CONSCIOUS AWARENESS EFFECTS IN IMPLICIT MEMORY TASKS: NEW DIRECTIONS FOR THE EXPLICIT MEMORY CONTAMINATION ISSUE

by

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Abstract

Conscious Awareness Effects in Implicit Memory Tasks:
New Directions for the Explicit Memory Contamination Issue

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There have been two concerns associated with subjects' awareness in unconscious (implicit) memory tasks: (1) it may lead to voluntary conscious (explicit) memory contamination, where subjects intentionally try to recall items from a prior study list; or (2) it may lead to involuntary explicit memory contamination, where items from a prior study list come to mind automatically as a function of conscious awareness.

While implicit memory researchers generally agree that awareness could lead to intentional recall processes in implicit memory studies, they do not believe that awareness alone (independent of intentional recall) will influence performance on implicit memory tasks (e.g., Bowers & Schacter, 1990).

The view that mere awareness does not affect performance on implicit memory tasks is based on a single study (Bowers & Schacter, 1990), where the performance of unaware subjects did not differ from aware on a number of indicators (i.e., level of priming and outcome following levels of processing study, LOP). More recently, however, a number of pilot studies (Mace, 1996, 2000a) have shown that awareness may affect performance on implicit tasks, where, for example, unaware subjects differed from aware on these same indicators.

This study investigated the possibility that awareness could influence performance on implicit memory tasks. In three experiments, the performance of unaware subjects was compared to aware on a word stem task following study under LOP conditions.

In all three experiments, the results showed the performance of unaware subjects differing from aware on the LOP variable and level of priming following semantic study. While aware subjects showed null and small (but nonsignificant) LOP effects on the word stem task, unaware subjects showed significant LOP reversals. While aware subjects showed robust priming for semantic study, semantic study priming was not significant for unaware subjects. The results also suggested that the effects of awareness for aware subjects were largely involuntary, where their performance on the word stem task dissociated from intentional recall subjects on LOP and response latencies, for example.

The results have a number of implications for the study of implicit memory. One, they suggest that implicit memory research may need to be conducted with samples of unaware subjects. Two, the LOP reversal and nonsignificant semantic study priming are novel findings which appear to have important implications for implicit memory theory.

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Introduction

In the early days of memory research, the typical laboratory experiments had subjects study a list of words, followed by a memory testing session where they may have been asked to recall the exact order that words appeared on the list (in a serial recall task), to recall them in any order they wished (in a free recall task), or to decide whether a new list of words contained any words from the previous word list (in a yes/no recognition task). In such experiments, subjects were fully aware of the relationship between the study phase and the testing session. They realized that they had to muster the full power of their recollective processes to retrieve or recognize words they had recently encountered on the study list. In the current era, we identify such memory processes as belonging to a class of conscious memory phenomena that many researchers have elected to call *explicit memory* (after Graf & Schacter, 1985). Formally, explicit memory tasks are defined as those that require subjects' awareness and intention to retrieve and recollect stimulus materials from a prior study episode.

Interestingly, however, the conscious (explicit) memory distinction was not made until researchers began working with memory paradigms that did not depend on conscious memory processes, but reflected memory for a prior episode, nevertheless. For example, following a standard list learning session, Warrington and Weiskrantz (1970) showed that amnesic subjects performed at chance levels on an explicit memory measure for such words (yes/no recognition memory task). However, when they were shown the first three letters of list words (e.g., ELE, for ELEPHANT) and asked to spontaneously form a word, the probability of their responding with a list word was significantly better than chance, despite their inability to remember list words, or even to express awareness that they were responding with list words. Researchers who worked with such memory paradigms (e.g., Jacoby & Witherspoon, 1982) labeled these phenomena "memory without awareness", to indicate the influences that prior experience can have on task performance without the need for conscious awareness or intention to remember such experience. Formally, tasks that measure the unconscious influences of memory have been labeled *implicit* (after Graf & Schacter, 1985, see Schacter, 1987, for an early review).

For nearly two decades, implicit memory phenomena have been a major focus of memory researchers. One of the challenges facing such research has come primarily from studies that involve normal subjects. That is, although implicit memory researchers usually go to great lengths to disguise the true purpose of the implicit memory task, normal subjects are quite capable of becoming aware of the relationship between the studied list and the implicit task, and then use such awareness to deliberately recollect items from the study session. The threat of contamination from explicit memory has been (and continues to be) an obstacle to sound theoretical development.

To illustrate this problem, let's take the case of one of the most frequently manipulated variables in this endeavor, the levels of processing variable (LOP). This paradigm involves engaging subjects at study in both nonsemantic (perceptual) and semantic (conceptual) processing of stimulus materials by having them answer questions about a word's graphemic or phonological characteristics (e.g., BRAIN: "Does it contain the letter 'A'?", or "Does it rhyme with TRAIN?"), or a meaning characteristic (e.g., BRAIN: "Is it a part of the nervous system?"). There is a vast body of literature that shows that explicit memory performance is greatly enhanced following semantic study, compared to nonsemantic study (the so-called LOP effect, e.g., Craik & Tulving, 1975; for a review, see Lockhart & Craik, 1990). However, it has been reported that LOP has no effect on a commonly used class of implicit memory measures (i.e., perceptual tasks, such as word stem, ELE_, and word fragment E_E_H_NT, completion). For example, in an early study, Graf, Mandler, and Haden (1982) had subjects process the graphemic (count vowels) or the meaning (rating words for the pleasantness of their meaning) attributes of words, followed by a test of implicit (word stem completion) and explicit (free recall) memory. They found no effect of LOP on the word stem task, while they found a large effect of LOP on the free recall task.

This dissociation between implicit and explicit memory is important because it lends support to the notion that explicit memory tasks such as recall and recognition are driven by conceptual factors, whereas implicit memory tasks such as word stem and word fragment completion are driven by perceptual factors (see Richardson-Klavehn & Bjork, 1988; Roediger & McDermott, 1993). However, this interpretation has been undermined by reports of significant LOP effects on these same types of implicit tasks (e.g., Challis & Brodbeck, 1992; Graf & Schacter, 1985; Thapar & Greene, 1994; for a review, see Brown & Mitchell, 1994). In fact, many of the studies where null LOP effects were reported also reported small (but nonsignificant) effects of LOP (e.g., Graf et al., 1982; Graf & Mandler 1984; Jacoby & Dallas, 1981). One interpretation for these findings is that LOP effects may have arisen because some subjects contaminated the implicit measure with explicit memory processes (e.g., engaging in deliberate recall).

This study is about the problem of explicit memory contamination in implicit memory research. It specifically examines a central problem in this area: the role of conscious awareness (awareness of the study-test relationship) in influencing performance on implicit tasks. There are two reasons why the issue of conscious awareness has been central to the problem of explicit memory contamination. One, awareness of the study-test relationship is the obvious precursor that may cause some subjects to engage in intentional recollection of items from the prior study session. Two, awareness alone, independent of intentional recollection, may induce a type of automatic explicit memory process (involuntary explicit memory) that is beyond both the subject and the experimenter's control. Of the two, the involuntary explicit memory process is clearly the most difficult to manage. Surprisingly, however, very little attention has been devoted to this issue, with most of the focus being directed at the problem of voluntary (intentional) recollection. This position is probably due to an outcome reported in Bowers and Schacter (1990) which suggested that awareness has no influence on performance in implicit tasks. However, a number of findings from recent studies that I have conducted in the explicit memory contamination area have suggested that awareness may indeed have an influence on performance in implicit memory tasks, thus prompting the current investigation. After an extensive review of the explicit memory contamination problem, I will discuss such findings, followed by an outline of how this study investigated the awareness issue.

Explicit Memory Contamination: Awareness and Intention

Concerns for explicit memory contamination in implicit memory tasks have centered around the issues of awareness and retrieval volition (intention to remember). To understand fully how these issues are treated in the explicit memory contamination problem, we need to take a detailed look at how they are used within the implicit/explicit memory definitional framework. For example, in an early review, Schacter (1989) fully describes how the terms explicit and implicit are used in relation to awareness and intention to remember:

> Explicit memory refers to intentional recollection of previous experiences as revealed on standard laboratory tests of recall and recognition. Explicit memory is roughly equivalent to "memory with consciousness" or "memory with awareness." Implicit memory... refers to

situations in which previous experiences facilitate performance on tests that do not require intentional or deliberate remembering, such as word stem and fragment completion, word identification, and lexical decision. Implicit memory, as revealed by priming effects on such tests, need not and often does not involve any conscious memory for a prior experience. However, it is important to distinguish between two senses of "conscious memory" or "conscious recollection" that are often used interchangeably. On the one hand, conscious recollection can refer to the manner in which retrieval is initiated. When a subject intentionally attempts to think back to a prior experience, as required on standard recall and recognition tests, this voluntary and deliberate initiation of retrieval can be described as "conscious." On the other hand, conscious recollection can refer to a phenomenological quality of the product of the retrieval process--the presence of what Tulving (1983) has called "recollective experience" or "sense of pastness." (p 356)

Indeed, an important distinction for the implicit/explicit framework, and for the question of explicit memory contamination, was that implicit memory could be expressed independently of awareness. While this seemed an obvious conclusion for amnesic subjects, since they often could not even express a global level of awareness for a prior study session, Bowers and Schacter (1990) saw the need to show that implicit memory in normal subjects could also be expressed without awareness. They confirmed that implicit memory in normal subjects also did not depend on awareness by showing robust levels of priming on a word stem completion task for subjects who reported on a post-test questionnaire no awareness of the study-test relationship (i.e., unaware that the implicit task contained word stems that corresponded to words from the study session).

