a 250-ms blank interval. Next the target word appeared in lowercase letters below the location of the context string for 33 ms. The target was then replaced by a mask consisting of a random pattern of dots covering the equivalent of eight character positions. The mask remained on the screen until the subject responded; then it was replaced by a row of dashes for 500 ms to indicate that the response had been detected. The experimenter then pressed a key to record the accuracy of the response and begin the next trial. The subject's task on each trial was to identify the briefly presented lowercase word. The 144 targets were presented in a random order following two practice trials.

### Results and Discussion

*General comments on the analyses.* The experiments reported here were analyzed in the same general way, so a few introductory comments are warranted. First, in most instances three conditions were included in each experiment, and comparisons were made among pairs of conditions using directional Bonferroni *t* tests with the familywise Type I error rate set at .05. In cases where analysis of variance (ANOVA) or a simple *t* test is applied, results are reliable with the Type I error rate set at .01 unless otherwise noted. Second, attempts to produce targets in the generation task led to a higher rate of encoding errors than did reading words aloud. To address concerns regarding item selection effects that might arise from the differential error rates, in each experiment that involved a generation task we conducted two sets of analyses on perceptual identification scores. One set of analyses excluded items on which an encoding error had been made, and these are the results that we report for each experiment. The other set of analyses included all items, regardless of errors during the encoding phase. These two sets of analyses produced exactly the same outcomes except for one result that appears in Table 1. Therefore, we are confident that the results we report are not the product of item selection effects.

*Perceptual identification.* The proportions of production errors during study were .08 in the generate condition and .01 in the read condition. The mean proportions of correct identification on the perceptual identification task are shown in Table 1. A 3 × 2 repeated measures ANOVA was conducted

Table 1  
*Experiment 1: Proportions of Correct Responses in Perceptual Identification When Generation Cues Were Definitions*

Context condition	Encoding condition		
	Generate	Read	Not studied
Context	.75	.71	.60
No context	.62	.59	.47

on the proportion-correct data to analyze the effects of encoding condition (read, generate, or not studied) and test context (context or no context). There was a reliable main effect of test context,  $F(1, 23) = 21.07$ ,  $MS_e = .028$ , with better performance for the context condition (.69 correct) than for the no-context condition (.56 correct). There was also a reliable main effect of encoding condition,  $F(2, 46) = 25.72$ ,  $MS_e = .012$ , with less accurate identification of the not-studied words (.54 correct) than of the generated words (.69 correct) or the read words (.65 correct). Contrary to our initial expectation, however, there was no hint of interaction,  $F < 1$ .

We followed up the main analysis with comparisons using a set of directional Bonferroni *t* tests. The effect of encoding condition was examined by collapsing across test context. There was reliable priming relative to the not-studied baseline for both of the preexposed conditions:  $t(23) = 5.79$ ,  $SE_{dm} = .037$ , for the generate condition; and  $t(23) = 5.52$ ,  $SE_{dm} = .029$ , for the read condition. The small difference between the generate condition and the read condition was not reliable.

The obtained results were not what we had anticipated. First, we had expected provision of context at test to influence the pattern of performance differentially in the generate and read conditions, but it clearly did not. Instead, the benefit of providing a relevant context word at test was the same across all encoding conditions. This outcome suggests that a single word taken from the definition was not sufficient to reinstate aspects of the original encoding episode that were specific to targets in the generate condition. Even more surprising was the failure to replicate the finding of greater priming for read than for generated words that has been obtained for the perceptual identification task (Jacoby, 1983b; Weldon, 1991) and for other tasks such as threshold identification (Winnick & Daniel, 1970) and word-fragment completion (Blaxton, 1989; Srinivas & Roediger, 1990). The central issue then became why such strong priming was found for generated words.

### Experiment 2

Although the results of Experiment 1 were unexpected, they are not entirely anomalous. As noted earlier, Toth and Hunt (1990) obtained equal or more priming with generated as compared to read targets, although that outcome may reflect

<sup>2</sup> In most of the experiments we also recorded vocal response latencies during both study and test. Because these data revealed very little that was not already apparent in the accuracy data, they are not discussed.

the high degree of visual experience provided for both sets of items during encoding. In addition, Schwartz (1989) used definitions as generation cues and obtained priming effects in perceptual identification that were nearly as large as those obtained after reading targets in isolation. Our results do, however, contrast with a similar experiment by Weldon (1991, Exp. 1) in which a clear advantage for read over generated items was found in perceptual identification when definitional phrases were used as generation cues.

These discrepant results might be accounted for by the fact that the Weldon experiment differed in a number of ways from Experiment 1 and from the Schwartz (1989) study. First, Weldon did not require subjects to produce an overt identification response to generated items during encoding. Instead, they were instructed to determine each target's identity and to rate its pleasantness. It is conceivable, therefore, that subjects did not comply with the instructions to actually generate the targets, which led to reduced identification performance. Second, Weldon manipulated the read and generate conditions between subjects, whereas in Experiment 1 and in the Schwartz study the encoding variable was manipulated within subjects. Research on explicit tests of memory has shown that the advantage of generating targets is reduced or eliminated when encoding task (generate vs. read) is manipulated between subjects (e.g., Begg & Snider, 1987; Hirshman & Bjork, 1988). It is possible that implicit and explicit tests of memory share a sensitivity to the method of manipulating this encoding task variable.

Some other factor, however, is also important in determining the amount of priming of generated targets. Jacoby (1983b) manipulated encoding task within subjects and required overt production of generated targets, just as in Experiment 1 and in the Schwartz (1989) experiments, yet he found little or no priming of targets generated from antonyms. We suspected, therefore, that the nature of the generation cues made a critical contribution to the difference between the results of Experiment 1 and Jacoby's study. An additional difference between these studies is that in Experiment 1 we included the first letter of the target as part of the generation cue, something Jacoby did not do. To rule out this and other methodological factors as complete explanations for the outcome of Experiment 1, we used Jacoby's antonym materials in Experiment 2 but included the target's first letter as part of the generation cue. In the design of Experiment 2 we also eliminated the test context variable that had been manipulated in Experiment 1, testing all targets in isolation as Jacoby had done.<sup>3</sup> If displaying the first letter is crucial, then antonyms in this experiment should behave like definitions in Experiment 1. If, on the other hand, the difference between definitions and antonyms as generation cues is critical, then we should replicate Jacoby's results in Experiment 2.

## Method

*Subjects.* A further 24 subjects from the same pool as Experiment 1 volunteered to take part in Experiment 2. None had participated in Experiment 1. For all experiments we report, an individual subject was tested in only one experiment. Four additional subjects were tested but were replaced because of floor or ceiling performance on

the perceptual identification test; 1 other subject was replaced because of a high error rate (35%) on the generation task.

*Apparatus and materials.* The same computer configuration was used as in Experiment 1. The critical cue-target antonym pairs consisted of the set of 60 pairs used by Jacoby (1983b) and are shown in Appendix B. The target items ranged in frequency from 0 to 1,070 per million with a mean of 170 per million. An additional set of 30 filler antonym pairs was developed as explained in Footnote 3.

*Procedure.* The 60 critical items were divided into three lists of 20, and one list was assigned to each of three encoding conditions: generate, read, or not studied. This assignment was counterbalanced across subjects using a Latin square design. In the study phase of a session, subjects were presented 10 practice trials followed by a random ordering of 40 critical and 20 filler trials. Half of the trials of each type were in the generate condition and half were in the read condition. Apart from using a single antonym in place of a sentence during generate trials, we used exactly the same study procedure in Experiment 2 as in Experiment 1. On generate trials the generation cue appeared in uppercase letters in the center of the screen, and the first letter of the target word followed by a question mark appeared below it. Subjects were instructed to generate the antonym of each capitalized word beginning with the specified first letter. The perceptual identification test began with a set of 10 practice trials and followed the format described in Experiment 1 except that all items were tested following the row of Xs as a warning signal and none were accompanied by a context word. All 60 critical and 30 filler items were tested in a random order.

## Results and Discussion

The proportion of errors (combining intrusion and articulatory errors) was .09 for the generate condition and .01 for the read condition. The top row of Table 2 presents the mean proportions of correct perceptual identification for Experiment 2. Differences between means were analyzed using a set of directional Bonferroni *t* tests as in Experiment 1. There was no significant difference between the generate and not-studied conditions,  $t < 1$ , and each of these conditions produced lower scores than the read condition:  $t(23) = 3.11$ ,  $SE_{dm} = .045$ , and  $t(23) = 3.68$ ,  $SE_{dm} = .037$ , for the generate and not-studied conditions, respectively.

These results are a straightforward replication of Jacoby's (1983b) finding using antonyms. Clearly, specifying the first letter of the to-be-generated target was not responsible for producing the unexpected outcome in Experiment 1. Instead, a critical factor appears to be the difference between the definition and antonym materials and the associated generation rules. As mentioned earlier, other procedural factors also

<sup>3</sup> Actually, we did manipulate context again at the time of test, but this time between subjects, providing the antonym cues at test to a separate group of subjects. In an effort to reduce the strategy of simply giving the antonym of the context word as the response on the perceptual identification task, we also included in the study and test phases a set of filler items that served as unrelated context-target filler pairs during the test phase. The same filler items were included in the materials presented to subjects whose data we report, although performance on these items was not analyzed. Subjects in the "context present" group, however, still adopted the antonym production strategy on the perceptual identification test, resulting in consistently high performance in all conditions. Consequently, the data from this group are not reported.

Table 2  
*Proportions of Correct Responses in Perceptual Identification When Generation Cues Were Antonyms (Experiment 2) or Synonyms/Associates (Experiment 3)*

Experiment	Encoding condition		
	Generate	Read	Not studied
2—Antonyms	.36	.50	.37
3—Synonyms/associates	.67	.65	.58

play a role in determining whether priming in perceptual identification will be equally strong for read and generated items, but the goal in the remaining experiments was to explore a series of hypotheses regarding the relationship between processes invoked by the generation task and subsequent enhancement of perceptual identification.

### Experiment 3

In Experiment 3 we tested the hypothesis that a one-word generation cue leads to a relatively unelaborated interpretation of the target word, whereas a sentence produces a more elaborated interpretation. If this is the case, then one might expect all one-word generation cues to produce the same pattern of results as antonyms produce. Alternatively, it may be that antonyms are odd in some sense, for reasons that will have to be determined subsequently. To test these hypotheses, we used two new types of one-word generation cues, synonyms and associates, in Experiment 3.

#### Method

*Subjects.* A further 27 subjects from the same pool as Experiments 1 and 2 volunteered to take part in Experiment 3. Five additional subjects were tested but replaced, 2 because of floor or ceiling performance on the perceptual identification test and 3 because of high error rates (30% or more) on the generation task.

*Apparatus and materials.* The same computer configuration was used as in Experiments 1 and 2. A set of 60 critical cue–target pairs, consisting of strong associate pairs (Postman & Keppel, 1970) and synonym pairs (Whitten, Suter, & Frank, 1979; Wilding & Mohindra, 1983), and a set of 30 filler items derived from the same sources were used. The 60 critical pairs are shown in Appendix C. Pilot testing with a larger set of cue–target pairs was used to select those pairs that were most likely to produce correct responses on the generation task. The critical target words ranged in frequency from 6 to 787 per million with a mean of 134 per million. The same conditions and counterbalancing scheme as those used in Experiment 2 were applied in Experiment 3.

*Procedure.* The procedure was identical to that of Experiment 2. Filler items were included as in Experiment 2 because the same computer program was used to control both experiments. The only exception was that during the study phase the instructions for the generation task indicated that subjects were to use the cue word to generate a word that was “closely related” to it and that began with the indicated letter.

#### Results and Discussion

The proportions of errors during encoding were .18 for the generate condition and .01 for the read condition. The error

rate for the generate condition was considerably higher than in Experiment 2, perhaps as a result of the greater uncertainty regarding the kind of item (synonym or associate) to be generated on a given trial. The bottom row of Table 2 presents the mean proportions of correct identification on the perceptual identification test in this experiment. Directional Bonferroni *t* tests showed that the proportions of correct responses in the generate and in the read conditions were reliably greater than in the not-studied condition:  $t(26) = 3.40$ ,  $SE_{dm} = .026$ , and  $t(26) = 2.60$ ,  $SE_{dm} = .027$ , respectively. The read and generate conditions did not differ reliably,  $t < 1$ . These results closely resemble those of Experiment 1, in that the generate condition displayed at least as much priming as the read condition. Clearly it is not the case that a lack of elaboration involved in the use of one-word generation cues was responsible for the absence of priming among generated antonyms.

### Experiment 4

The results of Experiments 1–3 strongly suggested that antonyms acted differently from other item types when generated prior to a perceptual identification test. In Experiment 4, we tried another type of material that we suspected might behave similarly to antonyms: famous names. The bond between two antonyms seems unusually strong, and this would appear to be true of famous first-name–surname pairs as well. Subjects in Experiment 4 generated the first name of a famous person from the first initial and the last name (e.g., *A. Einstein*) or read the first name in isolation (e.g., *Marilyn*, from *Marilyn Monroe*). The critical question was whether both generated and read first names would show priming in perceptual identification or whether priming would be restricted to read first names only.

Experiment 4 also was the first study in this series that included a recognition test. The primary goal of including a recognition test was to provide evidence that the encoding task manipulation was producing the expected pattern of results on a direct memory test. Subsequently, we became interested in the recognition data in their own right for what they could tell us about the distinction between memory for interpretive and elaborative encoding. We expected that dissociations between the recognition and perceptual identification tests would inform us about how these two encoding processes were affected by changes in the nature of the generation task. Because the primary concern was perceptual identification, however, the recognition test always followed perceptual identification.

#### Method

*Subjects.* A group of 18 subjects from the same pool as the prior experiments volunteered to take part. An additional 3 subjects were tested but replaced because their performance on the perceptual identification test was at ceiling.

*Apparatus and materials.* The study and perceptual identification phases of this experiment were conducted using the same equipment as in the earlier experiments. The 60 famous names shown in Appendix D were selected for use as critical items. The same encoding conditions and counterbalancing procedures as in Experiments 2 and 3 were used.

*Procedure.* The procedure followed that of Experiment 3. In the study phase, subjects read aloud 20 first names in isolation and generated 20 first names from a first-initial-last name cue (e.g., A. Lincoln). On each trial, a first name or an initial-last-name cue appeared at the center of the screen and remained until the subject responded. No warning signals were given. After a response, the experimenter pressed a key to record the response accuracy and to begin the next trial. The study phase consisted of 10 practice trials followed by 20 read and 20 generate trials in random order.

The perceptual identification test consisted of 10 practice trials followed by 60 critical first-name trials in random order. A trial began with a plus sign (+) presented at the center of the screen for 250 ms as a warning signal. After a blank interval of 500 ms, the target name appeared at the same location as the warning signal had occupied and remained in view for 33 ms. The target was then replaced by the random dot mask, which remained in view until a response was detected. The mask was then replaced by a row of hyphens that remained in view for 500 ms. The experimenter pressed a key to record response accuracy and to initiate the next trial. Following the perceptual identification test, subjects were given a recognition test consisting of a sheet of paper with the 60 critical first names printed in random order. Subjects were instructed to circle any name they had read aloud or generated in the first phase of the session.

## Results

*General comments on the analyses.* In Experiments 4–11, in which both perceptual identification and recognition tests were conducted, the perceptual identification test always preceded the recognition test. Because our primary interest was in perceptual identification, we did not want to contaminate performance in that test by any prior test. Of course, recognition performance may therefore have been contaminated by prior perceptual identification. To anticipate our results, however, the generally equivalent priming we often observed for generate and read items would probably differentially enhance recognition performance in the read condition, thereby working against the generation effect in recognition. The fact that we nevertheless consistently observed a strong generation effect in recognition should minimize concerns about contamination, although the data may underestimate the actual magnitude of the generation effect.