While the Bowers and Schacter (1990) report showed that normal subjects' performance on implicit tasks could be just like amnesics (i.e., without the expression of awareness), this study also confirmed what many researchers had already suspected about normal subjects performance on implicit tasks: Many subjects are aware of the study-test relationship. For example while as many as 50% of Bowers and Schacter's subjects claimed unawareness of the study-test relationship, the remaining 50% expressed awareness of this relationship. However, Bowers and Schacter used an unconventional experimental design which may have reduced awareness levels below what are normally present in the typical implicit memory experiment. That is, subjects were presented with a 95 item study list, where only 12 of the items were targeted for the implicit task. Typically, implicit memory researchers target all of the study items for inclusion in the implicit task, a method that seems more likely to result in higher levels of awareness. Indeed, when Richardson-Klavehn, Lee, Joubran, and Bjork (1994) followed up on this idea, they found that awareness was higher when more typical methods are used. For example, also using the post-test questionnaire method, they showed that awareness levels in implicit tasks may often range as high as 90% to 100% when as few as 25% of the study items are included in the implicit task. Similar awareness levels were also found more recently by Mace (2000a) when 75% to 100% of studied items were included in the implicit task.

Since subjects are generally not informed of the study-test relationship in implicit tasks, researchers surmised that, unlike amnesic subjects, normal subjects become aware of the study-test relationship as a result of a phenomenon known as spontaneous recollection (or more commonly known as "involuntary explicit memory", Schacter, Bowers, & Booker 1989; or "involuntary conscious memory", Richardson-Klavehn, Gardiner, & Java, 1994, 1996). For example, Richardson-Klavehn, Gardiner et al. write:

> Post-test interview and questionnaire measures, as well as anecdotal examples, indicate that significant numbers of normal subjects become aware of the presence of previously encountered items at some time during an indirect [implicit] test (Bowers & Schacter, 1990; Richardson-Klavehn, Lee, Joubran, & Bjork, in press). ...Richardson-Klavehn et al. found that 30 of 32 subjects in an indirect perceptual identification test were aware of the presence of old items, even though only 25% of the items were old. Five of these 30 suspected prior to the test that it would contain old items; for the remaining 25, awareness occurred spontaneously during performance of the test. These cases are examples of the kind of spontaneous awareness of the past that we describe as involuntary conscious memory. (p. 4)

The realization that such awareness was probably ubiquitous in implicit tasks raised a number of issues in the study of implicit memory. For example, unlike amnesic subjects, implicit memory for normal subjects should not be thought of as memory without awareness, since awareness commonly occurs for such subjects. This difference between normal and amnesic subjects thus suggested that the distinction between implicit and explicit forms of memory should emphasize the more fundamental differences in retrieval volition: That is, retrieval is intentional in explicit tasks, while it is unintentional (or automatic) in implicit tasks. But more critically, should the presence of phenomenal awareness of the past in normal subjects, an explicit memory phenomenon, be thought of as explicit memory contamination? The answer to this question hangs on whether awareness could directly or indirectly influence retrieval. The primary concern here was that awareness of the study-test relationship could influence performance on implicit tasks by causing subjects to switch from an unintentional retrieval mode of responding with the first thing that comes to mind to an intentional one where they try to recall items from the studied list.

Although some researchers may have suspected for some time that intentional recall occurred in implicit tasks, the first indicator that awareness may cause some subjects to adopt an intentional retrieval strategy was reported in Bowers and Schacter (1990). They found that aware subjects showed an effect of levels of processing (an outcome consistent with explicit memory performance), while unaware subjects did not (an outcome consistent with implicit memory performance). Although Bowers and Schacter never asked their aware subjects if they had engaged in deliberate recall, they reasoned that differences between them and unaware subjects were the likely result of some aware subjects electing such a strategy since these outcomes were in line with current theory. For example, LOP effects are not predicted for perceptually based implicit tasks such as word stem completion, but they are for explicit tasks such as free recall, or when an implicit task is treated like an explicit task (e.g., when subjects are instructed to use word stem as cues to remember, see Graf & Mandler, 1984) (for reviews of the leading theoretical frameworks, see Roediger & McDermott, 1993; Schacter, 1994). Therefore, Bowers and Schacter concluded that an LOP effect for aware subjects was probably due to some of these subjects treating the implicit task explicitly. This conclusion was later confirmed by Richardson-Klavehn, Lee et al. (1994) and Mace (2000a) who found that (1) as many as 40% to 92% of subjects engaged in an implicit task admitted to using deliberate recall, and (2) LOP effects were only present for these subjects.

Hence, the findings reported in Bowers and Schacter (1990), then, suggested that the differences between amnesic and normal subjects' performance are more than just differences in the subjective experience of remembering, since normal subjects can (and probably often do) contaminate the implicit measure with intentional retrieval strategies. Although there is still some contention over the presence (e.g., Rajaram & Roediger, 1993; Weldon, Roediger, Beitel, & Johnston, 1995) or magnitude (e.g., Richardson-Klavehn, Clarke & Gardiner, 1999; Richardson-Klavehn & Gardiner, 1998) of intentional retrieval effects in implicit tasks, there seems to be a consensus that such processes are, at the very least, a potential problem for implicit memory experimentation.

Notwithstanding the question of intentional retrieval processes in implicit tasks, an additional question in the explicit memory contamination problem concerns the influence that awareness itself may have on performance in implicit tasks, independent of intentional retrieval. That is, would the performance of aware subjects who do not engage in deliberate recall differ from unaware subjects in a manner that is suggestive of explicit memory influences? For example, Schacter et al. (1989) considered such a possibility within the context of a spontaneous recollection model (i.e., a form of involuntary explicit memory) where:

> The test cue brings to mind an event that occurred during the study episode, not just the lexical item. ...This represents an instance of classical Proustian memory: A cue involuntarily triggers a vivid recollection of a past event. Clearly, the concept of

> implicit memory was not intended to encompass Proustian recollections. (p. 52)

While very little attention has been devoted to the question of this type of awareness influence, or any other type of automatic awareness influences, it seems that the consensus among implicit memory researchers is that awareness does not influence retrieval performance in implicit memory tasks independent of intention to remember (Richardson-Klavehn et al., 1999; Richardson-Klavehn & Gardiner, 1995; Richardson-Klavehn, Gardiner et al., 1994; Richardson-Klavehn et al., 1996). For example, most recently Richardson-Klavehn et al. (1999) write that:

> In incidental [implicit] tests, it does not matter if participants are aware of responding with studied items, as long as they do not alter their test strategy from one of responding with the first item coming to mind to one of responding with studied items. (p. 282)

As mentioned earlier, it appears that such a view is based on a single finding reported in Bowers and Schacter (1990). In that influential study, Bowers and Schacter reported that word stem completion performance did not differ for their unaware subjects and a group of subjects they called test-informed (i.e., subjects who were made aware of the study-test relationship and told not to engage in deliberate recall), since neither of these groups revealed an LOP effect. Thus, using the same logic discussed above, they reasoned that the lack of an LOP effect for the test-informed (aware) group was consistent with implicit memory performance, thereby suggesting no independent influences of awareness.

This outcome, then, suggested that awareness itself is not an issue in concerns for explicit memory influences in implicit tasks (see Richardson-Klavehn et al., 1996). However, since awareness may lead to some subjects adopting intentional retrieval strategies on their own, it is currently believed that a good method for preventing the use of such strategies is to inform all subjects on the nature of the study-test relationship, with the instructions not to engage in intentional recall strategies (the test-informed method, Bowers & Schacter, 1990; Richardson-Klavehn, Gardiner et al., 1994; Richardson-Klavehn et al., 1996).