*Perceptual identification.* The proportions of errors committed while generating and reading names were .10 and .01, respectively. Any item on which a subject made an error during the study phase was excluded when that subject's data from the perceptual identification and recognition tests were analyzed. Table 3 presents the mean proportions of correct

perceptual identification and of yes responses on the recognition test. Regarding perceptual identification, directional Bonferroni *t* tests confirmed the result obvious in Table 3: Relative to the not-studied condition, there was reliable priming in the generate and read conditions,  $t(17) = 4.11$ ,  $SE_{dm} = .026$ , and  $t(17) = 3.90$ ,  $SE_{dm} = .032$ , respectively, but mean performance in the generate and read conditions was identical.

*Recognition.* The probability of claiming a not-studied item had occurred during the study phase was much lower than the hit rates in either the read or generate conditions, indicating that subjects were able to discriminate the two classes of items. This outcome occurred in all subsequent experiments as well and will not be discussed further. The important issue pertains to the hit rates found in the read and generate conditions. These results were as expected, given the work of Jacoby (1983b) and others. There was reliably better recognition of famous first names that had been generated than of those that had been read,  $t(17) = 4.42$ ,  $SE_{dm} = .057$ .

## Discussion

The recognition result eliminates the possible objection that the absence of a difference in priming in the perceptual identification data was the result of a manipulation that was simply too weak. In addition, it represents a dissociation between the recognition and perceptual identification tests. The differential effect of the encoding task on the two tests suggests that the pattern of results obtained in perceptual identification is not likely a consequence of subjects' using deliberate recollection as a basis for producing identification responses. Had subjects adopted such a strategy we would have expected markedly superior identification performance for generated words, as was found on the recognition test.

The perceptual identification results of Experiment 4 provide yet another illustration of priming following generation that is as great as that following isolated reading. The recognition results confirm that the generate versus read manipulation is a powerful one, at least as reflected by a direct test such as recognition. Taken together, the results of Experiments 1 through 4 suggested that the pattern of similar levels of priming following generation and read encoding tasks was a rather general one.

## Experiment 5

An important puzzle is why generating antonyms failed to produce priming in our work and in the Jacoby (1983b) study despite the clear priming for the other types of materials we have examined. Experiment 5 was designed to evaluate the hypothesis that generation from an antonym induces a highly specific interpretation of the target word, an interpretation not likely to be reinstated when that word is later tested in isolation. Earlier work has suggested that invoking a specific interpretation or sense of a word may not produce priming on a later task in which that sense fails to be reestablished (Durso & O'Sullivan, 1983; Lewandowsky, Kirsner, & Bainbridge, 1989; Masson & Freedman, 1990). To test the idea

Table 3  
*Experiment 4: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition When Targets Were First Names and Generation Cues Were Famous Last Names*

Task	Encoding condition		
	Generate	Read	Not studied
Correct perceptual identification	.72	.72	.60
Yes in recognition	.70	.45	.10

that generation of a target from an antonym invoked a highly specific interpretation of the target, we used context to manipulate the encoded sense of a target word. In each instance that sense was either common or rare so that it would be very likely or very unlikely to be instantiated when the word was presented in isolation.

To accomplish this, we used a set of homographs with a strong primary meaning and a much weaker secondary meaning. Each of the two senses was biased by using an appropriate context sentence. The generation cue consisted of a word-fragment for the target (e.g., s\_\_\_\_ll\_w) embedded in a sentence that was relevant to one of its meanings (e.g., cough syrup is hard to s\_\_\_\_ll\_w; the tiny bird was a s\_\_\_\_ll\_w). A word-fragment rather than just the first letter of the target was used to reduce the probability of generation errors.

The prediction from the specific-interpretation hypothesis was that biasing the secondary meaning would lead to less priming than would biasing the primary meaning because the secondary meaning would be much less likely to be invoked when the item was tested in isolation. That is, following generation, primary meanings should show priming analogous to that observed for sentences, synonyms, associates, and famous names. In contrast, secondary meanings should show much less priming following generation, analogous to antonyms.

### Method

*Subjects.* A sample of 16 subjects was recruited from the same pool as the earlier experiments.

*Apparatus and materials.* The same computer configuration was again used. The critical items consisted of a set of 80 homographs chosen from various sources (e.g., Nelson, McEvoy, Walling, & Wheeler, 1980) to have one dominant and one subordinate meaning. The frequency of occurrence (disregarding interpretation) of the homographs ranged from 0 to 895 per million with a mean of 91 per million. Two biasing context phrases were developed for each homograph, one for each meaning. The phrases were constructed so that the homograph could be embedded as the last word in the phrase. In addition, a word-fragment with between one and four letters removed was formed from each homograph (e.g., pl\_n\_ for plane). In the generate condition the phrase was presented with the homograph's fragment in the terminal position. These materials are shown in Appendix E.

There were four encoding conditions: generate in a context that biased the primary meaning of the homograph; generate in a context that biased the secondary meaning of the homograph; read in isolation; and not studied. The 80 critical items were divided into four lists of 20, and the lists were assigned to encoding conditions using a Latin square counterbalancing procedure.

*Procedure.* The procedure was similar to that of Experiment 4 except that each session began with a calibration phase similar to the perceptual identification test. The purpose of the calibration phase was to establish for each subject a display duration appropriate for the perceptual identification test. In this phase, subjects were given a series of 45 trials on which a word was presented briefly and followed by a random dot mask. The duration of the display was reduced as trials progressed. After the first five trials with durations ranging from 150 to 83 ms, four sets of 10 trials each were presented with durations ranging from 67 to 17 ms. On each trial a warning signal consisting of two hyphens separated by 10 character spaces appeared at the center of the screen for 500 ms. The target word was then presented

in lowercase letters between the hyphens for the designated duration and was replaced by the random dot mask. The mask remained on the screen until the experimenter pressed a key to record the correctness of the subject's response. Subjects were instructed to identify the briefly presented word. At the end of the calibration phase, a summary of the subject's performance on the four blocks of 10 trials was printed on the monitor visible only to the experimenter. The duration that produced closest to 50% correct was chosen for use in the final phase of the session. For all but 1 of the subjects, the selected duration was 33 ms; for the remaining subject, it was 50 ms.

The study phase consisted of 8 practice trials followed by 40 generate and 20 read trials presented in a random order. On each trial, a single target word (read condition) or a phrase ending in a word-fragment (generate condition) was presented at the center of the screen. After the subject read the word or completed the fragment, the experimenter pressed a key to record the correctness of the response, erase the screen, and begin the next trial. The perceptual identification test consisted of 80 trials using exactly the same procedure as the calibration phase. There were no practice trials, and the critical targets were presented in a random order. Finally, a recognition test was given. The 80 words that had appeared during perceptual identification were arranged in a random order on a single page, and subjects were instructed to circle any word that they remembered having read or generated in the second part of the experiment.

### Results and Discussion

There were no production errors in the read condition, but in the generate condition the error rates for targets generated in contexts that biased primary or secondary interpretations were .05 and .11, respectively. Table 4 presents the mean proportion correct on the perceptual identification test and the mean proportion of yes responses on the recognition test. Directional Bonferroni *t* tests were applied to the perceptual identification data. We found that mean proportions of targets generated from cues that biased primary versus secondary interpretations were not reliably different,  $t < 1$ , and therefore scores in the generate condition were collapsed across type of interpretation for the remaining comparisons. The generate and read conditions did not reliably differ,  $t < 1$ , but both conditions produced a priming effect relative to the not-studied condition:  $t(15) = 2.94$ ,  $SE_{dm} = .037$ , and  $t(15) = 2.51$ ,  $SE_{dm} = .040$ , respectively.

Another set of directional Bonferroni *t* tests was applied to data from the recognition test. There was a reliable advantage for targets generated using the primary rather than the secondary interpretation,  $t(15) = 2.57$ ,  $SE_{dm} = .039$ , and the average hit rate in these two types of target was reliably higher than the hit rate in the read condition,  $t(15) = 9.50$ ,  $MS_e = .040$ .

The results of this experiment were not consistent with the prediction derived from the specific-interpretation hypothesis. In particular, there was equivalent priming for both types of generated words and for the words that were read in isolation at the time of study.

When a manipulation has no effect, it is important to show that the materials were suitable for testing the hypothesis. The recognition test served the useful purpose of demonstrating that the meaning manipulation was a fairly powerful one. Consistent with Jacoby's (1983b) results, the generated words were recognized better than were the read words; indeed,

Table 4  
*Experiment 5: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition When Target Words Were Generated as the Primary or Secondary Meaning of a Homograph*

Task	Encoding condition			
	Generate		Read	Not studied
	Primary	Secondary		
Correct perceptual identification	.71	.71	.70	.60
Yes in recognition	.74	.64	.30	.14

generated words were recognized over twice as often as read words. More critical for present concerns, there was also a reliable difference in the recognition of the two types of generated words such that encoding a word in terms of its primary meaning led to better recognition than did encoding its secondary meaning. Thus, the materials were quite suitable, and the failure to find a difference between primary and secondary meanings in perceptual identification must be taken as evidence against the hypothesis that lack of priming is due to the development of a specific interpretation that is not called forward during the test. The brief visual presentation on the perceptual identification test apparently was capable of recruiting a record of the originally encoded interpretation of the homographs. Only on the recognition test, when subjects were required to deliberate about a target's prior occurrence, did the primary interpretation of the homographs dominate their processing.

Experiment 5 also produced an important dissociation between perceptual identification and recognition. Although the read and generate conditions produced the same amount of priming on perceptual identification, very different levels of recognition were found. We offer this result in support of the claim that priming in the Generate condition was not a consequence of strategies involving conscious recollection of prior occurrence. The case is made even stronger by the fact that within the generate condition, a dissociation between the two tests was obtained with respect to which meaning of a homograph was invoked during the study phase—no difference was observed on the perceptual identification test but a reliable difference was obtained on the recognition test. Although Experiment 5 failed to confirm the specific-interpretation hypothesis, it did provide important evidence for the argument that priming effects in the generate condition are not an artifact of conscious memory strategies.

### Experiment 6

Given the failure to find support for the specific-interpretation hypothesis, we developed an alternative explanation for the pattern of priming effects obtained in the first five experiments. We hypothesized that generating an antonym, more than any of the other generation tasks studied thus far, might lead to a particularly strong integration of the cue and target word. This "welding" of cue and target could, in the following way, work against the identification of the target when presented alone. Encoding context exerts an unusual

degree of control over the interpretive encoding of the target, especially with respect to knowledge that is recruited while attempting to generate the target word. In particular, when generating the antonym of a cue word it may be possible to access the antonym without activating knowledge of its synonyms because of direct connections between the representation of antonym pairs (Gross, Fischer, & Miller, 1989). Thus, the target could be initially produced without discriminating it from among other competing candidates of similar meaning. When later presented in isolation on a perceptual identification test, the target may recruit a number of related interpretations (some recruited by the target's orthographic characteristics, others by its semantic properties). Because the original encoding task did not provide prior experience at discriminating the target from among this set of candidates during interpretive encoding, the generation experience would not be relevant to the task of identifying the isolated target.

Begg, Snider, Foley, and Goddard (1989) made a similar argument concerning the generation effect on cued recall and recognition tests. In their case, the suggestion was that the generation task served to discriminate a target from related candidates and that the same kind of discrimination was needed on later memory tests. We suggest that discriminative processing occurs during both interpretive and elaborative encoding. Even for the antonym generation task, appropriate discriminations may be made elaboratively (e.g., to verify that a proposed candidate is the correct one), thereby producing enhanced recognition memory. For interpretive encoding, however, context may serve to radically alter the set of candidates recruited, thereby depriving the subject of the appropriate discriminative experience.

Experiment 6 was designed as an empirical evaluation of the integration hypothesis. We sought another set of materials that should produce strong integration of the target with the cue. Idioms were chosen because the individual words in an idiomatic expression only take on their desired meaning in the context of the entire phrase. Moreover, unlike Experiment 5, an idiom context should be more likely to exclude recruitment of candidates relevant to the usual interpretation of a target because of the strong preexisting unit that constitutes an idiom. Given the relatively weak constraints of the context sentences and the number of available letters in the word-fragment cues used in the generation task of Experiment 5, subjects may well have recruited and rejected alternative interpretations like those that were later invoked by the perceptual identification test.

In Experiment 6 the generation task required subjects to generate the final word of an idiom given the initial part of the idiom and the first letter of its last word (e.g., kick the b\_). If idioms result in strong integration of the target word into its context, and if integration is what causes the failure to find priming for generated antonyms, then we should also find reduced priming for words generated from idioms as opposed to the same words when read in isolation.

### Method

**Subjects.** Twenty-one subjects were recruited from the same pool as used in the prior experiments. Three additional subjects were tested but replaced, 2 because of equipment failure and 1 because of ceiling performance on the perceptual identification test.

**Apparatus and materials.** The apparatus from the earlier experiments was used. A set of 72 idiomatic expressions judged by the experimenters to be familiar to undergraduate students was compiled, and the last word in each expression was taken as the target word. Appendix F contains these critical idiomatic phrases. The normative frequency of occurrence for the 72 target words ranged from 0 to 787 per million with a mean of 94 per million. The 72 items were divided into three lists of 24, and the lists were assigned to three encoding conditions (generate, read, not studied) using a Latin square counterbalancing scheme.

**Procedure.** No calibration phase was used in this or any subsequent experiment. In the study phase there were two practice trials followed by a random ordering of 24 generate and 24 read trials. On generate trials, an idiomatic expression appeared left-justified on the computer monitor. Only the first letter of the last word in the expression was available, and the remaining letters were replaced by an underscore character. Subjects were to complete the phrase by uttering the appropriate final word. On read trials, the target word appeared alone in lowercase letter at the center of the screen, and subjects were to read it aloud. On both kinds of trials, a vocal response caused the display to be erased, and the experimenter pressed a key to record the correctness of the response and to begin the next trial. In the perceptual identification phase there were two practice trials followed by a randomly ordered presentation of the 72 critical targets. Each trial followed the same procedure as in Experiment 4, except that the blank interval between the warning signal and target was only 250 ms and a vocal response caused the screen to be erased rather than a display of hyphens to appear. The final task was a recognition test involving all 72 critical targets and was administered using the same procedure as in Experiments 4 and 5.

### Results and Discussion

The proportion of errors during encoding was .30 in the generate condition and .02 in the read condition. Consistent with the preceding experiments, the analyses we report did not include targets on which an encoding error was made, although analyses including all items produced the same pattern of effects.

Table 5 presents the mean proportion correct on the perceptual identification test and the mean proportion of yes responses on the recognition test. A set of directional Bonferroni *t* tests applied to the perceptual identification data indicated that there was reliable priming in both the Read and the Generate conditions,  $t(20) = 3.86$ ,  $SE_{dm} = .048$ , and  $t(20) = 2.91$ ,  $SE_{dm} = .034$ , respectively, but that identification was more accurate in the read than in the generate condition,

Table 5

*Experiment 6: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition When Target Words Were Generated in an Idiomatic Expression*

Task	Encoding condition		
	Generate	Read	Not studied
Correct perceptual identification	.60	.69	.50
Yes in recognition	.56	.46	.16

$t(20) = 2.33$ ,  $SE_{dm} = .036$ . The recognition data exhibited the usual pattern in which recognition was reliably better for generated than for read target words,  $t(20) = 2.57$ ,  $SE_{dm} = .042$ ,  $p < .02$ .

The results of this experiment were consistent with the prediction of the integration hypothesis. Under conditions in which the generation context leads to a high degree of integration of the cue and target, priming in perceptual identification for generated targets should be reduced. Although words generated from idiomatic expressions did show priming relative to nonstudied words, they showed reliably less priming than the same words when read in isolation. The idiom materials, then, were like the antonym materials in that they placed generated words at a disadvantage relative to read words in perceptual identification.

The recognition data displayed the opposite pattern to that in perceptual identification, with generated words being better recognized than read words. This contrasting finding on the two tests provides a conceptual replication of the crossover interaction reported for antonyms by Jacoby (1983b). The advantage of generated items on the recognition test, we suggest, was a consequence of elaborative encoding operations that occurred after the generated target had been recruited and selected as a response candidate. At this point, then, the integration hypothesis provided the best account of the overall pattern of results, although we admit to having no independent a priori measure of integration. The remaining experiments were designed to further test the integration hypothesis.

### Experiment 7

Experiment 6 demonstrated that generating a word in context (as part of an idiom) can lead to less priming than reading the same word in isolation. This outcome differed from the result in Experiment 1 in which generating a word as the answer to a definition produced as much priming as did reading that same word in isolation. The difference between these two experiments may be that the target word was set off from its context in Experiment 1 but integrated with its context in Experiment 6. In the case of reading a word in a sentence, Kintsch (1988) has suggested that relevant knowledge activated by a newly encountered word is enhanced and irrelevant knowledge quickly suppressed by the network constructed from the previously understood text. From this view we concluded that it may be possible for a target embedded in a sentence to be generated without invoking the discriminative processes typically associated with identifying a word

in isolation. Experiment 7 was designed as a test of this possibility. Generation targets were embedded in sentences, and the task was to complete the single-letter cue with the appropriate target word (e.g., To see your reflection just look in a m\_). These materials were similar to the materials of Experiment 1, but with the critical difference that the target word formed part of the sentence rather than being set off from it. In this sense, the task was more like Experiment 6 than Experiment 1, so we expected a pattern more like that of Experiment 6. Here, the target word should be bound to the context in which it was encoded, causing it to suffer when isolated from that context on the perceptual identification test.

### Method

*Subjects.* Twenty-one volunteers were recruited from the same pool as the preceding studies.

*Apparatus, materials, and procedure.* The same apparatus was used as in earlier experiments. A set of 72 critical target words, mainly nouns and verbs, were selected; for each one, a short sentence was written such that the target could be embedded near the end of the sentence. The materials are shown in Appendix G. The target words ranged in frequency of occurrence from 0 to 371 per million with a mean of 48 per million. The 72 items were divided into three lists of 24 and assigned to conditions as in earlier experiments. The procedure was identical to that used in Experiment 6. On generate trials in the study phase targets were shown embedded in their sentences, but only the first letter of the target was available and the remaining letters were replaced by an underscore character. On these trials, subjects were to generate the word that best completed the sentence and began with the indicated letter.

### Results and Discussion

The proportion of errors in producing the target word during study was .15 in the generate condition and .05 in the read condition. Table 6 displays the mean proportions of correct responses on the perceptual identification test and of yes responses on the recognition test. The pattern of results obtained in Experiments 1, 3, 4, and 5 reappeared in the perceptual identification data. A set of directional Bonferroni  $t$  tests applied to the perceptual identification data revealed that the generate and read conditions showed reliable priming relative to the not-studied condition,  $t(20) = 3.98$ ,  $SE_{dm} = .048$ , and  $t(20) = 4.75$ ,  $SE_{dm} = .041$ , respectively, and that there was no reliable difference between the generate and read

conditions,  $t < 1$ . The recognition data also followed the usual pattern, with a higher hit rate among words in the generate condition as compared to those in the read condition,  $t(20) = 5.26$ ,  $SE_{dm} = .043$ .

The prediction made in introducing this experiment was not supported. We had thought that there would be less priming for the generate condition than for the read condition because the similarity between the original processing and the test would be greater for the decontextualized read word than for the context-bound generated word. Instead, we found equivalent priming for the two conditions. One possibility for this equivalence is that the act of generation disrupted the normal flow of sentence comprehension, essentially isolating the target word. The disruption could lead to more target-specific processing, including recruitment of alternative candidates from which the target would have to be discriminated. Memory for these processing operations would be appropriate for the perceptual identification test. Unlike idioms or antonyms, arbitrarily constructed sentences apparently do not induce the powerful integrative encoding of a generated target under the procedures that we have used in these experiments. We propose that the task of generating the target may disrupt the integrative processing that ordinarily would occur during sentence comprehension. We tested this claim in the next experiment.

### Experiment 8

If it is the case that generating a word from a sentence context emphasizes target-specific encoding and disrupts the integration of that word into the context, then how might we encourage that integration to occur? This question led us to an initially counterintuitive realization: Actually presenting the entire word to be read in a sentence should reduce priming relative to generating it from context. Presentation in a sentence should prevent the breakup of syntactic and message-level processing that occurred in generating the word in Experiment 7. By changing from a generation task with sentences as generation cues to one in which subjects actually read the targets in a sentence context we expected to find less priming.

Taken together with the results of Experiment 7, this prediction ran counter to earlier transfer-appropriate processing views (Jacoby, 1983b; Roediger, Weldon, & Challis, 1989) because it implied that a word actually seen in a context would do worse in perceptual identification than the same word when it was not seen but generated from that context. That is, in Experiment 7 we obtained equal levels of priming for read and generated words. In Experiment 8, where words were seen in a sentence context, we anticipated less priming relative to the read condition—actually seeing the word would result in less priming. To test this idea, we ran two very similar experiments. In Experiment 8A, subjects simply read the materials aloud, half of the materials being isolated words (e.g., movie), and half being intact sentences containing the target word (e.g., On a long flight airlines often show a movie.). In Experiment 8B, the same materials were used, but instead of reading the sentences aloud subjects read them silently and were asked to form an image representing each sentence's

Table 6  
*Experiment 7: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition When the Target Words Were Generated in a Sentence*

Task	Encoding condition		
	Generate	Read	Not studied
Correct perceptual identification	.72	.72	.52
Yes in recognition	.72	.50	.14

meaning. Otherwise, the two experiments were identical, both using the same materials as in Experiment 7.

### Method

*Subjects.* The participants were again new individuals from the same pool as the preceding experiments. Experiment 8A used 21 subjects, and Experiment 8B used 18. One additional subject was tested in Experiment 8A but was replaced because of ceiling performance on the perceptual identification test.

*Apparatus, materials, and procedure.* All aspects of Experiment 8 were identical to those of Experiment 7 with the exception of substituting the entire target word for the first letter when targets appeared in a sentence context (read in context condition). In Experiment 8A subjects were instructed to read such sentences aloud, and in Experiment 8B they were instructed to silently read the sentences, to form a mental image that represented the meaning of the sentence, and to verbally rate on a 3-point scale the difficulty of forming that image.

### Results and Discussion

In the study phase of the experiment, all items were read aloud or silently. Although reading was monitored to ensure that all items were correctly read, no record was kept of instances of vocalization errors (e.g., false starts or self-corrected articulatory errors). Consequently, all targets were included in the analysis of perceptual identification and recognition data. The mean proportions correct on the perceptual identification test are shown in the first and third rows of Table 7 for Experiments 8A and 8B, respectively, and a set of directional Bonferroni *t* tests was applied to the data from each experiment. Consider first Experiment 8A. Words read in isolation produced a reliable priming effect,  $t(20) = 4.31$ ,  $SE_{dm} = .039$ , but those read in a sentence context did not,  $t(20) = 1.72$ ,  $SE_{dm} = .041$ . Moreover, identification performance was more accurate for items read in isolation than for items read in sentence contexts,  $t(20) = 3.05$ ,  $SE_{dm} = .032$ . In Experiment 8B, although both kinds of prior exposure produced reliable priming relative to the words not previously seen,  $t(17) = 4.95$ ,  $SE_{dm} = .035$ , and  $t(17) = 2.86$ ,  $SE_{dm} = .024$ , for words read in isolation and in sentence contexts, respectively, performance was again more accurate for words read in isolation,  $t(17) = 3.62$ ,  $SE_{dm} = .029$ .

As is evident from the second and fourth rows of Table 7, the recognition data look different from those obtained in Experiments 4 to 7. There was no reliable difference in recognition between the two reading conditions in either version of the experiment,  $ts < 1$ . Seeing a word during study led to the same probability of correctly recognizing it regardless of whether it was read alone or in a sentence context. This outcome contrasts with Jacoby's (1983b) finding that reading a word in isolation led to a lower hit rate in recognition than did reading a word in the context of its antonym. It appears that sentence contexts are more effective than antonyms at rendering a context-dependent record from which it is difficult to recover evidence for the occurrence of a particular target word.

The crucial data in Experiment 8 were the perceptual identification results in which the key prediction was upheld: There was significantly more priming for a word read in isolation than for the same word read in the context of a meaningful sentence. Presumably, normal discourse processes were engaged when a target was read in context, leading to the word's integration into that context. This pattern replicates findings reported by Levy and Kirsner (1989) and MacLeod (1989a) using perceptual identification and word-fragment completion, respectively, as the indirect test. In these studies, targets that appeared in a meaningful text produced little or no priming on the subsequent indirect test.

Although the perceptual identification results of Experiment 8 were similar to those obtained by Jacoby (1983b) and Roediger, Weldon, & Challis (1989), they are interesting because of their contrast to the results of Experiment 7. There, we demonstrated that a word generated but not seen could produce just as much priming as a word actually seen. In Experiments 7 and 8, taken together, we have shown that by varying the degree to which a word is absorbed into its study context, it is possible to obtain more priming with a word that is not seen than with one that has been visually processed. There is nothing in the previous versions of transfer-appropriate processing (e.g., Roediger, Weldon, & Challis 1989) that would predict this set of outcomes. Such views would have to predict more priming when the word was seen than when it was generated.

A direct comparison of priming in Experiments 7 and 8 is particularly instructive. For simplicity, we averaged the priming values for the two versions of Experiment 8; Table 11

Table 7  
*Experiments 8A and 8B: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition*

Experiment	Encoding condition		
	Read in sentences	Read in isolation	Not studied
8A—Read aloud			
Correct perceptual identification	.55	.65	.48
Yes in recognition	.52	.53	.18
8B—Imagery			
Correct perceptual identification	.70	.81	.63
Yes in recognition	.56	.56	.19

shows that this involved taking very few liberties. There was very similar priming relative to the not-studied condition whether the word was generated (.19, Experiment 7) or read in isolation (.20 in Experiment 7; .17 in Experiment 8), but there was considerably less when the word was read in context (.07, Experiment 8). This comparison highlights the point that a word generated but not seen can show (a) as much priming as the same word actually seen in isolation and (b) greater priming than the same word actually seen in context. We will return to this crucial result in the General Discussion.

### Experiment 9

The results of Experiments 7 and 8 support the hypothesis that integration of a target word with its encoding context reduces the likelihood that that word will be identified on the perceptual identification test. As a further test of this hypothesis we turned to another set of materials that were expected to produce an encoding that strongly integrated a target word with its context. In Experiment 9 word pairs consisting of a noun and a unique modifier (e.g., *flying saucer* and *stool pigeon*), like those used by Osgood and Hoosain (1974) and Schacter and McGlynn (1989), were used to encourage integrative encoding. For such items the interpretation of the modified noun is heavily influenced (usually toward an unusual sense) by the modifier. Unlike the use of phrase contexts to generate primary and secondary meanings of homographs as in Experiment 5, however, the use of a modifier was expected to result in a strong integration of the target with its context. To encourage this integration the targets were not generated but were read in context.

As in Experiment 8, we reasoned that reading a word in a powerful context would engage integral interpretive encoding of the target. Because targets would be tested subsequently in isolation, we expected priming effects to be reduced in Experiment 9, relative to priming observed for words read in isolation. The comparison of Experiments 5 and 9 parallels the comparison of Experiments 7 and 8 that we have just discussed. Once again, we predicted that, relative to the standard amount of priming established by reading a word in isolation, actually seeing a word in context would lead to less priming than generating a word from context without seeing it. In Experiment 9, then, targets were presented either in isolation or in the presence of a unique modifier and the task in all cases was to read aloud the word or word pair presented on each trial. We expected priming in the perceptual identification task to be reliably stronger for targets read in isolation compared with those read in context.

### Method

**Subjects.** The subjects were 24 students in an introductory psychology course at the Scarborough Campus of the University of Toronto. They received bonus points for participating.

**Apparatus and materials.** This experiment was carried out on an IBM-AT compatible microcomputer with a high-resolution color monitor. Millisecond accuracy timing routines were taken from Graves and Bradley (1987, 1988). Display characteristics and timing

were consistent with those in the preceding experiments. The only notable difference was that all displays now used black characters on a grey background, whereas bright green characters on a dark green background had been used in prior experiments. The set of 60 nouns and their modifiers is contained in Appendix H. The frequency range for the noun targets was 0 to 1,236 per million with a mean of 143 per million.

**Procedure.** The procedure was similar to that used in prior experiments. During the study phase, items were visible until the subject responded, after which the experimenter pressed a key to score the subject's accuracy and initiate a 500-ms blank period before the next item appeared. In the perceptual identification task, the words were presented for 33 ms followed by a "#####" mask that remained on the screen until the subject responded. Again, the experimenter scored accuracy and initiated a 500-ms blank period before the next trial. Recognition proceeded in the same way as perceptual identification, but without the mask. There were two practice trials preceding perceptual identification, but none preceding recognition.

During encoding, subjects read aloud isolated words and word pairs consisting of a noun and a unique modifier. Rather than assigning lists of 20 items to each of the three encoding conditions (read in isolation, read with a unique modifier, not studied) using a counterbalancing procedure, a unique random assignment of 60 items to the conditions was used for each subject with the constraint that 20 items be assigned to each condition. Rather than presenting the recognition test items on a sheet of paper, the 60 items were shown one by one in a random order different from that used in perceptual identification. As each word appeared, the subject was to say yes if it had been read in the first part of the session and no if it had not (even if it had been identified in the preceding perceptual identification phase).

### Results and Discussion

As in Experiment 8, both encoding tasks involved reading aloud so that the only encoding errors involved occasional, self-corrected vocal errors. Therefore, data from all items were included in the analysis of perceptual identification and recognition. Table 8 presents the proportions of correct perceptual identifications and of yes responses in recognition. A set of Bonferroni *t* tests applied to the perceptual identification data indicated that target words read in isolation and those read with a modifier produced reliable priming relative to the unstudied words,  $t(23) = 7.67$ ,  $SE_{dm} = .024$ , and  $t(23) = 4.06$ ,  $SE_{dm} = .029$ , respectively. Performance in the isolation condition, however, was reliably better than in the modifier condition,  $t(23) = 3.67$ ,  $SE_{dm} = .020$ . A similar advantage for items read in isolation over those read with a unique modifier was found in the recognition data,  $t(23) = 3.68$ ,  $SE_{dm} = .029$ .

Table 8  
*Experiment 9: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition*

Task	Encoding condition		
	Read with modifier	Read in isolation	Not studied
Correct perceptual identification	.59	.67	.47
Yes in recognition	.61	.72	.29

These results provide another illustration of the general argument that target words integrated with their contexts show less priming in perceptual identification than do those read in isolation. In Experiment 9 the same words were harder to identify when they had previously been read with unique modifiers rather than as isolated words. This result contrasts with the outcome of Experiment 5, in which homographs generated from a context that biased an unusual meaning produced just as much priming as homographs read in isolation or generated from a context favoring the dominant meaning. We propose that the task of generating a target may serve to disrupt the integrative processing that would ordinarily occur if a target is read as part of the context. In this sense, the contrast between Experiments 5 and 9 can be interpreted as similar to the contrast between Experiments 7 and 8. In both cases, words seen in context produced *less* priming than words not seen but generated from context.