In summary, there seems to be widespread agreement that implicit memory studies are subject to explicit memory contamination from intentional recall processes. The only contention here concerns the degree to which such processes may occur, and the appropriate method to use for their control (see Reingold & Toth, 1996; Richardson-Klavehn et al., 1996). While awareness of the study-test relationship is relatively high among normal subjects, there is a consensus that awareness alone is not a source of explicit memory contamination. In other words, awareness of the study-test relationship will not result in some sort of automatic (involuntary) explicit memory process that will influence performance on an implicit task (the no- influence view). This view has led to the assumption that it is safe (and indeed wise) to make subjects aware of the study-test relationship, so long as such information is used for the purpose of controlling deliberate recall processes.

Some Evidence Suggestive of an Awareness Influence Hypothesis

Findings from an unpublished study by Mace (1996) have suggested that the no-influence position may be mistaken. In investigating an unrelated issue regarding the LOP effect and perceptual implicit measures, this study utilized the same test-informed procedure employed in Bowers and Schacter (1990). In the study phase, three groups of subjects studied words under a variety of LOP study conditions (all were similar in nature to Bowers and Schacter's LOP study conditions). However, unlike the Bowers and Schacter outcome, the results showed significant effects of LOP for all three groups on a word fragment completion task. Although there was no unaware group in this study to compare these findings against, it can be argued that these findings may represent noteworthy failures to replicate the Bowers and Schacter outcome. For example, it has been shown that LOP effects in implicit memory tasks are a likely indicator of contamination from explicit memory (e.g., Bowers & Schacter; Mace, 2000a; Toth, Reingold & Jacoby, 1994). Accordingly, null LOP findings for Bowers and Schacter's test-informed group was the standard used for the claim that awareness has no influence on retrieval in implicit tasks. Thus, using this logic, the presence of significant LOP findings for the three test-informed groups in Mace (1996) seems to call into question the claim that awareness has no influence on performance in implicit tasks.

Post-test questionnaire measures can also be used to examine the no-influence view. In addition to Bowers and Schacter (1990), a number of investigators have used this method to assess explicit memory effects in implicit tasks (e.g., Mace, 2000a, b; Richardson-Klavehn, Lee et al. 1994). While Bowers and Schacter only used these methods to separate aware subjects from unaware, others have expanded on the method by asking aware subjects if they had ever tried to recall studied items (e.g., Mace, 2000a, b; Richardson-Klavehn, Lee et al. 1994). Such a modification allows for three levels of analysis: (a) from aware subjects who use recall strategies, (b) from aware subjects who do not use recall strategies, and (c) from uniformly unaware subjects. Among these three levels, the critical comparison for an awareness influence hypothesis is between (b) and (c). That is, between aware subjects who do not engage in recall and subjects who are unaware of the study-test relationship.

Recent studies by Mace (2000a, b) were the first to use post-test questionnaire methods to assess the awareness question. While the major focus of these studies was the influence that intentional recall had in the production of LOP effects in implicit tasks, these studies produced a sufficient number of unaware subjects to provide some insight into the awareness question (previous studies had not, e.g., Richardson-Klavehn, Gardiner et al., 1994; Richardson-Klavehn, Lee et al. 1994). In the first study (Mace, 2000a), subjects studied words under LOP conditions and received either a word stem or a word fragment completion task (subjects were given standard implicit task instructions). Since the number of unaware subjects in any one experiment was too low for a reliable comparison, the data from unaware and aware subjects (those who indicated no recall) had to be combined from all of the experiments (there were three experiments in total). Table 1 shows the outcome from this analysis. While both aware and unaware subjects showed more priming from nonsemantic study (a so-called reversed LOP effect), this difference was only significant for unaware subjects. Although this fact alone (i.e., outcome on the LOP variable) represents an important

Table 1

Priming Scores (i.e., studied - nonstudied) for the Word completion Tasks from Experiments 1-3 in Mace (2000a) as a Function of LOP and the Awareness Response on the Post-test Questionnaire

	LOP		
Awareness	Nonsemantic	Semantic	*n*
Unaware	.22	.05 *	10
Aware	.19	.15	23

Note. An asterisk indicates a reliable difference between LOP study conditions.

difference between these groups, another striking difference between them is the level of priming obtained in the semantic study condition: Aware subjects show three times as much priming in the semantic study condition. Like the findings discussed above (Mace, 1996), this finding is also inconsistent with the notion that awareness has no influence on performance in implicit tasks.

Table 2

Mean Proportion of Items Correctly Generated in the Category Generation Task in Experiment 1 of Mace (2000b) as a Function of LOP and of the Awareness Response on the Post-test Questionnaire

	LOP		
Response	Nonsemantic	Semantic	n
Unaware	.15	.15	14
Aware	.15	.21	19

Turning to the next study (Mace, 2000b), again the major focus was on the influence that intentional recall had in the production of LOP effects in implicit tasks, but this time the implicit measures used were those deemed to be conceptually driven (e.g., general knowledge and category generation). Table 2 shows the outcome for unaware and aware subjects on the LOP variable in Experiment 1 of that study. Again, the results appear to contradict the no-influence claim since unaware subjects show no effect of LOP, while aware subjects do.

Thus, the findings from these studies essentially represent five separate failures to replicate the Bowers and Schacter (1990) outcome. These failures seem to argue against the view that awareness has no influence on performance in implicit memory tasks. It is not clear why Bowers and Schacter (1990) did not find differences between aware (test-informed) and unaware subjects. It is possible that their finding was a single anomalous one (perhaps due to some unforeseen methodological flaw), thus explaining the failure to replicate. Whether their results were due to some unknown methodological flaw, or were in fact valid, the preliminary findings discussed above appear to suggest that the awareness influence question was too quickly abandoned.

Explaining an Awareness Influence Hypothesis

If the preliminary results discussed above represent influences of awareness, then there are two possible accounts for such influences, neither of which is mutually exclusive. Each of these accounts can be considered a broad view, containing a number of subsidiary views. One assumes that awareness has a causative role in the retrieval process that is independent of intention to remember, possibly of the type discussed by Schacter el al. (1989), where test cues spontaneously remind subjects of items from the study list. The other assumes that awareness does not play a causative role in retrieval that is independent of intentional retrieval strategies.

The second of these accounts is the simplest level of explanation. It suggests that performance differences between aware and unaware subjects are the result of some aware subjects using intentional retrieval strategies despite, in the case of test-informed conditions, their instructions not to do so, or in the case of post-test questionnaire analyses, their claims that they never employed such a strategy. There are potentially two accounts associated with this view, each capable of accommodating both sets of data. One suggests that subjects in test-informed conditions chose to disregard the experimenter's instructions and thus used intentional retrieval strategies to improve their performance, whereas subjects in the post-test measures were for some reason reluctant to admit that they had engaged in deliberate recall. The other account assumes that both groups neither disregarded instructions nor were they hesitant to report having done so, but that they were unaware that they had actually engaged in strategic recall processes. For example, subjects may be confused about the nature of intentional recall processes, or they may be unable to recognize having engaged in such processes when they involve a low level of strategy.

The other broad account suggests that awareness alone, independent of intention and conscious strategies, may have been responsible for item retrieval in the implicit tasks. Such a notion would probably require that a number of theoretical models be developed to explain how "mere" awareness could result in retrieval. Thus far, the involuntary conscious memory account is the only model that has been considered. In this view, awareness is seen as a post-retrieval event that is coupled with or follows the retrieval of an item. For example, Schacter et al. (1989) describe it as situations where "a test cue involuntarily triggers a 'full-blown re-experiencing' of a recent event." Richardson-Klavehn, Gardiner et al. (1994) write:

> Involuntary conscious memory occurs when a subject gives the first word coming to mind that fits a stem, and the retrieved word is accompanied by conscious

> awareness that it is a previously encountered item. (p. 23)

Since awareness follows from the actual retrieval of an item, this view would have to suggest that it plays a somewhat indirect role in the retrieval process, possibly by influencing the retrieval of items appearing latter on the list.

However, a seemingly more powerful model would consider awareness as a pre-retrieval event that is capable of playing a more direct role in the retrieval process. Simply put, a subject's awareness that a test item is associated with an item seen earlier automatically induces the retrieval of that item without any effort or intention on his or her part, beyond the mere thought the test stimulus may be an item encountered earlier. For example, using this model to illustrate performance on a word stem task, we may imagine that both an aware subject and an unaware subject are responding with the first thing that comes to mind, but that the aware subject experiences many more items from the study session coming to mind, thus making responding with recently studied items a more probable event.

Implications of an Awareness Influence Hypothesis

Methodological Issues: The Task Purity Problem

Ultimately, it may prove difficult, if not impossible, to completely distinguish between different types of awareness models, or between such awareness accounts and the intentional retrieval account discussed above. However, the resolution of these theoretical issues probably matters little for the study of implicit memory and the problem of explicit memory contamination. That is, regardless of their sources, if awareness influences are powerful enough to produce large differences between aware and unaware subjects on implicit memory measures, then sound methods for eliminating their influences must be incorporated into the study of implicit memory, if researchers want to unambiguously learn about implicit memory phenomena.

However, as mentioned, the no-influence assumption has led researchers away from this possibility, with some suggesting contrary methodologies that likely have had the effect of incorporating awareness into implicit memory studies. That is, believing that the only threat to sound implicit memory research is a subject's use of intentional retrieval, researchers have advocated the practice of test-informing subjects, with the idea that such a procedure could greatly reduce, if not eliminate, explicit memory contamination from potential intentional retrieval effects (e.g., Bowers & Schacter, 1990; Brooks, 1999; Richardson-Klavehn et al., 1996). For instance, Richardson-Klavehn et al. write:

> The problem with incidental tests is not to rule out subjective awareness of past events, but to rule out contamination by voluntary retrieval strategies. We suggest, with others (e.g., Bowers & Schacter, 1990; Roediger & McDermott, 1993), that the surest method for minimizing the role for voluntary retrieval strategies in incidental tests is to inform subjects of the study-test relationship... but to emphasize that they should nevertheless adopt an involuntary retrieval strategy.(p. 147)

However, even at the broadest level of analysis, the findings discussed above seem to suggest that such a practice may instead enhance explicit memory contamination, since the performance of aware subjects in pilot work (Mace, 2000a, b) seems to differ quite markedly from unaware subjects. Thus, the critical issue here is to determine whether or not awareness can influence performance on implicit tasks. The resolution of this question would help researchers decide which extreme method to take: one where subjects are made aware of the study-test relationship, or one where only unaware subjects are used.

Theoretical Issues: The Task Purity Problem

If awareness influences have been commonly present in implicit memory studies, then the next question to ask is how have such influences impacted the study of implicit memory? The preliminary data from Mace (2000a) may provide some directions here. To illustrate, let's begin with the assumption that awareness influences are *real*, but that their effects are subtle relative to the effects of intentional recall. Next, assume that according to some points of view, most subjects do not use intentional recall strategies (e.g., Rajaram & Roediger, 1993; Richardson-Klavehn et al., 1999; Richardson-Klavehn & Gardiner, 1998), but they usually are, however, aware of the study-test relationship (e.g., Mace, 2000a; Richardson-Klavehn, Lee et al., 1994). Now, consider how the LOP variable may be impacted by the relative strength argument. If subjects do not commonly use intentional recall strategies, then LOP effects are not likely to appear. However, such results may very well represent the more subtle influences of awareness. For example, if we assume that the LOP reversal for unaware subjects in Mace (2000a) represents the pure implicit memory outcome, then the appearance of a null effect on this variable would represent a subtle but important departure from this outcome. It is possible that such a scenario has occurred in the literature since LOP reversals are entirely uncommon, while null (and small) LOP effects are often observed (for a review of the LOP variable and implicit memory tasks, see Brown & Mitchell, 1994).

If this scenario holds, and we assume that the LOP reversal is *the proper* implicit memory effect, then we may ask if this a sensible outcome for this type of implicit memory task (i.e., a perceptual implicit memory task)? To answer this question, we need to review a highly influential account of perceptual implicit memory.

Schacter (1990, 1992, 1994) and Tulving and Schacter (1990) postulated a system to account for performance on perceptual implicit memory tasks. In their view, performance on perceptual implicit memory tasks is mediated by a network of distinct perceptual implicit memory systems (corresponding to distinct cortical regions) whose functions are to represent the perceptual aspects of stimuli. They have labelled this network the *perceptual representation system* (PRS), calling its components (or subsystems): The *visual word form system*, the *auditory word form system*, and the *object recognition system.* Each of these subsystems is viewed as functioning independently, without the aid of the others. Each is seen as a presemantic system which is responsible only for the input-output operations of basic perceptual information. For example, the visual word form system is responsible for the representation of the orthographic aspects of words, the auditory word form system their phonological aspects, while the object recognition system processes the structural form of objects.

If the PRS (e.g., the visual word form system) is responsible for the representation of perceptual information, it seems reasonable to expect a reversal of the traditional levels of processing effect, since nonsemantic study tasks focus subjects' attention more on the perceptual aspects of verbal stimuli, while semantic study tasks have them focus more on their conceptual aspects. Thus, this implies that the LOP reversal is a sensible result, since it is more consistent with the PRS view than the small or null LOP effects that are commonly found on implicit memory tasks. It also implies that awareness effects in the literature may have prevented LOP reversal from being more commonly observed.

Investigating the Awareness Question

The main purpose of the present study was to investigate the awareness influence question by following up on the results obtained in Mace (2000a). This involved three experiments, where subjects were engaged in a word stem completion task following study under the same LOP conditions used in Mace (2000a). In general, the method used for testing the awareness question involved comparing the performance of subjects on the word stem task who were uniformly unaware of the study-test relationship to those who were uniformly aware of this relationship. This method was similar to the assessment of awareness influences in Bowers and Schacter (1990), because the criterion for unawareness was admission on a post-test questionnaire of unawareness of the study-test relationship, whereas the criterion for awareness was the method of informing subjects of the study-test relationship at the outset of the implicit task.

There were two noteworthy findings in Mace (2000a). The first was the dissociation between aware and unaware subjects on the LOP variable, where aware subjects showed no effect of LOP, while unaware subjects showed a significant LOP reversal. This finding was critical since the dissociative pattern contradicted the widely accepted view that awareness has no influence on performance in implicit memory tasks. The second important finding involved the LOP reversal itself. This finding was also critical because significant LOP reversals have not previously been reported in the literature (see Brown & Mitchell, 1994), and thus, since it was found with unaware subjects, it may be more representative of "truly" implicit memory.

Accordingly, it was reasoned that obtaining these same findings here would have a number of implications for the study of implicit memory. One, they would suggest that awareness can significantly influence the study of implicit memory, and therefore, it may be advisable to base implicit memory research solely on subjects who are unaware. Two, since the LOP reversal would have resulted from unaware subjects, this could have implications for implicit memory theory as they relate to the PRS account.

Finally, subsidiary to these issues was the possibility that awareness effects may be due to involuntary forms of explicit memory. Since this could have implications for both the study of implicit and explicit memory, attempts were made to distinguish between awareness influences as sources of involuntary explicit memory phenomena or as sources of intentional recall strategies. However, a cautionary note should be included here. Evidence more consistent with either of these models is suggestive rather than conclusive, since the self-report nature of such data make unambiguous interpretation difficult.

Experiment 1

In Bowers and Schacter (1990), both unaware and aware (those who were told not to use recall strategies) subjects did not reveal an effect of LOP on a word stem completion task. The similar findings for these two groups on this variable led to the prevailing view that awareness has no influence on performance in implicit tasks (the no-influence view). However, as discussed earlier, a number of preliminary outcomes (e.g., Mace, 1996, 2000a) seemed to argue against this view. On the one hand, Mace (1996) found significant LOP effects for three groups where the test-informed method was used. On the other hand, Mace (2000a) revealed a dissociation between aware and unaware subjects, where the aware subjects showed a null LOP effect while unaware showed a never before reported LOP reversal. These findings indicated (1) that awareness may have an influence on implicit memory performance, while (2) the outcome for the unaware group in Mace (2000a) may hold special significance for the PRS view. However, since neither study of Mace's (1996, 2000a) was originally intended as a test of an awareness-influence view, there are problems with using these results as unequivocal evidence for it. For example, in the earlier study there was no unaware comparison group.

Thus, the LOP effects found for the test-informed groups may also have been found for an unaware group, possibly suggesting no influence of awareness. In Mace (2000a) the LOP reversal was based on a small number of unaware subjects (n= 10), and may not be a robust effect.

While it is possible that the various conditions discussed above produced spurious evidence that favored an awareness-influence view, it is also possible that the results did not argue strongly enough for it. For example, while aware subjects in Mace (2000a) showed no effect of LOP, this finding was still in the direction of a LOP reversal (although not significant, see Table 1). It is important to note, however, that awareness for these subjects was determined by a post-experimental, self-report measure. Subjects reported becoming aware of the study-test relationship at various points in the implicit task, near the beginning, middle, or end, with most claiming awareness occurring near the middle. Thus, if we assume that awareness does in fact have an influence, we may imagine that said reporting phenomenon would have resulted in an underestimate of its influence on performance, since many of the aware subjects were unaware for at least the first half of the task. We may also imagine that if the test-informed method that is currently favored by many had been used (e.g., Bowers & Schacter, 1990; Richardson-Klavehn et al., 1996), awareness effects may have been greater, since this method makes subjects aware at the outset of the implicit task.