Unlike Experiment 8, however, in Experiment 9 recognition of words read in context and tested in isolation was not as accurate as words read and tested in isolation. We suggest that this occurred for the same reason that a recognition difference was found in Experiment 5 between homographs generated in contexts that biased the primary versus secondary interpretation. Recognition decisions typically depend on recruitment of elaborative encoding operations that follow the interpretive encoding of the target. Uniquely modified nouns or homographs biased toward the secondary meaning take on an interpretation that is very different from the one likely to be invoked when items are tested in isolation. Consequently, in cases where subjects encoded an unusual meaning of a target, the elaborative encoding operations carried out during study were not likely to be reconstructed during later recognition (see Thomson, 1972).

### Experiment 10

With the integration hypothesis as an explanatory framework, we can now reconsider the fact that generation from antonyms produces a different pattern in perceptual identification than most of the other generation cues we have explored. What causes generated antonyms to show no advantage over unstudied words, although the same target words show priming if initially read in isolation? We have suggested that the critical feature of antonyms is that the interpretive encoding of the generated target is highly constrained by the generation cue, precluding operations that are typically needed to select the target from a background of related competitors. The lack of experience with these discriminative processes works against identifying targets when they later appear in isolation. According to the view we have outlined, however, restrictions associated with the interpretive encoding of the generated target do not characterize the interpretive encoding of the generation cue. The cue word is initially encoded in isolation, and then is used to produce the target word via elaboration. If we are correct that the perceptual identification test taps primarily interpretive encoding operations, then we should observe priming for the cue word from which an antonym was generated.

### Method

*Subjects.* The subjects were 24 students from the same pool as in Experiment 9. They received bonus points for participating.

*Apparatus and materials.* This experiment was carried out using the same equipment and program as used in Experiment 9. The set of 60 antonym pairs was a slightly modified version of the set used in Experiment 2.

*Procedure.* The procedure was virtually identical in all respects to that used in Experiment 9. The only significant change was that subjects either generated a target word from its antonym cue word plus the first letter (e.g., drunk-s) or read the cue word alone (e.g., drunk). All test items in perceptual identification and recognition were the cue words, so that every word had actually been seen and read at the time of initial encoding.

### Results and Discussion

The proportion of encoding task errors was .06 in the generate condition; there were no errors in the read condition. Subsequent analyses of perceptual identification and recognition excluded items for which a subject did not correctly generate the antonym. The proportions of correct perceptual identifications and of yes responses in recognition are shown in Table 9. A set of directional Bonferroni *t* tests supported the conclusions that words from the read condition and cue words from the generate condition both produced reliable priming in perceptual identification relative to items in the not-studied condition,  $t(23) = 5.62$ ,  $SE_{dm} = .034$ , and  $t(23) = 5.55$ ,  $SE_{dm} = .037$ , respectively. The read and generate condition means were not reliably different,  $t < 1$ . The recognition results showed that generation exerted an influence even on cue words. Recognition of cue words from which targets had been generated was superior to recognition of cue words that had been read in isolation,  $t(23) = 5.83$ ,  $SE_{dm} = .047$ .

Experiment 10 demonstrated that the failure to find priming in perceptual identification for words in an antonym generation task (Jacoby, 1983b; our Experiment 2) is limited to the generated target and does not occur for the cue word from which the target was generated. Of course, in the present experiment, the word tested in perceptual identification had been seen at study, whether alone or as a cue for generation. Apparently, reading a word in isolation is sufficient to produce priming regardless of its impending use as a generation cue. We suggest that there was priming with generation cues because the processes involved in the initial encoding of cue words are very similar across study and test—in both cases

Table 9  
*Experiment 10: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition When Target Words Were Cues Used to Generate an Antonym or Read in Isolation*

Task	Encoding condition		
	Generation cue	Read	Not studied
Correct perceptual identification	.64	.62	.43
Yes in recognition	.91	.64	.28

the item appears initially in isolation. The interpretive encoding of the word (in this case, the cue word) is critical to the indirect perceptual identification test; the subsequent elaboration required by generation affects primarily the direct test.

That generation did have an impact is evident in the recognition data, which can be treated as a "manipulation check." The well-documented generation effect on direct tests of memory was obtained for the cue word just as it has been for the generated target (Jacoby, 1983b). Recognition accuracy was considerably higher for the same word when it was a cue to generation as opposed to a word read in isolation. Thus, the lack of difference between the generate and read conditions in perceptual identification is not the result of there being something wrong with the generation task.

Recently, McDaniel and Waddill (1990) reported a generation effect for cue words, but only in cued recall (Experiments 1 and 3) and not in recognition (Experiment 2). This difference between cued recall and recognition was critical to their theoretical argument. Indeed, they argued that the only other relevant study (Greenwald & Johnson, 1989, Experiment 2) had found a significant generation effect for cue words in recognition because cued recall had preceded recognition, thereby contaminating it. Although we cannot dispute their criticism, the same claim cannot be applied to the present experiment. Consequently, our finding calls into question the generality of the McDaniel and Waddill conclusion. A possible reason for the highly successful recognition of generation cues is that subjects may have adopted the strategy of generating the antonym of each recognition target and basing the recognition decision on memory for the encoding of the pair. In this way, it would have been possible for the generation effect in recognition to be driven by memorability of the targets or of the cue-target combinations.

### Experiment 11

We have suggested that generated targets become integrated with their cue word when the generation task involves antonym cues. In particular, to arrive at a cue's antonym, a subject must discriminate among a set of possible candidates determined by knowledge regarding the generation cue (Begg et al., 1989). By contrast, when a target is presented on a perceptual identification test, a set of candidate interpretations is recruited that is determined by knowledge closely related to the meaning of the target. We assume that during the first few moments of viewing a target, knowledge regarding its meaning and the meaning of semantically related neighbors is recruited (Carr & Dagenbach, 1990; Greenwald, Klinger, & Liu, 1989). Initially, this knowledge is not adequate to specify the target among the recruited knowledge, but as processing continues, evidence converges on the target's meaning and knowledge regarding other candidates is deactivated or suppressed (Carr & Dagenbach, 1990). A more complete description of this idea is provided in the General Discussion, but for now the main point is that an important determinant of priming among generated targets is assumed to be the degree of overlap between the sets of candidate interpretations in-

voled by a generation cue and by the perceptual identification test.

In the case of generation cues that invoke knowledge closely related to the core meaning of a target, such as synonyms, a significant overlap in recruited knowledge will be created between the generation task and subsequent perceptual identification. We reasoned that it might be possible to invoke such knowledge even during an antonym generation task by requiring subjects to use two different generation rules from trial to trial—antonym generation and synonym generation. Poulton (1982) provided strong evidence for the view that subjects may transfer unobtrusive strategies across tasks under these conditions (see also Brown, Neblett, Jones, & Mitchell, 1991). By requiring frequent switching between generation rules, we expected that knowledge relevant to both rules would often be recruited, and that subjects would be required to discriminate the appropriate target from among the candidates implied by these knowledge sources. The critical consequence of mixing antonym and synonym generation rules should be to cause the recruitment of candidates similar in meaning to targets, even when the generation rule calls for an antonym. Memory for the operations involved in discriminating the target from among these related candidates was expected to yield priming effects in the subsequent perceptual identification task.

### Method

*Subjects.* The subjects were a further 18 undergraduates from the pool used in Experiments 1–8. One additional subject was replaced because of failure to follow instructions.

*Apparatus and materials.* The apparatus was the same as that used in Experiments 1–8. The materials consisted of the 60 antonym pairs used in Experiment 2 (Appendix B) and a set of 60 synonym pairs (Appendix I) drawn from the same sources as in Experiment 3. The range of frequency of occurrence for the synonym targets was 0 to 542 per million with a mean of 60 per million. The two sets of items were each divided into three lists of 20 items, and a Latin square design was used to independently assign one list of each type to the three encoding conditions (generate, read, not studied).

*Procedure.* The study phase consisted of six practice trials followed by 80 critical trials. Half of the trials required subjects to read aloud a target word (20 from the antonym set and 20 from the synonym set), and the other half required the subject to generate an appropriate response from a cue word and the first letter of the target. Twenty of the generate trials involved generating an antonym, and 20 involved generating a synonym. At the beginning of each trial a one-word instruction—READ, ANTONYM, or SYNONYM—appeared at the center of the screen, indicating what task was to be performed on that trial. After a 500-ms delay, the remainder of the display was presented in lowercase letters below the instruction word. For read trials, the target word was displayed; for generate trials, the cue word appeared immediately below the instruction word, and the initial letter of the target and a question mark appeared below the cue word. Detection of a vocal response caused erasure of the screen and the trial was terminated as in the earlier experiments.

The perceptual identification test was conducted as in Experiment 6 except that the blank interval between the warning signal and the target word was 500 ms. A recognition test consisting of the 120 critical targets was administered as in Experiments 4–8.

## Results and Discussion

There were no errors made in reading either the antonyms or the synonyms, but the rate of production errors in the generation task was .11 for synonyms and .06 for antonyms. The primary analysis of the perceptual identification data (Table 10) was a  $3 \times 2$  ANOVA, with encoding condition (read, generate, not studied) and item type (synonym, antonym) as factors. There was a reliable main effect of item type,  $F(1, 17) = 31.23$ ,  $MS_e = .006$ , with performance on synonyms (.76) better than that on antonyms (.67). There was also a reliable main effect of encoding condition,  $F(2, 34) = 15.14$ ,  $MS_e = .011$ , reflecting the fact that the generate condition (.78) and the read condition (.72) led to better performance than the not-studied condition (.64). The interaction between encoding condition and item type was not significant,  $F < 1$ , indicating that performance patterns on antonyms and synonyms were very similar.

Differences among the encoding conditions, collapsing across item type, were evaluated with a set of directional Bonferroni  $t$  tests. Both the generate and read conditions produced reliable priming relative to the not-studied condition,  $t(17) = 4.84$ ,  $SE_{dm} = .039$ , and  $t(17) = 3.74$ ,  $SE_{dm} = .030$ , respectively. The small advantage for the generate condition over the read condition did not reach significance,  $t(17) = 2.29$ ,  $SE_{dm} = .035$ .

Turning to recognition, performance on synonyms and antonyms was virtually identical, and conformed to the usual pattern. Hit rates were analyzed using a  $2 \times 2$  ANOVA, with item type (synonym, antonym) and encoding condition (generate, read) as factors. Only the main effect of encoding condition was reliable,  $F(1, 17) = 49.02$ ,  $MS_e = .041$ , with the generate condition (.65) producing much better recognition than the read condition (.32). The probability of recognizing synonyms (.50) was virtually identical to that of recognizing antonyms (.48),  $F < 1$ , and the interaction was not reliable,  $F(1, 17) = 1.41$ ,  $MS_e = .017$ .

The recognition data showed the usual strong advantage of generate over read. However, unlike the perceptual identification data, there was no evidence of an advantage for synonyms over antonyms. Thus, we have an important dissociation in this experiment. The priming effect in perceptual identification was greater with synonyms than with antonyms,

but there was no difference between these items in recognition. This dissociation is interesting in its own right but also helps to dispel concerns about whether subjects might be using explicit retrieval strategies on the perceptual identification test. If such were the case, the item effect should have been similar on the two tests.

The results of Experiment 11 indicate that the way in which the antonym generation task is performed changes when it is only one of a number of generation rules under consideration. This result supports the view that priming effects in perceptual identification are not determined by the nature of the generation cues per se, but by the processes applied in executing the generation task. We take the lack of priming in the case of antonym generation (Jacoby, 1983b; our Experiment 2) to be evidence that generated antonyms become exceptionally well integrated with their generation context, inducing discriminative processing that is different from that which typically occurs when an item is read in isolation. When targets are subsequently presented out of that context on a perceptual identification test, no priming is observed because the discriminative processes appropriate for the perceptual identification test were not engaged during the original interpretive encoding induced by the antonym generation task. The restrictive effect of integration during interpretive encoding can be disrupted by the presence of a competing generation rule (e.g., synonyms) that encourages appropriate discriminative processing.

## General Discussion

### Summary of the Results

We have reported 11 experiments investigating influences on priming in perceptual identification, a prevalent indirect measure of memory. In most of these experiments, we also contrasted perceptual identification with recognition, a direct measure of memory. Before considering how to interpret these findings in their broader context, we briefly outline what has been found. A summary of the critical results of each experiment is shown in Table 11. Two data sets from each experiment are presented: (a) priming scores in perceptual identification (subtracting the not-studied baseline from the relevant studied condition), and (b) recognition scores for the same conditions based on the difference between hit and false alarm rates.

We began with the unexpected finding in Experiment 1 that targets generated from sentence cues could produce at least as much priming in perceptual identification as targets read in isolation. Although methodological factors appear to contribute to this result, given that Weldon (1991) used similar materials and obtained less priming with generated targets, we were able to replicate Jacoby's (1983b) finding of no priming among generated antonyms using our method (Experiment 2). We therefore pursued a series of hypotheses regarding the nature of generation processes associated with antonym cues that might prevent priming on the perceptual identification task. We ruled out hypotheses regarding a special status for single-word generation cues or generation rules

Table 10  
*Experiment 11: Proportions of Correct Responses in Perceptual Identification and of Yes Responses in Recognition When Generation Cues Were Synonyms or Antonyms*

Task	Encoding condition		
	Generate	Read	Not studied
Correct perceptual identification			
Synonyms	.84	.75	.68
Antonyms	.72	.69	.61
Yes in recognition			
Synonyms	.64	.31	.11
Antonyms	.63	.33	.12

Table 11  
*Priming in Perceptual Identification and Recognition Accuracy for All Experiments*

Experiment	Priming in perceptual identification		Hit rate – false alarm rate in recognition	
	Encoded in context	Encoded in isolation	Encoded in context	Encoded in isolation
1—Generate from a definition				
Test context	.15	.11		Not tested
No test context	.15	.12		Not tested
2—Generate from an antonym	.00 <sup>a</sup>	.14 <sup>b</sup>		Not tested
3—Generate from a synonym/associate	.09	.07		Not tested
4—Generate from a famous last name	.12	.12	.60	.35 <sup>b</sup>
5—Generate from a primary (pri.)/secondary (sec.) homograph meaning	.11 (pri.)	.11 (sec.)	.10	.60 (pri.)
6—Generate from an idiom	.10	.18 <sup>b</sup>	.40	.30 <sup>b</sup>
7—Generate from a sentence	.19	.20	.58	.36 <sup>b</sup>
8—Read in a sentence				
Read aloud	.07 <sup>a</sup>	.17 <sup>b</sup>	.34	.36
Imagery	.07	.18 <sup>b</sup>	.37	.37
9—Read with a unique modifier	.12	.20 <sup>b</sup>	.32	.42 <sup>b</sup>
10—Generate from an antonym, test cue	.21	.19	.63	.36 <sup>b</sup>
11—Generate from a synonym or antonym				
Synonym	.16	.07 <sup>bc</sup>	.52	.20 <sup>b</sup>
Antonym	.11	.08	.50	.21 <sup>b</sup>

*Note.* Priming scores represent the difference between a studied condition and the not-studied condition.

<sup>a</sup> Priming was not reliable in a given condition. <sup>b</sup> Two conditions for a given experiment differ reliably in perceptual identification or in recognition. <sup>c</sup> The difference was not reliable in the unconditionalized analysis.

in which cue–target pairs are strongly associated (Experiments 3 and 4) and the notion that priming fails when a generation cue inspires an unusual interpretation of a target (Experiment 5).