The goal of Experiment 1 was to test the awareness influence hypothesis, where the various aforementioned problems were not present in the design. The overall method involved comparing performance of an aware group (the test-informed method) to an unaware group on a word stem completion task following study under the same LOP conditions used in Mace (2000a). The aware and unaware groups differed only in the instructions they had received for the implicit task. Subjects in the unaware group were not informed of the study-test relationship, while subjects in the aware group were made explicitly aware of this relationship (with the additional instructions that they refrain from any sort of deliberate recall). As in Bowers and Schacter (1990), a post-test questionnaire was used to index unawareness in the unaware group. The questionnaire method was also used to determine if any subjects in the aware group had used recall strategies. These conditions should have allowed for a fair test of the awareness-influence hypothesis.

Accordingly, the predictions associated with the awareness question were relatively straightforward. If awareness has no influence on performance in implicit tasks, then the performance of aware subjects should not differ from unaware with respect to overall level of priming, and outcome on the LOP variable. If, on the other hand, awareness does influence performance, then the performance of aware subjects should dissociate from unaware on any or all of these measures.

As discussed earlier, awareness effects may result from subjects' surreptitious use of deliberate recall, or they may result from some form of involuntary explicit memory. To help with the assessment of this question, an intentional recall group was also tested. Following LOP study, this group was instructed to use word stems as cues to recall studied items. Comparing performance between this group and the aware and unaware groups may provide some insight into this question.

Method

Subjects, Design and Materials

One-hundred and twenty-eight subjects were recruited from Brooklyn College's introductory psychology subject pool. Subjects were randomly assigned to one of the three experimental groups, where 71 participated in the unaware group, 33 in the aware group, and 24 in the intentional recall group (more than 24 subjects had to be tested in the unaware and aware groups in order to satisfy the unawareness and awareness criteria of these groups, see below). All subjects received course credit for their participation.

The experimental design was comprised of a 3 (Test Group: unaware vs. aware vs. intentional recall) x 2 (LOP: nonsemantic vs. semantic) mixed factorial arrangement, where Test Group was manipulated between subjects, while LOP was manipulated within subjects. For LOP, subjects studied words nonsemantically (syllable counting) and semantically (pleasantness rating), thus forming a standard LOP manipulation. In Test Group conditions, awareness was manipulated by not informing subjects in the unaware group about the study-test relationship, whereas subjects in both the aware and intentional recall groups were informed of its nature. Subjects in the aware group were told to keep their awareness of the study-test relationship in mind. This instruction was used so that the full potential of awareness could be gauged, and thus the results of this group could be used as a model of performance for subjects who are continuously aware. Regarding retrieval instructions, both unaware and aware groups were given the standard implicit instructions to respond with the first word that came to mind. Thus, the only factor that varied between these two groups was awareness of the study-test relationship. However, since subjects in the aware group were aware of the study-test relationship, they had to be instructed not to use recall strategies. The retrieval instructions for the intentional recall group were standard explicitly cued recall instructions, where subjects were to use word stems to recall studied words. In addition, inclusion instructions were used. Subjects were permitted to respond with the first word that came to mind, in the case where they were unable to recall a word.[1] This method was used so that their results could represent the combined performance of implicit responding, awareness, and strategic recall.

The materials for this experiment consisted primarily of medium frequency nouns (drawn from various sources), varying in length from 6-10 characters. Two study lists were formed, each containing 72 items (see Appendix A). Each list was broken into a nonsemantic processing block and a semantic processing block, with 36 items in each block. In an effort to reduce awareness in the unaware group, only 32 of these items (16 from each processing block) were targeted for inclusion in the implicit task. Thus, the remaining items were used as fillers (16 in each block), and primacy and recency buffers (12 at the beginning of the list, 12 at the end).

The word stem completion task contained 96 word stems, formed by deleting all but the first three characters (e.g.,

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[1] This method is sometimes used by researchers when they are comparing implicit to explicit memory performance (e.g., Richardson-Klavehn & Gardiner, 1996, for complete details, see Jacoby, 1991).

ELE_, for ELEPHANT). In total, 64 items corresponded to the words from the two study lists, 32 constituted practice or filler items (commencing the task, and having no correspondence to any previously presented study item). Words stems had at least 5 possible completions, with no two word stems sharing the same first three characters.

The two study lists were completely counterbalanced across subjects, with half of the subjects studying one list, the remaining half studying the other. This allowed each subject to serve as a baseline control for the respective nonstudied list since the word stem task was comprised of both study lists. All study words were counterbalanced across LOP conditions so that each word served equally often in each of the LOP study conditions. Processing blocks were counterbalanced for order so that half of the subjects received the nonsemantic block first, followed by semantic block, with the remaining half receiving the reverse order.

Post-test questionnaires were designed to query subjects about their awareness and use of intentional recall strategies. The questionnaire for the unaware group asked subjects (1) if they had noticed that some of the word stems corresponded to words from the study list, and if so, (2) did they ever try to recall a studied item in order to complete a word stem (see Appendix B). Subjects who answered "no" to question 1 were classified as unaware, and retained for the unaware group. Subjects who answered "yes" to question 1 and "no" to question 2 were classified as aware, and excluded from the unaware group. Subjects who answered "yes" to both questions 1 and 2 were classified as intentional recall, and also excluded from the unaware group. Testing for the unaware group continued until at least 24 subjects were classified as unaware by this method. This was done in a manner that complied with the counterbalancing requirements specified above. The questionnaire for the aware group asked subjects if they ever tried to recall a studied item in order to complete a word stem (see Appendix C). Subjects who answered "no" to this question were retained for the aware group, those who answered "yes" were excluded. Testing for the aware group also continued until at least 24 subjects were classified as aware (not having engaged in recall) by this method, again in compliance with the counterbalancing requirements.

Procedure

The experiment consisted of four phases: study, distractor, testing, and questionnaire. Subjects participated in groups of four. Unaware, aware, and intentional recall subjects were told that they were to participant in three different linguistic tasks (with no mention that the word stem task was an index of memory). The purpose of these instructions was to prevent rehearsal of studied items and to reduce awareness in unaware subjects. After these general instructions were delivered, the study, distractor, and testing phases were delivered on IBM-compatible personal computers, followed by the questionnaire phase.

Study Phase. The study phase began with either a nonsemantic-study task (followed by the semantic-study task) or the semantic-study task (followed by a nonsemantic-study task). For the nonsemantic-study condition, subjects were instructed to count the number of syllables in words appearing on screen. For the semantic-study condition, subjects were instructed to rate words appearing on screen for the pleasantness of their meaning on a scale from 1-7, where 1 was very unpleasant and 7 was very pleasant. Study words were displayed individually on screen (centered and in standard uppercase font), with a unique random presentation order for each subject (determined within blocks). Study trials were self-paced, with a response terminating a trial. All responses were entered on the keyboard.

Distractor Phase. Immediately following the study phase, all subjects were engaged in a distractor task where they had to decide if words presented on screen were the names of countries. One-hundred and twenty items were presented on screen, where items were the names of countries, cities, or states. This task occupied subjects for approximately five to seven minutes.

Testing Phase. Immediately following the distractor phase, all subjects were engaged in the word stem completion task. For the word stem task, all subjects were shown an example of a word stem (and a possible completion) and told that their task was to complete such stems with the first word that came to mind (no reference was made to the previous study session). They were told that the task requires that they only respond with the first word coming to mind, and that they should never suppress or substitute that response for another.

After these instructions, the task began with the 32 filler items, followed by the 64 targeted items (32 from the studied list, 32 from the nonstudied list, randomly presented). The purpose of the filler item phase was to help reduce test awareness in the unaware group, and to induce and encourage maintenance of the implicit mode of responding for aware subjects. Unaware subjects were not given any further instructions beyond the initial implicit task instructions.

For aware and intentional recall subjects, the task stopped at the end of the 32-item filler phase, and additional task instructions were delivered. Aware and intentional recall subjects were told that the task was to continue with some of the items now corresponding to items from the study phase. Aware subjects were told to keep their awareness of the study-test relationship in mind while they continued to perform the word stem task by responding with the first word coming to mind, never trying to recall words from the study phase. They were also told that they should not be concerned with whether a word coming to mind was (or was not) from the study phase, thus responding with whatever word comes to mind, never trying to make a word come to mind or suppress one that did. This instruction was given to help discourage deliberate recall (if subjects thought studied words should be coming to mind), or the suppression of studied words coming to mind (if subjects thought studied words should not be coming to mind). Intentional recall subjects were told that they should use word stems to recall words from the study phase. However, if they had failed to recall a word, they may respond with the first word that comes to mind.

All test stimuli were presented on screen (center) individually in standard uppercase font, with a different random presentation order for each subject. Test trial duration was limited to 15 s. All responses were entered on the keyboard.

Questionnaire Phase. Following the word stem task, the post-test questionnaires were administered to subjects in the unaware and aware groups. All subjects were told that there were no right or wrong answers to the questions, and that the questionnaire's purpose was to provide the investigators with information on how individuals experience the experimental tasks. They were also told that their responses were neither a reflection of their performance (good or bad), nor would they affect their credit for participating in the experiment. Following these instructions, subjects filled out their questionnaires in private.

Results and Discussion

Analysis of Questionnaire Responses

Twenty-seven (38%) of the 71 subjects participating in the unaware group indicated that they were unaware of the study-test relationship. Of the 71, 44 indicated that they became aware of the study-test relationship at some point during the word stem task (spontaneously aware). Of these 44 spontaneously aware subjects, 34 said they did not use recall strategies, and 10 said that they did (overall 48% & 14%, respectively). Of the 33 subjects participating in the aware group (instructed aware), 9 (27%) indicated that they had sometimes used recall strategies, 24 (73%) indicated that they did not.

The purpose of this analysis was to exclude data from subjects reporting awareness (in the unaware group) and use of recall strategies (in the aware group). Accordingly, all of the analyses involving these groups were based on data from subjects who reported that they were unaware of the study-test relationship in the unaware group (i.e., only the 27 unaware reported above), or that they did not use recall strategies in the aware group (i.e., only the 24 who met this criterion reported above).

Main Analyses

Table 3 summarizes the results of Experiment 1. Displayed are the mean proportions of studied and nonstudied items correctly completed on the word stem task as a function of LOP and group ($n = 24$ in each group). In order to comply with the counterbalancing requirements and maintain an equal n, three of the 27 unaware subjects in the unaware group were randomly excluded from the analysis.

Priming Analysis. Performance on the nonstudied items did not differ among the groups ($F < 1.0$). On average, the completion rate for nonstudied items was .08, thus representing chance performance for the studied lists. A priming analysis was then conducted to see if performance on studied items was greater than performance on nonstudied items. A 3 (Item Status: nonstudied vs. semantically studied vs. nonsemantically studied) X 3 (Group: unaware vs. aware

Table 3

Mean Proportions of Items Correctly Completed on the Word Stem Completion task in Experiment 1 as a Function of LOP and Group

	LOP		
Group	Nonsemantic	Semantic	Nonstudied
Unaware	.24	.12	.08
Aware	.22	.28	.08
Intentional	.22	.34	.08

vs. intentional recall) analysis of variance (ANOVA) revealed a significant main effect for Item Status (F[2, 208]= 49.93, MSE= 0.19, $p < .001$), indicating that performance on studied items was significantly better than chance. However, this effect was qualified by a significant Item Status X Group interaction, $F(4, 208)= 8.52$, $p < .001$. It appeared that one source of this interaction was the unaware group's small increase in performance for semantic study compared to the nonstudied baseline, where performance was only .04 above chance (see Table 3). Indeed, this impression was confirmed by the least significant difference for this analysis (LSD = .06), which indicated that performance for semantic study in unaware subjects was the only study condition that was not significantly better than chance levels (see Table 3). This finding appears to support the awareness influence view. Since this pattern was only found for the unaware group, while a significant priming effect for semantic study was found in the aware group, the suggestion is that the significant priming following semantic study for the aware group was due to their awareness of the study-test relationship.

LOP Analysis. To assess the awareness question by comparing performance on the LOP study variable, a 3 (Group: unaware vs. aware vs. intentional recall) X 2 (LOP: nonsemantic vs. semantic) ANOVA was conducted. This analysis found a significant main effect for Group, $F(2, 69) = 6.97$, $MSE = 0.30$, $p < .01$, but not for LOP, $F < 1.0$. However, these findings were qualified by a significant Group X LOP interaction, $F(2, 69) = 13.92$, $MSE = 0.20$, $p < .001$. The pattern of the interactive effect involving the LOP variable was highly suggestive of an awareness influence (see Table 3). That is, follow up analyses showed that one source of this interaction was differing performance on the LOP variable, where the unaware group showed a significant LOP reversal while the aware group showed a null LOP pattern (the LSD for this analysis was .07). Even though LOP was not significant for the aware group, the failure to obtain findings similar to the unaware group (the LOP reversal) suggests that awareness influenced outcome on this variable.

Also contributing to the interactive effect was the performance of intentional recall subjects on the LOP variable. Consistent with traditional findings (e.g., Craik & Tulving, 1975; Graf & Mandler, 1984), LOP was significant for this group. Taken together then, this interaction showed that all three groups have dissociated from one another on the LOP variable, where unaware showed a strong LOP reversal, the aware a small but null LOP effect, and the intentional recall group a traditional LOP effect. At an ideal level, these varying outcomes may be interpreted as owing to three different levels of performance on the word stem task: unaware (or "purely" implicit), aware, and strategically aware performance. While the dissociative findings between unaware and aware groups seem to be clear evidence of awareness influences, the remaining question concerns the source of such influences. The differences between the aware group and the intentional recall group on the LOP variable may provide insight into this question.

The LOP effect observed for the intentional recall group is consistent with the idea that this group followed instructions and engaged in strategic recall. The lack of this same type of LOP effect for the aware group (and their dissociation from the unaware group) is consistent with the notion that their performance may have been mediated (in whole or in part) by an involuntary form of explicit memory. However, it certainly should be noted that the dissociative results between the aware and intentional recall groups may also indicate that they differed only in terms of their levels of strategic recall, where less strategic recall was utilized in the aware group, even though they had been instructed not to use such strategies.

Timing Analysis

Response times can also be an indication of subjects' retrieval strategies. Richardson-Klavehn et al. (1999) showed that subjects given intentional recall instructions for a word stem task took on average more time to complete the stems than subjects given implicit instructions. It was reasoned that a comparison of the response times for the three groups here may indicate how subjects in the aware group were treating the word stem task. If overall latencies for the aware group do not differ from the unaware group, this would suggest that the aware group subjects were using implicit retrieval strategies. On the other hand, if overall latencies for the aware group were longer (and possibly closer to the intentional recall group), this would tend to indicate that the aware group subjects were using intentional retrieval strategies.

Table 4 shows the mean response times on the word stem task in all three groups for nonstudied and studied items. It appears from the table that intentional recall subjects took longer to complete word stems than both aware and unaware subjects. It also appears that response times for aware subjects generally do not differ from unaware

Table 4

Mean Response Times in Seconds for Items Completed on the Word Stem Completion task in Experiment 1 as a Function of LOP and Group

	LOP			
Group	Nonsemantic	Semantic	Nonstudied	*M*
Unaware	4.7	4.8	5.9	5.1
Aware	5.1	5.0	5.8	5.3
Intentional	7.8	6.9	7.9	7.5
M	5.9	5.6	6.5	

subjects, possibly indicating that aware group subjects were responding implicitly. To assess these impressions a 3

(Group: unaware vs. aware vs. intentional recall) X 3 (Item Status: nonstudied vs. nonsemantically studied vs. semantically studied) ANOVA was performed. The ANOVA showed that Group and Item Status did not significantly interact ($F[4, 92] = 2.04$, $MSE = 1.20$, $p > .05$), but significant main effects were shown for Group ($F[2, 46] = 18.09$, $MSE = 7.37$, $p < .001$) and Item Status ($F[2, 46] = 19.25$, $MSE = 0.831$, $p < .001$). The LSD statistic showed that latencies for the intentional group were significantly longer than both unaware and aware groups (LSD = 1.6), while latencies for aware and unaware groups did not differ. In addition, the latencies for nonstudied items were significantly longer than both nonsemantic and semantic studied items (LSD = 0.5).

These results indicate that aware subjects were treating the word stem task more implicitly than they were strategically, possibly indicating that awareness influences were more of an involuntary nature. The results also showed that latencies for nonstudied items were significantly longer than studied items (both semantic and nonsemantic), a finding consistent with obtaining priming effects for studied items, overall. However, this last result should be interpreted with caution. Latencies have not been established as a measure of priming on this task, thus only a possible correlate of priming. The problem here is that there is no existing theory to consult on the relation between response latencies and priming, and only a scant database. This database consists of two studies using word stem tasks (Richardson-Klavehn et al., 1999; Richardson-Klavehn & Gardiner, 1998). Both show significant priming effects on the word stem task for a variety of study conditions, but response latencies did not differ for studied versus nonstudied items (contrary to the results reported here). The only consistency between the results reported here and these two studies was that all found significantly longer latencies for intentional recall groups compared to implicit groups.