The remaining experiments were guided by the hypothesis that reduced priming among generated targets was the result of integrated encoding of a target and its context. In addition to the antonym generation task, three other encoding tasks—generation of a target as part of an idiom (Experiment 6) and reading a target in a sentence context (Experiment 8) or with a unique modifier (Experiment 9)—were correctly predicted to produce little or no priming on the basis of their encouragement of integration of a target with its context. Of particular interest was the conclusion drawn from considering Experiments 7 and 8 together—a word generated in context but never actually seen produced more priming than the same word when it was actually seen in the same context. The proposed distinction between interpretive and elaborative encoding received support in Experiment 10 inasmuch as antonym generation cues, which initially were encoded in isolation but then were elaborated to complete the generation task, produced as much priming in perceptual identification as words read in isolation but yielded a far greater hit rate than read items on a recognition test. Finally, in Experiment 11 we demonstrated that even generated antonyms can produce strong priming in perceptual identification when encoding strategies are influenced toward the recruitment of relevant knowledge.

### *Transfer-Appropriate Processing*

We have taken the results of this series of experiments as preliminary support for a modified version of the original transfer-appropriate processing framework (Morris et al., 1977; Roediger, Weldon, & Challis, 1989). The data we have obtained are difficult to account for within a system that relies only on the distinction between data-driven and conceptually driven processes. In six of the experiments, for performance on perceptual identification, a test viewed typically as data-driven, at least as much priming was observed for targets that were generated but not seen as for targets that were read in isolation. One might wish to argue that these results were obtained because subjects implicitly spelled out targets or checked their first letter against the generation cue during the course of generating them and that these covert data-driven processes were responsible for priming effects. But this explanation does not account for the *pattern* of priming effects we obtained, with some generation tasks producing less priming than reading. Moreover, this idea is incompatible with our finding that a word actually seen in a sentence context produces a smaller priming effect than that same word when it is not seen, but is generated from the sentence context.

As currently formulated, Roediger's (Roediger, Srinivas, & Weldon, 1989; Roediger, Weldon, & Challis, 1989) transfer-appropriate processing account also runs into difficulty with this set of results. We have advocated, therefore, a modification of the transfer-appropriate framework in which

a distinction is made between initial interpretive encoding of an item and ensuing elaborative encoding. Interpretive encoding is responsible for constructing a knowledge-based interpretation of a stimulus and is strongly influenced by the context in which the stimulus is presented. Crucial elements of encoding context include the nature of the encoding task and of any other stimuli used in performing that task (see also Micco & Masson, 1991). For example, in generating a target from some cue, the cue strongly determines the body of knowledge recruited in service of producing the appropriate target. An important consequence of recruiting knowledge is that multiple interpretations for a symbol are initially available and a critical objective is to converge on the correct one. The discriminative processing required by this objective might be characterized as interactive activation (J. L. McClelland & Elman, 1986; J. L. McClelland & Rumelhart, 1981; Rumelhart & McClelland, 1982) or integration of evidence that favors one candidate over its competitors (Massaro, 1989; Rueckl & Oden, 1986). Memory for an encoding episode will benefit encoding on a later presentation of the target if the two encodings invoke similar bodies of knowledge, thereby requiring similar discriminative processing (Begg et al., 1989).

The potency of recruited alternatives related to a target presented in the perceptual identification task is illustrated in the finding reported by Allport (1977) that such alternatives may be offered as frequently as 20% of the time in response to a masked target (e.g., *jazz* reported instead of the target *blues*). Interestingly, Allport noted that none of the protocols from normal subjects included antonyms of targets. We observed intrusions similar to those described by Allport (e.g., *water* when shown *lake*, *tackle* when shown *grass*). We also observed a more curious phenomenon. After producing an incorrect response to a generation cue (e.g., *Bing* instead of *Bill*, given the cue B. Cosby; *scream* instead of *sing*, given the cue Opera performers do not speak their lines but rather s\_\_ them), subjects occasionally reported that incorrect response on the perceptual identification test when the target item was presented (e.g., *Bing* in response to the item *Bill*; *scream* in response to *sing*). These episodes may be regarded as instances in which the erroneous response was distinctively processed against the background of the target response as a competitor. Then, when the target was briefly presented during perceptual identification, the erroneously generated item was among the recruited knowledge and consequently influenced selection of an identification response. We suspect that the overlap in knowledge recruited by the generation and perceptual identification tasks is due in part to the influence of memory for the initial encoding episode on the processing of the target during perceptual identification. For instance, *scream* might have been an unlikely component of the knowledge recruited when *sing* appeared on the perceptual identification test had it not been for the earlier episode involving opera singers.

The discriminative processing hypothesized by this approach is assumed to play a central role in modality effects as well. Roediger, Weldon, and Challis (1989; Weldon & Roediger, 1987) have shown that when an item is encoded and tested in different physical forms (e.g., auditory-visual, picture-word), repetition priming is reliably weaker than when the same form is used on both occasions. We suggest that

different knowledge may be recruited by auditory and visual or by verbal and pictorial presentations of a single concept, because these different modalities represent different routes to constructing the meaning of symbols. In the initial moments of encoding a symbol, knowledge relevant to that symbol and to other physically similar symbols may be recruited (e.g., word nodes in an interactive activation model become active). With continued processing of the symbol, the competing interpretations fail because they are not adequately supported by the data and they may be actively inhibited by the successful interpretation. Under the assumption that increased efficiency in this discriminative processing is the basis for repetition priming effects, changing modalities would reduce priming because different constellations of knowledge and, therefore, different discriminations are involved.

Repetition priming is affected also by changes in the context in which an item is encoded. Contextual elements such as a generation cue or sentence frame strongly influence the body of knowledge recruited during an item's encoding. Later presentation of that item in an altered context may invoke a different body of knowledge, in which case priming effects will be weakened or absent. For example, context can steer the encoding of a word away from the knowledge that will be recruited when the item is presented in isolation. Examples of encoding tasks that have produced this effect include generation of a target from its antonym (Jacoby 1983b; our Experiment 2) and reading a word in a sentence or text (Levy & Kirsner, 1989; MacLeod, 1989a; Oliphant, 1983; our Experiment 8).

An important aspect of the modified framework we have set out, but one that we have not directly explored, concerns the integration of data-driven and conceptually driven processes that conspire to produce an interpretive encoding of a stimulus. These two types of processes are assumed to work in concert to construct an interpretation from the knowledge invoked jointly by context and the physical symbol itself (see also Micco & Masson, 1991). This perspective does not emphasize the distinction between data-driven and conceptually driven processes as the basis for dissociations between indirect and direct tests of memory. Instead, emphasis is placed on the distinction between interpretive and elaborative encoding as a means of accounting for such dissociations.

In contrast to the interpretive encoding operations that we have emphasized to this point, elaborative encoding operations are assumed to be deliberate or reflective processes carried out after a stimulus has been interpreted (Johnson, 1983). Elaborative processes are able to move beyond the constraints imposed by elements of the immediate encoding context and may emphasize data-driven or conceptually driven processes. They may be used to examine the distinctive characteristics of a stimulus or to highlight the relation between that stimulus and other similar entities (Begg et al., 1989). In general, the expression of memory for encoding episodes can be viewed as a reenactment of either interpretive or elaborative encoding operations, or both. Indirect memory tests, such as perceptual identification, that require only the identification of a stimulus, are especially sensitive to memory for interpretive encoding operations that contribute to the initial identification of an item. Direct tests, such as recogni-

tion, that demand conscious judgment of prior occurrence, are sensitive to memory for both types of encoding, but particularly to elaboration (see Jacoby & Hollingshead, 1990).

The framework we have described may also help guide exploration of the influence of certain methodological variables on repetition priming effects. Of particular interest are the contrasts (a) between the results we reported in Experiments 1 and 7 regarding generation of targets from sentence cues and Weldon's (1991) result using short phrases as generation cues, and (b) between the results of Experiments 3 and 11 involving associates and synonyms as generation cues and a study by A. G. R. McClelland and Pring (1991) using associates as generation cues and word-stem completion as an indirect test of memory. In our experiments there was as much priming in generation conditions as in a read condition, whereas Weldon and McClelland and Pring obtained less priming among generated items compared with read items. A potentially important factor in accounting for this discrepancy is that both Weldon and McClelland and Pring manipulated encoding task between subjects, whereas we consistently used a within-subjects manipulation. In their exploration of the effect of generation on cued recall, Begg and Snider (1987) found that the advantage of generated items appeared only when read and generated items were presented in the same study list. When pure lists were studied, read items were remembered as accurately as generated items. Begg and Snider concluded that requiring subjects to generate items turned them into "lazy readers" in the sense that it inhibited discriminative encoding of words.

Our conjecture is that this "laziness" may have an early genesis, in the interpretive encoding of read items. Subjects may emphasize the task of translating an orthographic code into a phonological one for purposes of pronunciation and then engage in less recruitment of knowledge regarding the meaning of the items. This reduction in discriminative processing of the meaning of read items would place them at a disadvantage on a perceptual identification test in which discriminative processing is necessitated by the brief exposure duration of targets. By this reasoning, the similar levels of priming among generated and read items that we have found is ascribed to reduced priming among read items. Moreover, this reduction is due not to greater conceptually driven processing, but to a *reduction* of such processing among read items. We are currently investigating this hypothesis.

### *Implications for Other Views*

The application of the transfer-appropriate processing framework we have advocated is similar to one developed by Graf and Mandler (1984; Graf & Ryan, 1990; Mandler, 1980, 1989). They emphasize integrative and elaborative encoding operations that are assumed to act as two different memory-organizing processes. Graf and Mandler's view of integration corresponds to what we have termed *interpretive encoding* of a stimulus, but there is an important difference. They view integrative processes as being directed to elements of the target item itself, to the exclusion of other related knowledge, whereas we claim that *interpretive encoding* consists of building a specific, context-dependent interpretation of a stimulus that depends on processing knowledge beyond the boundaries

of the target item. The contextually sensitive processing that we have emphasized as part of interpretive encoding is ascribed in the Graf and Mandler approach to elaborative encoding. In both views, integrative or interpretive encoding is seen as contributing to performance on indirect tests of memory, and elaborative encoding (in either incarnation) is the major determinant of performance on direct tests of memory.

We see advantages to the approach we have taken over the one favored by Graf and Mandler. First, the pattern of generation effects on perceptual identification that we have reported points up the varying degree to which interpretive encoding of even a highly familiar stimulus may be shaped by context. Second, encodings that produce priming on indirect memory tests clearly include aspects of study context not admissible by the Graf and Mandler approach. One example is the finding that priming effects were larger when more test items had been studied earlier (Allen & Jacoby, 1990; Jacoby, 1983a). A second example is that repetition priming in lexical decision was stronger when repeated targets were preceded by previously studied primes, regardless of whether the original prime-target pairings were reinstated (Smith et al., 1989). These list-wide, episodic context effects were obtained even under conditions in which direct and indirect memory tests were dissociated, so they cannot be attributed to the use of conscious retrieval strategies. We conclude that these effects are the signature of context-dependent, interpretive encoding of targets and that the influence of some aspects of context extends across encoding trial boundaries.

Another framework similar to the one outlined here was proposed by Hirshman et al. (1990) to account for their finding of repetition priming for generated items on picture- and word-fragment completion tests. They suggested that two separate conceptual representations are formed during encoding. One representation is called *perceptual semantics* and is involved in stimulus identification and the other, *elaborative semantics*, represents semantic elaborations. In this framework perceptual semantics contribute to performance on indirect memory tests that require stimulus identification, and elaborative semantics are used in direct memory tests. These two constructs are closely analogous to the interpretive and elaborative encoding concepts that we have described. Our proposal is more general, however, in that we do not limit the distinction between interpretive and elaborative encoding processes to semantic information. Data-driven processing can occur in either type of encoding and can influence subsequent performance on either direct or indirect memory tests (Blaxton, 1989; Morris et al., 1977). In addition, we have emphasized the context sensitivity of interpretive encoding processes and have applied this notion in our account of instances in which encoding tasks, such as reading a target in a sentence, yielded little or no repetition priming.

A third view of the distinction between direct and indirect expressions of memory has been founded on the notion of separate memory systems (e.g., Sherry & Schacter, 1987; Tulving, 1983). The crucial idea is that performance on these two kinds of test is mediated by fundamentally different memory systems. Direct memory tests can be completed successfully only if certain brain structures such as the hippocampus are intact or properly developed, whereas indirect

memory test performance is spared even if these structures have been damaged and performance on direct memory tests is seriously compromised (for reviews see Schacter, 1985; Squire, 1986; Tulving & Schacter, 1990).

A representative proposal from this perspective is that many indirect memory tests, including perceptual identification, are driven by *perceptual representation systems* (Schacter, Cooper, & Delaney, 1990; Tulving & Schacter, 1990). It has been proposed that these systems are concerned with the form and structure of stimuli rather than with their meaning. For example, one system is taken to be responsible for representing the visual form of words and underlies priming effects on indirect memory tests with words. Another perceptual representation system develops structural descriptions of objects and was proposed by Schacter et al. (1990; Schacter, Cooper, Delaney, Peterson, & Tharan, 1991) as the source of priming effects on an object classification task following prior exposure to novel objects. Schacter et al. concluded that priming was based on a structural description system that is independent of semantic and episodic memory because the objects did not depict meaningful entities and priming was independent of recognition memory.

We are concerned that the view proposed by Schacter and his colleagues does not adequately consider the *purpose* of developing structural descriptions. Just as the goal of graphemic analysis of a word is to interpret its meaning as a symbol, the development of a structural description of an object has a purpose (e.g., to determine whether the object can be used as a tool, whether it is animate, etc.). The construction of a structural description is intimately tied to these interpretive functions. Consequently, we see no need to posit the existence of a separate perceptual representation system. The fact that priming effects on indirect memory tests can be dissociated from performance on direct memory tests is, in our view, a natural consequence of the differential emphasis of these two kinds of test on what we have termed *interpretive* and *elaborative encoding* operations.

An important issue is raised by the parallel, inherent in the perceptual representation system approach, between priming effects with words and objects. The emphasis on visual experience typically accorded priming effects with words (and undermined by our present results) may have ramifications for the perceptual representation system proposal in general. This proposal may be incomplete by virtue of its emphasis on the visual analysis of an object with little regard to how that analysis interacts with other operations to produce a purposive interpretation. The results of our experiments show that, at least in the domain of word identification, visual analysis proceeds in accordance with an interpretive goal and interacts with other knowledge sources and skills to produce an encoding. We suggest that similar principles apply to objects and other symbols that are subjected to interpretive encoding.

### Conclusion

The contribution of specific episodes to task performance even under conditions where there is no awareness of a particular past experience poses an interesting and crucial problem for memory research. Much of the work on this

problem has been motivated by the goal of understanding the relation between this indirect expression of memory and direct memory tests that emphasize awareness of specific episodes. An especially promising approach is one that emphasizes the concept of transfer-appropriate processing. Memory for specific prior episodes may be recruited by task demands that engage processes similar to those applied at an earlier time. The framework adopted by Roediger and his colleagues (e.g., Roediger, Weldon, & Challis, 1989) has been of great value in bringing this concept to bear on the problem of understanding indirect and direct memory. There is, however, mounting evidence in favor of a shift away from an emphasis on data-driven versus conceptually driven processes as a basis for distinguishing these two aspects of memory.

The experiments we have reported provide evidence that priming on an indirect memory test typically assumed to be based on data-driven operations was powerfully influenced by encoding context. Moreover, we found that priming effects can sometimes be greater when an item is not seen than when it is. Consequently, we support a version of transfer-appropriate processing in which a distinction is made between initial interpretive encoding and subsequent elaborative encoding operations. We are particularly interested in interpretive encoding, which fulfills the goal of constructing an interpretation of a stimulus in terms of its surrounding context. From our perspective, the crucial questions regarding the nature of indirect memory and its relation to direct memory lie in understanding how various aspects of context influence interpretive encoding and how task performance recruits memory for these encodings to reenact the route to interpretation.

### References

- Allen, S. W., & Jacoby, L. L. (1990). Reinstating study context produces unconscious influences of memory. *Memory & Cognition*, 18, 270-278.
- Allport, D. A. (1977). On knowing the meaning of words we are unable to report: The effects of visual masking. In S. Dornic (Ed.), *Attention and performance VI* (pp. 505-533). Hillsdale, NJ: Erlbaum.
- Anderson, J. R., & Reder, L. M. (1979). An elaborative processing explanation of depth of processing. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 385-403). Hillsdale, NJ: Erlbaum.
- Begg, I., & Snider, A. (1987). The generation effect: Evidence for generalized inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 13, 553-563.
- Begg, I., Snider, A., Foley, F., & Goddard, R. (1989). The generation effect is no artifact: Generating makes words distinctive. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 977-989.
- Blaxton, T. A. (1989). Investigating dissociations among memory measures: Support for a transfer-appropriate processing framework. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 657-668.
- Brown, A. S., Neblett, D. R., Jones, T. C., & Mitchell, D. B. (1991). Transfer of processing in repetition priming: Some inappropriate findings. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17, 514-525.
- Bruce, D., & Fagan, R. L. (1970). More on the recognition and free recall of organized lists. *Journal of Experimental Psychology*, 85, 153-154.
- Carpenter, P. A., & Daneman, M. (1981). Lexical retrieval and error

- recovery in reading: A model based on eye fixations. *Journal of Verbal Learning and Verbal Behavior*, 20, 137–160.
- Carr, T. H., & Dagenbach, D. (1990). Semantic priming and repetition priming from masked words: Evidence for a center-surround attentional mechanism in perceptual recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 341–350.
- Connor, J. M. (1977). Effects of organization and expectancy on recall and recognition. *Memory & Cognition*, 5, 315–318.
- Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11, 671–684.
- Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, 104, 268–294.
- Durso, F. T., & O'Sullivan, C. S. (1983). Naming and remembering proper and common nouns and pictures. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 9, 497–510.
- Estes, W. K., & DaPolito, F. (1967). Independent variation of information storage and retrieval processes in paired-associate learning. *Journal of Experimental Psychology*, 75, 18–26.
- Graf, P., & Mandler, G. (1984). Activation makes words more accessible but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behavior*, 23, 553–568.
- Graf, P., & Ryan, L. (1990). Transfer appropriate processing for implicit and explicit memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 978–992.
- Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 11, 501–518.
- Graves, R., & Bradley, R. (1987). Millisecond interval timer and auditory reaction time programs for the IBM PC. *Behavior Research Methods, Instruments, & Computers*, 19, 30–35.
- Graves, R., & Bradley, R. (1988). More on millisecond timing and tachistoscope applications for the IBM PC. *Behavior Research Methods, Instruments, & Computers*, 20, 408–412.
- Greenwald, A. G., & Johnson, M. M. S. (1989). The generation effect extended: Memory enhancement for generation cues. *Memory & Cognition*, 17, 673–681.
- Greenwald, A. G., Klinger, M. R., & Liu, T. J. (1989). Unconscious processing of dichoptically masked words. *Memory & Cognition*, 17, 35–47.
- Gregg, V. (1976). Word frequency, recognition, and recall. In J. Brown (Ed.), *Recall and recognition* (pp. 183–216). London: Wiley.
- Gross, D., Fischer, U., & Miller, G. A. (1989). The organization of adjectival meanings. *Journal of Memory and Language*, 28, 92–106.
- Hintzman, D. L. (1990). Human learning and memory: Connections and dissociations. *Annual Review of Psychology*, 41, 109–139.
- Hirshman, E., & Bjork, R. A. (1988). The generation effect: Support for a two-factor theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 14, 484–494.
- Hirshman, E., Snodgrass, J. G., Mindes, J., & Feenan, K. (1990). Conceptual priming in fragment completion. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 634–647.
- Horowitz, L. M., & Manelis, L. (1972). Toward a theory of redintegrative memory: Adjective-noun phrases. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 6, pp. 193–224). San Diego, CA: Academic Press.
- Horowitz, L. M., & Prytulak, L. S. (1969). Redintegrative memory. *Psychological Review*, 76, 519–532.
- Hunt, R. R., & Toth, J. P. (1990). Perceptual identification, fragment completion, and free recall: Concepts and data. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 282–290.
- Jacoby, L. L. (1983a). Perceptual enhancement: Persistent effects of an experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 9, 21–38.
- Jacoby, L. L. (1983b). Remembering the data: Analyzing interactive processes in reading. *Journal of Verbal Learning and Verbal Behavior*, 22, 485–508.
- Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General*, 110, 306–340.
- Jacoby, L. L., & Hollingshead, A. (1990). Toward a generate/recognize model of performance on direct and indirect tests of memory. *Journal of Memory and Language*, 29, 433–454.
- Jacoby, L. L., Kelley, C. M., & Dywan, J. (1989). Memory attributions. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honor of Endel Tulving* (pp. 391–422). Hillsdale, NJ: Erlbaum.
- Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General*, 118, 126–135.
- Johnson, M. K. (1983). A multiple-entry, modular memory system. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 17, pp. 81–123). San Diego, CA: Academic Press.
- Kintsch, W. (1968). Recognition and free recall of organized lists. *Journal of Experimental Psychology*, 78, 481–487.
- Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review*, 95, 163–182.
- Kolers, P. A. (1979). A pattern-analyzing basis of recognition. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory* (pp. 363–384). Hillsdale, NJ: Erlbaum.
- Kolers, P. A., & Roediger, H. L. (1984). Procedures of mind. *Journal of Verbal Learning and Verbal Behavior*, 23, 425–449.
- Kučera, H., & Francis, W. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.
- Leonard, J. M., & Whitten, W. B. (1983). Information stored when expecting recall or recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 9, 440–455.
- Levy, B. A., & Kirsner, K. (1989). Reprocessing text: Indirect measures of word and message level processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 407–417.
- Lewandowsky, S., Kirsner, K., & Bainbridge, V. (1989). Context effects in implicit memory: A sense-specific account. In S. Lewandowsky, J. C. Dunn, & K. Kirsner (Eds.), *Implicit memory: Theoretical issues* (pp. 185–198). Hillsdale, NJ: Erlbaum.
- MacLeod, C. M. (1989a). Word context during initial exposure influences degree of priming in word fragment completion. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 398–406.
- MacLeod, C. M. (1989b, November). *Word frequency effects on implicit and explicit memory tests*. Paper presented at the annual meeting of the Psychonomic Society, Atlanta, GA.
- Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review*, 87, 252–271.
- Mandler, G. (1989). Memory: Conscious and unconscious. In P. R. Solomon, G. R. Goethals, C. M. Kelley, & B. R. Stephens (Eds.), *Memory: Interdisciplinary approaches* (pp. 84–106). New York: Springer-Verlag.
- Massaro, D. W. (1989). Testing between the TRACE model and the fuzzy logic model of speech perception. *Cognitive Psychology*, 21, 398–421.
- Masson, M. E. J., & Freedman, L. (1990). Fluent identification of repeated words. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 355–373.

- McClelland, A. G. R., & Pring, L. (1991). An investigation of cross-modality effects in implicit and explicit memory. *Quarterly Journal of Experimental Psychology*, 43A, 19–33.
- McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology*, 18, 1–86.
- McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review*, 88, 375–407.
- McDaniel, M. A., & Waddill, P. J. (1990). Generation effects for context words: Implications for item-specific and multifactor theories. *Journal of Memory and Language*, 29, 201–211.
- Micco, A., & Masson, M. E. J. (1991). Implicit memory for new associations: An interactive process approach. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17, 1105–1123.
- Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, 16, 519–533.
- Nelson, D. L., McEvoy, C. L., Walling, J. R., & Wheeler, J. W. (1980). The University of South Florida homograph norms. *Behavior Research Methods and Instrumentation*, 12, 16–37.
- Oliphant, G. W. (1983). Repetition and recency effects in word recognition. *Australian Journal of Psychology*, 35, 393–403.
- Osgood, C. E., & Hoosain, R. (1974). Saliency of the word as a unit in the perception of language. *Perception & Psychophysics*, 15, 168–192.
- Postman, L., & Keppel, G. (1970). *Norms of word association*. San Diego, CA: Academic Press.
- Poulton, E. C. (1982). Influential companions: Effects of one strategy on another in the within-subjects designs of cognitive psychology. *Psychological Bulletin*, 91, 673–690.
- Richardson-Klavehn, A., & Bjork, R. A. (1988). Measures of memory. *Annual Review of Psychology*, 39, 475–543.
- Roediger, H. L., & Blaxton, T. A. (1987). Retrieval modes produce dissociations in memory for surface information. In D. S. Gorfein & R. R. Hoffman (Eds.), *Memory and cognitive processes: The Ebbinghaus centennial conference* (pp. 349–379). Hillsdale, NJ: Erlbaum.
- Roediger, H. L., Srinivas, K., & Weldon, M. S. (1989). Dissociations between implicit measures of retention. In S. Lewandowsky, J. C. Dunn, & K. Kirsner (Eds.), *Implicit memory: Theoretical issues* (pp. 67–84). Hillsdale, NJ: Erlbaum.
- Roediger, H. L., Weldon, M. S., & Challis, B. H. (1989). Explaining dissociations between implicit and explicit measures of retention: A processing account. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honor of Endel Tulving* (pp. 3–41). Hillsdale, NJ: Erlbaum.
- Rueckl, J. G., & Oden, G. C. (1986). The integration of contextual and featural information during word identification. *Journal of Memory and Language*, 25, 445–460.
- Rumelhart, D. E., & McClelland, J. L. (1982). An interactive activation model of context effects in letter perception: Part 2. The contextual enhancement effect and some tests and extensions of the model. *Psychological Review*, 89, 60–94.
- Schacter, D. L. (1985). Multiple forms of memory in humans and animals. In N. Weinberger, J. McGaugh, & G. Lynch (Eds.), *Memory systems of the brain* (pp. 351–379). New York: Guilford Press.
- Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 13, 501–518.
- Schacter, D. L., Cooper, L. A., & Delaney, S. M. (1990). Implicit memory for unfamiliar objects depends on access to structural descriptions. *Journal of Experimental Psychology: General*, 119, 5–24.
- Schacter, D. L., Cooper, L. A., Delaney, S. M., Peterson, M. A., & Tharan, M. (1991). Implicit memory for possible and impossible objects: Constraints on the construction of structural descriptions. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17, 3–19.
- Schacter, D. L., & McGlynn, S. M. (1989). Implicit memory: Effects of elaboration depend on unitization. *American Journal of Psychology*, 102, 452–481.
- Schwartz, B. L. (1989). Effects of generation on indirect measures of memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 1119–1128.
- Sherry, D. F., & Schacter, D. L. (1987). The evolution of multiple memory systems. *Psychological Review*, 94, 439–454.
- Smith, M. C., MacLeod, C. M., Bain, J. D., & Hoppe, R. B. (1989). Lexical decision as an indirect test of memory: Repetition priming and list-wide priming as a function of type of encoding. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 1109–1118.
- Squire, L. R. (1986). Mechanisms of memory. *Science*, 232, 1612–1619.
- Srinivas, K., & Roediger, H. L. (1990). Classifying implicit memory tests: Category association and anagram solution. *Journal of Memory and Language*, 29, 389–412.
- Thomson, D. M. (1972). Context effects in recognition memory. *Journal of Verbal Learning and Verbal Behavior*, 11, 497–511.
- Toth, J. P., & Hunt, R. R. (1990). Effect of generation on a word-identification task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 993–1003.
- Tulving, E. (1983). *Elements of episodic memory*. Oxford, England: Clarendon.
- Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science*, 247, 301–306.
- Watkins, M. J., & Tulving, E. (1975). Episodic memory: When recognition fails. *Journal of Experimental Psychology: General*, 104, 5–29.
- Weldon, M. S. (1991). Mechanisms underlying priming on perceptual tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17, 526–541.
- Weldon, M. S., & Roediger, H. L. (1987). Altering retrieval demands reverses the picture superiority effect. *Memory & Cognition*, 15, 269–280.
- Whitten, W. B., Suter, W. N., & Frank, M. L. (1979). Bidirectional synonym ratings of 464 noun pairs. *Journal of Verbal Learning and Verbal Behavior*, 18, 109–127.
- Whittlesea, B. W. A., & Cantwell, A. L. (1987). Enduring influence of the purpose of experiences: Encoding-retrieval interactions in word and pseudoword perception. *Memory & Cognition*, 15, 465–472.
- Wilding, J., & Mohindra, N. (1983). Preferred synonyms for each noun of 279 synonym pairs. *British Journal of Psychology*, 74, 91–106.
- Winnick, W. A., & Daniel, S. A. (1970). Two kinds of response priming in tachistoscopic recognition. *Journal of Experimental Psychology*, 84, 74–81.
- Witherspoon, D., & Moscovitch, M. (1989). Stochastic independence between two implicit memory tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 22–30.

## Appendix A

### Definitions and Target Words Used in Experiment 1

Each definition contained a word (shown here in italics) that served as the context word during perceptual identification. The target word follows each definition.

what a *child* is called when it matures. *adult*  
 the person who presides over a *trial*. *judge*  
 the round object that steers a *truck*. *wheel*  
 what someone would do with a *book*. *read*  
 something one uses to sit at a *desk*. *chair*  
 the orange vegetable a *rabbit* eats. *carrot*  
 the product extracted from a *dairy* cow. *milk*  
 the white precipitation that falls during *winter*. *snow*  
 what is sounded when a *thief* robs a safe. *alarm*  
 the classification for *steel*. *metal*  
 the action you do with your feet on a *ball*. *kick*  
 the utensil one uses to spread *honey* on bread. *knife*  
 the driver of a *plane*. *pilot*  
 the mark received for a *test*. *grade*  
 the dial that increases the sound on a *stereo*. *volume*  
 the alcohol produced when *grapes* ferment. *wine*  
 the humorous individual who works in a *circus*. *clown*  
 the individual value of each item in a *store*. *price*  
 the place on a *bike* that one puts their feet. *pedal*  
 the type of walk done during a *parade*. *march*  
 the leader of an *indian* tribe. *chief*  
 the individual segment of a *chain*. *link*  
 the wax object which when ignited creates a *flame*. *candle*  
 an action taken by a *union* when its demands are not met. *strike*  
 the emission from a *lighted cigar*. *smoke*  
 something a *bird* might get up early for. *worm*  
 a glass container that holds a *flower*. *vase*  
 the granular material found on a *beach*. *sand*  
 the elevated platform on which a *play* takes place. *stage*  
 the musical group that plays at a *dance*. *band*  
 a fine string used with a *needle* in order to sew. *thread*  
 what you open and close in order to *exit*. *door*  
 the sheep fur one uses to *knit* with. *wool*  
 the parasitic insect found on a *canine*. *flea*  
 the malt liquor found in a 12 ounce *bottle*. *beer*  
 the noise a *bee* makes. *buzz*  
 the place where a *bear* hibernates. *cave*  
 the masculine version of a *deer*. *buck*  
 the small bird that comes out of a *hatched egg*. *chick*  
 what a tickle in your nose causes when you have a *cold*. *sneeze*  
 the utensil most commonly used to eat a *salad*. *fork*  
 the dry sandy area where a *camel* is generally found. *desert*  
 a *rubber* substance that removes pencil mistakes. *eraser*  
 the visual imagery that occurs during *sleep*. *dream*  
 the verbal activity one does on a *phone*. *talk*  
 the dish used in order to eat *soup*. *bowl*  
 a place where one goes to *learn*. *school*  
 a sticky liquid substance used to *assemble a model*. *glue*  
 the vessel used to *boil water when making tea*. *kettle*  
 the line which results from having made a *fold*. *crease*  
 a small pool formed from lots of *rain*. *puddle*  
 the small manual machine which *records images on film*. *camera*  
 a large locomotive vehicle which *rolls along a track*. *train*  
 a public place where a *farmer goes to sell his wares*. *market*  
 the body part a *sock* covers. *foot*  
 a small enclosed body of water that a *cabin* is near. *lake*  
 an item on which you lay your head in order to *rest*. *pillow*