Analyses of Nonsemantic and Semantic Study Conditions

Although not entirely orthogonal to the priming and LOP analyses, an across-groups analysis of performance for nonsemantic and semantic study also provided some insights into the awareness issue. Table 3 shows that no change has occurred across groups for nonsemantic study, while considerable change has occurred for semantic study. This impression was confirmed by two separate one-way ANOVA's (Nonsemantic study [$F < 1.0$], Semantic study, $F[2, 71] = 20.02$, $MSE = 0.24$, $p < .001$), where the LSD statistic (.07) revealed no differences between the aware groups and the intentional recall group, while the unaware group differed significantly from them.

There are at least two broad inferences that can be drawn from these findings. One, the primed performance of the unaware group in nonsemantic study is as good as the two aware groups, a finding that suggests that there are no inherent differences between the unaware and aware groups in terms of their ability to express primed performance on the word stem task. Two, since change was only observed for semantic study, it suggests that awareness only influenced performance following semantic study.

Analysis of Questionnaire Data

If awareness of the study-test relationship for the aware group (instructed aware) was responsible for the various results reported above, then a similar pattern of results should be evident for subjects who were assigned to the unaware group, but reported awareness on the self-report measure (spontaneously aware). To assess this question, the data from the questionnaire for the unaware group were used to compare performance of subjects who reported being unaware with those who reported becoming spontaneously aware of the study-test relationship at some time during the word stem task.

Table 5 shows these data as a function of LOP. The data for the unaware subjects are the same as those reported in the main analysis above (see Table 3). For the spontaneously aware subjects, the data are based on 32 of the 34 subjects who reported spontaneous awareness and no strategic recall (two were excluded from the analysis to comply with the counterbalancing criteria). As is evident in Table 4, the results for spontaneously aware subjects in this analysis appear to be very similar to those for the aware group (instructed aware, compare to Table 3). In both cases, the semantic completion rate for aware subjects is two times

Table 5

Mean Proportions of Items Correctly Completed on the Word Stem Completion Task in Experiment 1 as a Function of LOP and the Awareness Response on the Post-test Questionnaire

	LOP		
Response	Nonsemantic	Semantic	*n*
Unaware	.24	.12	24
Spontaneously Aware	.23	.23	32

that of unaware. More importantly, spontaneously aware subjects also appear to dissociate from unaware on the LOP variable. A 2 (Questionnaire Response: unaware vs. spontaneously aware) X 2 (LOP: nonsemantic vs. semantic)

ANOVA conducted on these data confirmed that spontaneously aware subjects did dissociate from unaware on LOP, where Questionnaire Response X LOP significantly interacted ($F[1, 46] = 3.95$, $MSE = 0.21$, $p = .05$) and the LSD (.07) indicated a null effect for the spontaneously aware subjects. These findings also support the awareness influence view, in that awareness for these subjects had the same pattern of influence on performance in the word stem task as it did for subjects in the instructed-aware group.

Summary and Conclusions

All of the main analyses supported the view that awareness of the study-test relationship influences performance on a task designed to measure implicit memory. The priming analysis showed that priming following semantic study did not reach statistical significance for the unaware group, while it did for the aware groups, thus indicating influences of awareness. The LOP analysis showed the unaware group dissociating from the aware, where the former showed a LOP reversal and the latter did not, also indicating influences of awareness. Additional support was also obtained by supplementary analyses. The results for subjects who reported awareness on the questionnaire were uniformly consistent with the results for the aware group. Also, the timing analysis suggested that awareness effects may have been due largely to involuntary explicit memory processes.

These findings are inconsistent with the view that awareness has no effect on implicit memory measures (e.g., Bowers & Schacter, 1990; Richardson-Klavehn et al., 1996).

In addition to these general findings, some important insights into the nature of "truly" implicit (unaware) memory may have been learned from this experiment. This was the first time that priming was not found to be significantly above chance levels following semantic study. In addition, the significant LOP reversal was also a somewhat novel finding (the exception being the pilot data from Mace, 2000a). Taken together, these findings suggest that (1) semantic study may not always prime performance on an implicit memory measure, and (2) some forms of implicit memory may rely exclusively on perceptual representations, and therefore are highly dependent on the nature of prior perceptual processing.

Experiment 2

In Experiment 1, the unaware group showed two novel effects, nonsignificant semantic study priming and a LOP reversal, both having important implications for the study of implicit memory. Since these two effects were not observed in the aware group, it was concluded that awareness of the study-test relationship influenced performance on the implicit task, thus having the effect of significantly altering the outcome. The larger implications of this conclusion are that said novel findings have not appeared in the implicit memory literature probably because past research has been based on samples where awareness was ubiquitous. Thus, the only reason that the novel findings appeared in Experiment 1 is because this was a rare instance where implicit memory was indexed with an unaware (or "truly" implicit) sample. However, is it possible that there was a unique set of conditions in Experiment 1 that was responsible for the novel effects, and not the unique sample (the unaware subjects)? And, possibly the reason that the novel effects did not appear for the aware group was because a design flaw in their test instructions prevented them from doing so, and thus not their awareness.

Suppose that there were some inherent properties in the LOP manipulation that, coupled with the design of the study and testing phases, had brought about the novel findings in the unaware group. Now, assuming that the no-influence view is true, these same novel findings would have also appeared for the aware group. However, imagine that the instructions that the aware group received for the implicit test (i.e., hold their awareness in mind continuously) produced a demand characteristic, where subjects saw such instructions as an enticement to use recall strategies, thus causing many subjects to use recall strategies despite the instructions not to. If all of these events occurred in Experiment 1, the effects observed for the aware group could have been produced entirely by recall strategies. This suggests that a different set of instructions may have allowed for the LOP reversal to be observed in the aware group, thus possibly indicating support for the no-influence view. It also suggests that if done properly, the test-informed method may be useful for controlling contamination from deliberate recall, since the same results obtained from an unaware sample can be obtained with an aware sample (e.g., Bowers & Schacter, 1990).

One of the major purposes of Experiment 2 was to test out the possibility that the effects for the aware group were produced by a demand characteristic inherent in their instructions. This was accomplished by comparing the performance of unaware and aware groups (as in Experiment 1) to a new aware group (the aware-ignore group), where the instructions for this new group were designed to maximally counteract the possibility that subjects had used recall strategies as a result of the type of awareness instructions that they had received. The method for this new (aware-ignore) group involved informing them of the study-test relationship, with the additional instructions that they were to completely ignore (or forget) their awareness of the study-test relationship, not allowing any thoughts of the study-test relationship to come into mind while they were performing the implicit task. It was reasoned that subjects in this group may be less likely to use recall strategies, since they may view their task as one where they are to work at putting thoughts of the study-test relationship out of their mind (Wegner and colleagues have shown that subjects are capable of suppressing thoughts when instructed to do so, see Wegner, 1994; Wegner, Schneider, Carter & White, 1987).

The design of Experiment 2 permitted a number of issues to be addressed. One question concerned the possibility that awareness effects in Experiment 1 were produced by a demand characteristic. Regarding this issue, it was reasoned that if awareness has no effect on performance in an implicit task, and the effects for the aware group in Experiment 1 were produced by a demand characteristic, then the performance of the aware-ignore group should be very similar in nature to the unaware group. If, on the other hand, the performance of the aware-ignore group turns out to be very similar to the aware group (where both dissociated from the unaware), then it was reasoned that these findings could be used to rule out the demand characteristic possibility, as well as to address a number of other issues.

Since such findings would represent a replication of the findings in Experiment 1, they would tend to strengthen the conclusions made earlier concerning the awareness issue. In addition, it was thought that the findings of the aware-ignore group could address two more somewhat related issues. One, they could be used to suggest that once subjects become aware, their performance will be changed by such awareness, no matter the instructions (e.g., don't think about your awareness, think about it, don't use recall, etc.). Thus, the results from the aware-ignore group could model the performance of subjects who try not to think about their awareness, the aware group, subjects who continuously think about it. Two, if subjects are less likely to use recall strategies in the aware-ignore group, then it was reasoned that this group could be used to support the view that awareness effects are largely due to involuntary forms of explicit memory.

Method

Subjects, Design, and Materials

One-hundred and fifty-nine subjects were recruited from the same source used in Experiment 1 (all received course credit for their participation). Subjects were randomly assigned to one of the four experimental groups, where 77 participated in the unaware group, 34 in the aware group, 24 in the aware-ignore group, and 24 in the intentional recall group (again, more than 24 subjects had to be tested in the unaware and aware groups in order to satisfy the criteria for these groups).

The experimental design was a 4 (Test Group: unaware vs. aware vs. aware-ignore vs. intentional recall) x 2 (LOP: nonsemantic vs. semantic) mixed factorial arrangement, where Test Group was manipulated between-subjects, while LOP was manipulated within-subjects. As in Experiment 1, the LOP study manipulation involved counting syllables (nonsemantic) and ratings words for pleasantness (semantic). The method for the Test Group conditions were identical to Experiment 1, except for the aware-ignore group. The aware-ignore group was informed of the study-test relationship, but they were told to ignore their awareness entirely while they were responding to word stems with the first word coming to mind.