where a *watch* is worn. *wrist*  
 the individual room where an *inmate* is held. *cell*  
 the set of joined notes that is played on a *guitar*. *chord*  
 the designated area where *tennis* is played. *court*  
 the hole in a *tooth* which requires a filling. *cavity*  
 where one typically displays a *poster*. *wall*  
 the city roadway on which one would *drive* a car. *street*  
 an uncontrolled contraction of a *muscle*. *spasm*  
 the exterior of an *orange* which is removed before eating. *peel*  
 the bodily organ which creates a *pulse*. *heart*  
 the instrument used to *shave* facial hair. *razor*  
 the informative report that is announced on the *radio* every hour. *news*  
 what the bottom of a *shoe* is called. *sole*  
 the part of a *bucket* one holds to pick it up. *handle*  
 what an angry group experiencing *panic* can cause. *riot*  
 the foamy substance used to *clean* oneself. *soap*  
 the sales person who sells you items when you *shop*. *clerk*  
 what churned *cream* is called. *butter*  
 the main reception area in a *hotel*. *lobby*  
 the resting structure most commonly found in a *park*. *bench*  
 the sharp metal object on the end of a line used to catch a *fish*. *hook*  
 the hard rough exterior of a *tree*. *bark*  
 the encasement used to encircle a *photo*. *frame*  
 the fine-toothed instrument used to untangle *hair*. *comb*  
 the reflective object one looks into to see their *image*. *mirror*  
 the dead colorful portion of a tree which is shed in the *fall* season. *leaf*  
 the group of singers commonly found in a *church*. *choir*  
 the king of the jungle who lets out a *roar*. *lion*  
 the hairy portion at the back of the head of a *horse*. *mane*  
 the small rodent who enjoys *cheese*. *mouse*  
 the writer who creates a *novel*. *author*  
 the fabric for covering the *floor* from wall to wall. *carpet*  
 the rectangular rust colored clay object that *mortar* holds in place. *brick*  
 the noontime meal generally found on a *plate*. *lunch*  
 the thick red substance that flows through *veins*. *blood*  
 the thin path one takes when they go on a *hike*. *trail*  
 another name for the *float* in the water that boats tie up to. *buoy*  
 the loud sound emitted by a *police* car when in pursuit. *siren*  
 the leather seat that a *cowboy* puts on his horse. *saddle*  
 the large machine that lifts *cargo* out of a ship's hold. *crane*  
 the machine one puts wet clothes in after doing the *wash*. *dryer*  
 the breakable transparent material that a *window* is made of. *glass*  
 the singular portion of a *stair*. *step*  
 the room in which clerical *work* is commonly done. *office*  
 the food group an *apple* belongs to. *fruit*  
 the heavenly item one gazes upon when one makes a *wish*. *star*  
 the moist item that cutting an *onion* can bring to your eye. *tear*  
 the large dispenser of *fuel* that cars drive up to. *pump*  
 the listing of meals that is commonly found in restaurants. *menu*  
 the musical manner in which performers at an *opera* deliver their lines. *sing*  
 the audible part of a *taxi* used to encourage other motorists to speed up. *horn*  
 the long round metal item that a *hammer* drives into wood. *nail*  
 the symbolic rectangular cloth item that is commonly hoisted up a *pole*. *flag*  
 the larger fighting unit that a *troop* belongs to. *army*  
 the granular substance that gives one a *sweet* taste. *sugar*  
 the lame step one makes while walking with a *cane*. *limp*  
 the large shaft dug in the ground from which one can extract *coal*. *mine*  
 the single sheet of *paper* found in a book. *page*  
 the buck-toothed animal who builds dams and is sought for his *pelt*. *beaver*  
 the metal figure one is given after having won a *race*. *trophy*  
 the monetary sum one must pay after one parks illegally and receives a *ticket*. *fine*  
 the classification of a *ruby*. *jewel*

(Appendix A continues on next page)

the small body of water that a *duck* commonly swims upon. *pond*  
 the sharp tip on the head of an *arrow*. *point*  
 the final sum of adding one *number* to another. *total*  
 the small measuring device one steps on to find out their *weight*. *scale*  
 what one does with their face when they are *happy*. *smile*  
 the cinematic feature that is often shown on a long *flight*. *movie*  
 the part of a stove that one would use to cook a *cake*. *oven*  
 the specific 60 second period a *timer* keeps track of. *minute*  
 the long oratory lecture made at a *podium*. *speech*  
 the long string that does up one's *shoes* and is tied in a bow. *lace*  
 the dish on which one puts a *teacup*. *saucer*  
 the dip in the earth that lies between two *hills*. *valley*  
 the name of the *round* model of the world. *globe*  
 the tiny infant commonly put in a *cradle*. *baby*  
 the piece of beef that is cooked on a *grill*. *steak*  
 the name of the clipped grass area that a patio often is near. *lawn*  
 the payment of a *wage* on a fixed monthly basis. *salary*  
 the display of information on a wall that a *doctor* uses to test eyes. *chart*  
 the machine one uses at home to suck *dirt* up off the floors. *vacuum*  
 the creeping plant that monkeys can use to swing through a *jungle*. *vine*  
 the body of twelve people to whom a *lawyer* presents evidence for a verdict. *jury*  
 the name of the individual seed that forms *corn*. *kernel*  
 the manually used instrument which propels a *kayak*. *paddle*  
 the part of the head that a *mask* covers. *face*  
 a precious hard item that sometimes is found in an *oyster*. *pearl*

## Appendix B

### Antonym Cue and Target Pairs Used in Experiments 2, 10, and 11

Antonym cue	Target	Antonym cue	Target
<i>before</i>	after	<i>major</i>	minor
<i>life</i>	death	<i>rich</i>	poor
<i>sober</i>	drunk	<i>buy</i>	sell
<i>rise</i>	fall	<i>loose</i>	tight
<i>remember</i>	forget	<i>summer</i>	winter
<i>soft</i>	hard	<i>profit</i>	loss
<i>always</i>	never	<i>entrance</i>	exit
<i>day</i>	night	<i>sit</i>	stand
<i>singular</i>	plural	<i>higher</i>	lower
<i>long</i>	short	<i>smooth</i>	rough
<i>float</i>	sink	<i>question</i>	answer
<i>north</i>	south	<i>asleep</i>	awake
<i>pretty</i>	ugly	<i>open</i>	close
<i>over</i>	under	<i>clean</i>	dirty
<i>strong</i>	weak	<i>full</i>	empty
<i>innocent</i>	guilty	<i>ceiling</i>	floor
<i>hot</i>	cold	<i>lost</i>	found
<i>bride</i>	groom	<i>cry</i>	laugh
<i>back</i>	front	<i>more</i>	less
<i>fast</i>	slow	<i>pleasure</i>	pain
<i>dead</i>	alive	<i>future</i>	past
<i>top</i>	bottom	<i>push</i>	pull
<i>friend</i>	enemy	<i>junior</i>	senior
<i>shallow</i>	deep	<i>blunt</i>	sharp
<i>stale</i>	fresh	<i>sweet</i>	sour
<i>smile</i>	frown	<i>true</i>	false
<i>love</i>	hate	<i>late</i>	early
<i>bad</i>	good	<i>depart</i>	arrive
<i>teach</i>	learn	<i>first</i>	last
<i>winner</i>	loser	<i>war</i>	peace

## Appendix C

## Synonym or Associate Cue and Target Pairs Used in Experiment 3

Synonym/antonym cue	Target	Synonym/antonym cue	Target
<i>chief</i>	indian	<i>idea</i>	think
<i>railway</i>	train	<i>lock</i>	key
<i>toe</i>	foot	<i>tango</i>	dance
<i>human</i>	being	<i>arm</i>	leg
<i>form</i>	shape	<i>nation</i>	country
<i>wagon</i>	wheel	<i>saucer</i>	cup
<i>minute</i>	second	<i>pain</i>	hurt
<i>avenue</i>	street	<i>rubber</i>	tire
<i>blood</i>	red	<i>river</i>	stream
<i>mail</i>	letter	<i>python</i>	snake
<i>afraid</i>	scared	<i>purchase</i>	buy
<i>sunday</i>	church	<i>food</i>	eat
<i>library</i>	book	<i>pine</i>	tree
<i>door</i>	window	<i>atom</i>	bomb
<i>frame</i>	picture	<i>silver</i>	gold
<i>navy</i>	army	<i>nest</i>	bird
<i>sail</i>	boat	<i>liquid</i>	water
<i>courage</i>	brave	<i>home</i>	house
<i>thread</i>	needle	<i>bloom</i>	flower
<i>circle</i>	round	<i>belly</i>	stomach
<i>stout</i>	fat	<i>globe</i>	world
<i>lamp</i>	light	<i>table</i>	chair
<i>ale</i>	beer	<i>boulder</i>	rock
<i>cork</i>	bottle	<i>touch</i>	feel
<i>tobacco</i>	smoke	<i>bread</i>	butter
<i>reply</i>	answer	<i>silence</i>	quiet
<i>mouse</i>	rat	<i>hog</i>	pig
<i>hammer</i>	nail	<i>pony</i>	horse
<i>capsule</i>	pill	<i>cradle</i>	baby
<i>garment</i>	clothes	<i>bow</i>	arrow

## Appendix D

## Famous Names Used in Experiment 4

Clark	Gable	Gordon	Lightfoot
Albert	Einstein	Alfred	Hitchcock
Marilyn	Monroe	Phil	Donahue
Dolly	Parton	Stevie	Wonder
Fred	Astaire	Jackie	Gleason
Bill	Cosby	Robert	Redford
Jane	Fonda	Martin	Luther
Charles	Darwin	Jimmy	Carter
Bobby	Orr	Ernest	Hemingway
Richard	Nixon	Barry	Manilow
Florence	Nightingale	George	Washington
Alan	Alda	Sophia	Loren
Wayne	Gretzky	Michael	Jackson
Mark	Twain	Henry	Kissinger
Frank	Sinatra	Benjamin	Franklin
Shirley	Temple	Howard	Hughes
Davy	Crocket	Thomas	Edison
Oliver	Cromwell	Ronald	Reagan
Brian	Mulroney	Paul	Bunyan
Abraham	Lincoln	Archie	Bunker
Margaret	Thatcher	James	Bond
Barbara	Streisand	William	Shakespeare
John	Lennon	Lucille	Ball
Warren	Beatty	Julius	Caesar
Anne	Landers	Isaac	Newton
Peter	O'Toole	Pierre	Trudeau

(Appendix D continues on next page)

Doris  
Norman  
Donny  
Brigitte

Day  
Rockwell  
Osmond  
Bardot

Winston  
Walt  
Karl  
Carol

Churchill  
Disney  
Marx  
Burnett

## Appendix E

### Context Phrases and Target Words (in Parentheses) Used in Experiment 5

The first phrase in each set biased the primary meaning of the homograph target, and the second phrase biased the secondary meaning.

the father held the baby in his a\_\_ms. (arms)  
 pacifists are against nuclear a\_\_ms.  
 in New Orleans you can hear a jazz b\_\_nd. (band)  
 her hair was held by a rubber b\_\_nd.  
 he was a wise, old s\_\_g\_\_ (sage).  
 she spiced the stuffing with s\_\_g\_\_.  
 my money is deposited in the b\_\_nk. (bank)  
 the water rushed by the river b\_\_nk.  
 a baseball game uses a bat and a b\_\_l. (ball)  
 Cinderella lost her slipper at the b\_\_l.  
 the judge posted b\_\_l. (bail)  
 water is in the boat so I must b\_\_l.  
 in the Rockies we saw a grizzly b\_\_r. (bear)  
 a broken promise can be hard to b\_\_r.  
 it was not very far, just a city bl\_\_k. (block)  
 the problem produced a mental bl\_\_k.  
 lunch was her favorite m\_\_l. (meal)  
 the cows ate a mix of corn m\_\_l.  
 the poker player called her bl\_\_f. (bluff)  
 she ran to the edge of the bl\_\_f.  
 the Queen is the head of st\_\_t\_\_. (state)  
 the motor was in a very bad st\_\_t\_\_.  
 Pandora should not have opened the b\_\_x. (box)  
 two fighters in a ring are ready to b\_\_x.  
 cough syrup is difficult to s\_\_ll w\_\_. (swallow)  
 the nest was made by a s\_\_ll w\_\_.  
 fishermen catch fish in a n\_\_t. (net)  
 gross salary minus deductions is a n\_\_t.  
 the frozen popsicle was ice c\_\_d. (cold)  
 to be unfriendly is to be c\_\_d.  
 the director gives the actor a c\_\_e. (cue)  
 the hustler grabbed his pool c\_\_e.  
 the speeding car pulled out to p\_\_s. (pass)  
 the quarterback threw a long p\_\_s.  
 the elevator on the top floor went d\_\_n. (down)  
 comforters are made from goose d\_\_n.  
 a shrub is a kind of a pl\_\_t. (plant)  
 workers build machines in a pl\_\_t.  
 a mallard is a kind of d\_\_k. (duck)  
 to miss being hit he had to d\_\_k.  
 the jewels were safe in the v\_\_lt. (vault)  
 the athlete was good at the pole v\_\_lt.  
 a race car goes very f\_\_t. (fast)  
 to go totally without food is to f\_\_t.  
 the fruit was juicy and f\_\_sh. (fresh)  
 he was flirtatious and very f\_\_sh.  
 on this show you can buy, sell, or tr\_\_d\_\_. (trade)  
 he was a machinist by tr\_\_d\_\_.  
 a swatter is used to kill a f\_\_y. (fly)

most birds are able to f\_\_y.  
 he says that he feels f\_\_ne. (fine)  
 the texture of her hair was f\_\_ne.  
 they put the coffin in the gr\_\_v\_\_. (grave)  
 his tone of voice was sullen and gr\_\_v\_\_.  
 put both feet on the g\_\_nd. (ground)  
 to make bread the wheat must be g\_\_nd.  
 he clenched his fist and let go a p\_\_ch. (punch)  
 the party drink was a fruit p\_\_ch.  
 on my shoulders there rests a h\_\_d. (head)  
 he was appointed department h\_\_d.  
 there was nowhere to get away and h\_\_d. (hide)  
 leather is made from an animal h\_\_d.  
 so he would not escape she kept a h\_\_ld. (hold)  
 the receptionist put me on h\_\_ld.  
 the bouncer was big and h\_\_ky. (husky)  
 her voice was low and h\_\_ky.  
 he masterminded a secret pl\_\_t. (plot)  
 he planted a garden on their small pl\_\_t.  
 the sprinter got ready for her r\_\_c\_\_. (race)  
 we are all part of the human r\_\_c\_\_.  
 the old man was gentle and k\_\_d. (kind)  
 the actress was one of a k\_\_d.  
 she spread the bread with raspberry j\_\_m. (jam)  
 the cars were stopped by a traffic j\_\_m.  
 the caboose is located at the r\_\_ar. (rear)  
 they had been good children to r\_\_ar.  
 the camera caused a flash of l\_\_g\_\_t. (light)  
 the dessert was fluffy and l\_\_g\_\_t.  
 the money is all m\_\_ne. (mine)  
 he works in a coal m\_\_ne.  
 she is tired and could use a r\_\_st. (rest)  
 you take these and I'll take the r\_\_st.  
 she gave them a lecture that was st\_\_n. (stern)  
 the back of a boat is called the st\_\_n.  
 in church she played the o\_\_g\_\_n. (organ)  
 the heart is a bodily o\_\_g\_\_n.  
 the clerk weighed it on the sc\_\_l\_\_. (scale)  
 he choked on a fish sc\_\_l\_\_.  
 she lost her wedding r\_\_g\_\_. (ring)  
 the phone sounded a r\_\_g\_\_.  
 the swim team had a great c\_\_ch. (coach)  
 two black stallions pulled the c\_\_ch.  
 the beams were hoisted by a cr\_\_n\_\_. (crane)  
 we saw a flock of herons and a cr\_\_n\_\_.  
 the child learned how to c\_\_nt. (count)  
 one addresses Dracula as c\_\_nt.  
 a flea or an ant is a kind of b\_\_g. (bug)  
 the spy searched the room for a b\_\_g.

to cool off we dove into the p\_\_l. (pool)  
 the boys liked to play p\_\_l.  
 he signed the checks with a p\_\_n. (pen)  
 they kept the pigs in a p\_\_n.  
 the burglar picked the l\_\_k. (lock)  
 the cargo ships went through a l\_\_k.  
 she ate an after-dinner m\_\_t. (mint)  
 the coins came from the m\_\_t.  
 at the airport he caught a pl\_\_n\_\_. (plane)  
 to smooth some wood use a pl\_\_n\_\_.  
 he had a tattoo on his ch\_\_t. (chest)  
 the treasure was in the ch\_\_t.  
 his broken leg was in a c\_\_t. (cast)  
 the movie had a great c\_\_t.  
 while in the army he drove a t\_\_k. (tank)  
 the attendant filled the gas t\_\_k.  
 the photographer developed the f\_\_m. (film)  
 oil in water forms a thin f\_\_m.  
 to light the fire she used a m\_\_t\_\_h. (match)  
 the tennis player won his m\_\_t\_\_h.  
 the jury was led out of the c\_\_rt. (court)  
 tennis is played on a c\_\_rt.  
 he looked up and saw a shooting s\_\_r. (star)  
 the great John Wayne was a movie s\_\_r.  
 his three-piece suit needed a t\_\_e. (tie)  
 the playoff game ended in a t\_\_e.  
 the decorators put up an oak p\_\_n\_\_l. (panel)  
 the questions were posed to the p\_\_n\_\_l.  
 we cooled off once we turned on the f\_\_n. (fan)  
 the actor talked with an admiring f\_\_n.  
 for breakfast she ate eggs and t\_\_st. (toast)

the father of the bride offered a t\_\_st.  
 to stand guard all night was his d\_\_y. (duty)  
 the customs officer said to pay a d\_\_y.  
 an acorn is a kind of n\_\_t. (nut)  
 the mechanic tightened the n\_\_t.  
 she set the dining room t\_\_b\_\_. (table)  
 the data were presented in a t\_\_b\_\_.  
 to make the bed she folded the sh\_\_t. (sheet)  
 the job required filling out a sh\_\_t.  
 the children played in their bare f\_\_t. (feet)  
 a yardstick measures up to three f\_\_t.  
 the vegetable on the cob is c\_\_n. (corn)  
 wearing tight shoes can cause a c\_\_n.  
 to cook an egg, water must b\_\_l. (boil)  
 the painful sore on his back was a b\_\_l.  
 a group of ships make up a fl\_\_t. (fleet)  
 the runner was swift and fl\_\_t.  
 parmesan is a cheese that you gr\_\_t. (grate)  
 she caught her heel in the metal gr\_\_t.  
 the ships often came to this p\_\_t. (port)  
 before dinner he enjoyed a glass of p\_\_t.  
 his pockets always jingle with ch\_\_g\_\_. (change)  
 before I go swimming I must ch\_\_g\_\_.  
 he repaired the left shoe's s\_\_l\_\_. (sole)  
 she ordered the fillet of s\_\_l\_\_.  
 you should always obey a stop s\_\_g\_\_. (sign)  
 the contract is valid once you s\_\_g\_\_.  
 in the barn were two cows and a st\_\_r. (steer)  
 you peddle the bike and I'll st\_\_r.  
 a locomotive engine pulled the tr\_\_n. (train)  
 to be good at any sport you must tr\_\_n.

## Appendix F

### Idiomatic Expressions and Target Words (in Parentheses) Used in Experiment 6

go from bad to w\_\_ (worse)  
 speak of the d\_\_ (devil)  
 son of a g\_\_ (gun)  
 keep a stiff upper l\_\_ (lip)  
 on the tip of one's t\_\_ (tongue)  
 axe to g\_\_ (grind)  
 on pins and n\_\_ (needles)  
 save for a rainy d\_\_ (day)  
 snake in the g\_\_ (grass)  
 needle in the h\_\_ (haystack)  
 gone with the w\_\_ (wind)  
 spitting i\_\_ (image)  
 melt in one's m\_\_ (mouth)  
 kick the b\_\_ (bucket)  
 salisbury s\_\_ (steak)  
 sitting on top of the w\_\_ (world)  
 skin and b\_\_ (bones)  
 at the drop of a h\_\_ (hat)  
 back seat d\_\_ (driver)

can of w\_\_ (worms)  
 drop d\_\_ (dead)  
 all in a day's w\_\_ (work)  
 wolf in sheep's c\_\_ (clothing)  
 writer's c\_\_ (cramp)  
 diamond in the r\_\_ (rough)  
 bed of r\_\_ (roses)  
 below the b\_\_ (belt)  
 hot under the c\_\_ (collar)  
 birds and the b\_\_ (bees)  
 boggle the m\_\_ (mind)  
 chew the f\_\_ (fat)  
 dime a d\_\_ (dozen)  
 get away with m\_\_ (murder)  
 head for the h\_\_ (hills)  
 eat humble p\_\_ (pie)  
 drive a hard b\_\_ (bargain)  
 pick and c\_\_ (choose)  
 bring home the b\_\_ (bacon)

(Appendix F continues on next page)

take for g__ (granted)	turn a cold s__ (shoulder)
twiddle one's t__ (thumbs)	gild the l__ (lily)
on second t__ (thought)	wear and t__ (tear)
fair and s__ (square)	lump in one's t__ (throat)
go fly a k__ (kite)	cat has nine l__ (lives)
blue in the f__ (face)	end of the l__ (line)
face the m__ (music)	rose colored g__ (glasses)
nip and t__ (tuck)	feather in one's c__ (cap)
hit the r__ (road)	fit as a f__ (fiddle)
a shot in the d__ (dark)	fit like a g__ (glove)
flat as a p__ (pancake)	fine-toothed c__ (comb)
pain in the n__ (neck)	clean bill of h__ (health)
drown one's s__ (sorrow)	cloak and d__ (dagger)
rain or s__ (shine)	kick in the p__ (pants)
for crying out l__ (loud)	keep the ball r__ (rolling)
tooth and n__ (nail)	put two and two t__ (together)
tickled p__ (pink)	Russian r__ (roulette)

## Appendix G

### Sentence Contexts and Target Words (in Parentheses) Used in Experiments 7 and 8

In Experiment 7 the sentences contained a word stem with the first letter as part of the generation cue, as shown here. In Experiment 8 the word stem was replaced with the entire target word.

You steer a truck by turning the w\_\_\_. (wheel)  
 When at a desk you sit on a c\_\_\_. (chair)  
 Dairy cows are used for m\_\_ production. (milk)  
 If a thief attempts to rob a safe an a\_\_ will sound. (alarm)  
 You use your feet in order to k\_\_ a ball. (kick)  
 You spread honey on bread by using a k\_\_\_. (knife)  
 The leader of an indian tribe is the c\_\_\_. (chief)  
 A flickering flame is ignited when you light a wax c\_\_\_. (candle)  
 When labor demands are not met, unions will initiate a s\_\_\_. (strike)  
 An early bird is said to catch the w\_\_\_. (worm)  
 Fresh cut flowers are placed in a v\_\_ filled with water. (vase)  
 On the beach you will find s\_\_ granules. (sand)  
 Plays are conducted on an elevated platform called the s\_\_\_. (stage)  
 The music at dances is usually provided by a live b\_\_\_. (band)  
 In order to sew you must be able to put the t\_\_ through the needle. (thread)  
 When you exit a room you close the d\_\_\_. (door)  
 When knitting some people only use pure sheep's w\_\_\_. (wool)  
 Dogs are often bothered by an insect called a f\_\_\_. (flea)  
 A type of malt liquor sold in a bottle is b\_\_\_. (beer)  
 When eating salad, some people forget to use the correct f\_\_\_. (fork)  
 Camels are usually found crossing the sandy Egyptian d\_\_\_. (desert)  
 You can eliminate an error made in pencil by using an e\_\_\_. (eraser)  
 Upon waking, some people attempt to analyze what their last d\_\_ symbolized. (dream)  
 Soup is usually served in a shallow b\_\_\_. (bowl)  
 If you make tea, boil the water in the k\_\_\_. (kettle)  
 Cabins are sometimes built close to the shores of a l\_\_\_. (lake)  
 When sleeping, people rest their head on a p\_\_\_. (pillow)  
 A watch is worn on the w\_\_\_. (wrist)  
 A violent prisoner is held in an individual jail c\_\_\_. (cell)  
 A tooth that requires filling has a c\_\_\_. (cavity)  
 Posters are typically hung on the w\_\_\_. (wall)  
 Cars are driven on a city s\_\_\_. (street)  
 Before eating an orange, one usually removes the orange p\_\_\_. (peel)  
 The pulse is created by a pumping h\_\_\_. (heart)  
 Facial hair is removed with a r\_\_\_. (razor)

A bucket is picked up by its h\_\_\_. (handle)  
 An angry mob of people can cause a r\_\_\_. (riot)  
 Sales in a shop are handled by a c\_\_\_. (clerk)  
 Churned cream turns into b\_\_\_. (butter)  
 Tired people in the park can sit on a b\_\_\_. (bench)  
 Hair can be untangled by carefully using a c\_\_\_. (comb)  
 To see your reflection just look in a m\_\_\_. (mirror)  
 Many people sing in their church c\_\_\_. (choir)  
 The longest hair on the horse is its tail and m\_\_\_. (mane)  
 A novel is created by an a\_\_\_. (author)  
 The floor in some houses is covered by a wall to wall c\_\_\_. (carpet)  
 The noontime meal is generally known as l\_\_\_. (lunch)  
 Veins are the vessels through which b\_\_ flows. (blood)  
 When in the forest, people hike on a t\_\_\_. (trail)  
 A police car in pursuit turns on its loud s\_\_\_. (siren)  
 Wet laundry is hung on a line or put in a d\_\_\_. (dryer)  
 Windows are made of breakable g\_\_\_. (glass)  
 When walking down stairs place each foot firmly on each s\_\_\_. (stair)  
 People gaze to the heavens and make a wish on a s\_\_\_. (star)  
 Gasoline is usually dispensed from a gas p\_\_\_. (pump)  
 The meals a restaurant serves are listed in a m\_\_\_. (menu)  
 Opera performers do not speak their lines but rather s\_\_ them. (sing)  
 In order to get motorists to speed up taxi drivers honk the h\_\_\_. (horn)  
 Hammers are used to drive a n\_\_ into wood. (nail)  
 Beverages and foods are made sweet by adding s\_\_\_. (sugar)  
 People with canes usually walk with a l\_\_\_. (limp)  
 Each leaf of a book is called a p\_\_\_. (page)  
 After summing all the numbers one can determine the t\_\_\_. (total)  
 In order to determine your weight you step on a s\_\_\_. (scale)  
 On a happy person's face you will see a toothy s\_\_\_. (smile)  
 On a long flight airlines often show a m\_\_\_. (movie)  
 A cake is baked in an o\_\_\_. (oven)  
 The string on shoes that one ties in a bow is the l\_\_\_. (lace)  
 The earth is often depicted on a round g\_\_\_. (globe)  
 Dirt can be extracted from the floor by using a v\_\_\_. (vacuum)  
 Monkeys swing through the jungle on a v\_\_\_. (vine)  
 A mask is used to cover the f\_\_\_. (face)

Appendix H

Uniquely Modified Nouns Used in Experiment 9

coffee break	pool table	snow fall	rock star	service station	heart attack
looking glass	post office	stock market	north pole	first class	flash flood
coast guard	motion picture	real estate	flip side	flower girl	space suit
peanut butter	trap door	head cold	sponge cake	pen name	poker chip
tuning fork	bread board	paper towel	old maid	new wave	prairie dog
iron lung	home run	voice box	hung over	blood test	blind date
joy ride	night cap	work load	black eye	photo finish	hip joint
wheat germ	sea horse	rest room	public school	dead end	darning needle
red tape	rat race	printing press	playing card	stumbling block	stool pigeon
nursing home	book mark	flying saucer	free lance	price war	ice pick

(Appendix I follows on next page)

Appendix I  
Synonym Cue (in Italics) and Target Pairs Used in Experiment 11

Synonym cue	Target	Synonym cue	Target	Synonym cue	Target	Synonym cue	Target	Synonym cue	Target	Synonym cue	Target
<i>sight</i>	vision	<i>fire</i>	flame	<i>wood</i>	lumber	<i>mistake</i>	error	<i>bush</i>	shrub	<i>wagon</i>	cart
<i>jail</i>	prison	<i>soup</i>	broth	<i>money</i>	cash	<i>talk</i>	speak	<i>earth</i>	soil	<i>pair</i>	couple
<i>road</i>	street	<i>grave</i>	tomb	<i>penny</i>	cent	<i>middle</i>	center	<i>student</i>	pupil	<i>razor</i>	shaver
<i>begin</i>	start	<i>pile</i>	heap	<i>sweat</i>	perspire	<i>tiny</i>	small	<i>horse</i>	pony	<i>smell</i>	odor
<i>pants</i>	trousers	<i>trap</i>	snare	<i>rabbit</i>	bunny	<i>quiet</i>	silent	<i>trip</i>	journey	<i>jump</i>	leap
<i>pail</i>	bucket	<i>paddle</i>	oar	<i>ghost</i>	spirit	<i>idiot</i>	fool	<i>flower</i>	blossom	<i>port</i>	harbor
<i>sound</i>	noise	<i>beer</i>	ale	<i>present</i>	gift	<i>engine</i>	motor	<i>crazy</i>	insane	<i>stomach</i>	belly
<i>robber</i>	thief	<i>town</i>	city	<i>stick</i>	twig	<i>coat</i>	jacket	<i>salary</i>	wages	<i>glove</i>	mitten
<i>work</i>	labor	<i>path</i>	trail	<i>fight</i>	battle	<i>grass</i>	lawn	<i>fabric</i>	cloth	<i>boat</i>	ship
<i>curve</i>	bend	<i>country</i>	nation	<i>carpet</i>	rug	<i>rock</i>	stone	<i>ocean</i>	sea	<i>feel</i>	touch

Received August 7, 1990

Revision received July 10, 1991

Accepted July 31, 1991 ■

**MEMBERS OF UNDERREPRESENTED GROUPS:  
REVIEWERS FOR JOURNAL MANUSCRIPTS WANTED**

If you are interested in reviewing manuscripts for APA journals, the APA Publications and Communications Board would like to invite your participation. Manuscript reviewers are vital to the publication process. As a reviewer, you would gain valuable experience in publishing. The P&C Board is particularly interested in encouraging members of underrepresented groups to participate more in this process.

If you are interested in reviewing manuscripts, please write to Leslie Cameron at the address below. Please note the following important points:

- To be selected as a reviewer, you must have published articles in peer-reviewed journals. The experience of publishing provides a reviewer with the basis for preparing a thorough, objective review.
- To select the appropriate reviewers for each manuscript, the editor needs detailed information. Please include with your letter your vita. In your letter, please identify which APA journal you are interested in and describe your area of expertise. Be as specific as possible. For example, "social psychology" is not sufficient—you would need to specify "social cognition" or "attitude change" as well.
- Reviewing a manuscript takes time. If you are selected to review a manuscript, be prepared to invest the necessary time to evaluate the manuscript thoroughly.

Write to Leslie Cameron, Journals Office, American Psychological Association, 750 First Street, NE, Washington, DC 20002-4242.