The materials used, the design of the study lists, and the construction and design of the word stem completion task were all identical to Experiment 1. All other design features, including all of the counterbalancing requirements, were also identical to Experiment 1.

The post-test questionnaires for unaware and aware groups were the same as Experiment 1. The questionnaire used for the aware-ignore group was the same as that used for the aware group. As in Experiment 1, the inclusion and exclusion of subjects from their respective groups involved only retaining subjects who indicated unawareness (for the unaware group) and those who indicated that they did not use recall strategies (for the aware and aware-ignore groups). Testing for these groups continued until 24 subjects (in each group) had met the requirements of their group, done in a manner to comply with all of the counterbalancing requirements.

Procedure

For all groups, the study, and testing phases were identical to Experiment 1, except for the test instructions used for the aware-ignore group (the distractor phase was dropped because it was suspected that it may have increased awareness levels, since some subjects in Experiment 1 thought that they were responding with items from this phase). Following the 32-practice item phase, the aware-ignore group was told that the word stem task would continue with some of the items corresponding to items from the study phase. They were told that they were to continue to perform the task by responding with the first word that comes to mind, and to completely ignore their awareness of the study-test relationship. They were told that their specific task was to work at keeping all thoughts about the study-test relationship out of mind while they were responding to word stems. They were told that when a word comes to mind, they should not think about its source (i.e., it's from study, it's not from study). Also, if a word comes to mind that they recognize from study, they should respond with it, and then continue to push thoughts of the study-test relationship out of mind. This instruction was given to discourage suppression of study items that may come to mind automatically.

Results and Discussion

Analysis of Questionnaire Responses

Similar to Experiment 1, 28 (36%) of the 77 subjects participating in the unaware group indicated that they were unaware of the study-test relationship. Of the 77, 49 indicated awareness of the study-test relationship (spontaneously aware). Of the 49 spontaneously aware subjects in the unaware group, 32 said that they did not use recall strategies, while the rest (17) said that they did (overall 42% & 22%, respectively). Of the 34 subjects participating in the aware group (instructed aware), 10 (29%) indicated that they had sometimes used recall strategies, 24 (70%) indicated that they did not. For the aware-ignore group (also instructed aware), all 24 subjects said that they did not use recall strategies. The discrepancy between subjects in the aware and the aware-ignore groups reporting the use of recall strategies seems to suggest that aware-ignore subjects probably did not use recall strategies.

As in Experiment 1, the purpose of this analysis was to exclude data from subjects reporting awareness in the unaware group and those who used recall strategies in the aware and aware-ignore groups from all analyses involving these groups. Thus, the analyses reported below used the same exclusion criteria set forth in Experiment 1, where only the 28 unaware subjects in the unaware group and the 24 aware subjects who did not use recall in the aware group were used.

Main Analyses

Table 6 displays the results of Experiment 2. Shown are the mean proportions of studied and nonstudied items correctly completed on the word stem task as a function of LOP and group (n = 24 in each group). In compliance with the counterbalancing requirements, four subjects were randomly excluded from the unaware group (thus n = 24 for this group). The findings shown in Table 6 seem to virtually replicate those obtained in Experiment 1.

Table 6

Mean Proportions of Items Correctly Completed on the Word Stem Completion task in Experiment 2 as a Function of LOP and Group

	LOP		
Group	Nonsemantic	Semantic	Nonstudied
Unaware	.26	.13	.08
Aware-Ignore	.26	.26	.08
Aware	.27	.30	.08
Intentional	.29	.34	.08

Priming Analysis. As in Experiment 1, performance on the nonstudied items did not differ among the groups ($F < 1.0$). The average completion rate for these items was also the same as Experiment 1 (.08). To assess priming, a 3 (Item Status: nonstudied vs. semantically studied vs. nonsemantically studied) X 4 (Group: unaware vs. aware vs.

aware-ignore vs. intentional recall) ANOVA was carried out. This analysis showed a significant main effect for Item Status ($F[2, 276] = 72.93$, $MSE = 0.25$, $p < .001$), indicating that performance on studied items was significantly above chance, but this effect was qualified by a significant Item Status X Group interaction, ($F[6, 276] = 3.94$, $p < .01$). Once again, the source of this interaction was traced to the semantic study condition for the unaware group, where performance was only .05 above the nonstudied rate (see Table 6). The LSD statistic (.07) confirmed that this study condition was not significantly greater than chance, thus replicating the finding for the unaware group in Experiment 1. The LSD also confirmed that priming for semantic study in both the aware and aware-ignore groups was significant (.22 and .18 above chance, respectively). These findings replicated the previous finding for the aware group, thus indicating an effect of awareness for this group. They also show that the aware-ignore and aware groups did not differ from one another in semantic study priming, while both differed from the unaware group. This suggests that awareness of the study-test relationship has also influenced performance for the aware-ignore group.

LOP Analysis. Assessing the awareness question with performance on the LOP study variable, a 4 (Group: unaware vs. aware vs. aware-ignore vs. intentional recall) X 2 (LOP:

nonsemantic vs. semantic) ANOVA was conducted. The outcome of this analysis was similar to Experiment 1, where the main effect of Group, $F(3, 92) = 3.86$, $MSE = 0.50$, $p < .02$, was significant, while LOP was not, $F < 1.0$. Once again, this pattern of results was qualified by a significant Group X LOP interaction, $F(3, 92) = 5.79$, $MSE = 0.20$, $p < .01$. As can be seen in Table 6, the interactive pattern is very similar to Experiment 1, where both of the aware groups and the intentional recall group appear to dissociate from the unaware group on the LOP variable. The LSD confirmed (.06) that this was indeed the case, where it indicated that LOP was not significant for the aware groups and the intentional recall group, while a significant LOP reversal was indicated for the unaware group (replicating the previous finding).

Thus, with the exception of the intentional recall group (where LOP was not significant), these findings agreed perfectly with the findings in Experiment 1. The dissociation of the aware group from the unaware is highly indicative of an effect of awareness for the former group. A central interest here was the outcome for the aware-ignore group. Since the performance for this group on the LOP variable did not differ from the aware group (while it did from the unaware), it suggests that awareness influenced their performance in virtually the same manner as it did for the aware group. It also suggests that this influence has occurred despite the difference in the instructions for the aware-ignore and aware groups (i.e., put your awareness out of mind, keep your awareness in mind). This seems to rule out the possibility that awareness effects for the aware group were a function of a demand characteristic associated with their instructions.

Timing Analysis

Again, an analysis of the mean response times for the word stem task was carried out. Table 7 shows the mean response times on the word stem task in all four groups for nonstudied and studied items. Again, it appears that intentional recall subjects have the longest response times on the word stem task. It also appears that response times for subjects in both of the aware groups do not differ from unaware subjects. The response time data were analyzed in a 4 (Group: unaware vs. aware-ignore vs. aware vs. intentional recall) X 3 (Item Status: nonstudied vs. nonsemantically studied vs. semantically studied) ANOVA. Again, the ANOVA showed that Group and Item Status did not significantly interact ($F[6, 138] = 1.96$, $MSE = 1.27$, $p > .05$), but significant main effects were again shown for Group ($F[3, 69] = 31.32$, $MSE = 6.70$, $p < .001$) and Item Status ($F[2, 46] = 18.79$, $MSE = 0.682$, $p < .001$). LSD statistics confirmed that latencies for the intentional group were

Table 7

Mean Response Times in Seconds for Items Completed on the Word Stem Completion task in Experiment 2 as a Function of LOP and Group

	LOP			
Group	Nonsemantic	Semantic	Nonstudied	M
Unaware	4.3	4.4	5.1	4.6
Aware-ignore	4.6	4.8	4.9	4.7
Aware	4.6	4.8	5.2	4.9
Intentional	8.0	7.7	8.8	8.1
M	5.4	5.4	6.0	

significantly longer than the unaware and both aware groups (with no differences among the latter three groups, LSD = 1.51), while latencies for nonstudied items were significantly longer than both nonsemantic and semantic studied items (LSD = 0.5).

Thus, these findings tend to replicate those in Experiment 1. The critical finding was no difference in latencies between the unaware, aware-ignore and aware subjects, suggesting that both aware-ignore and aware subjects were responding on the task more implicitly than they were strategically. Again, this seem to suggest that the awareness effects were more of an involuntary nature.

Analyses of Nonsemantic and Semantic Study Conditions

The across-groups analyses of performance for nonsemantic and semantic study (respectively) was also consistent with Experiment 1. As can be seen in Table 6, no change appears to be present for all groups on nonsemantic study, while change has occurred on semantic study. Two separate one-way ANOVA's showed that the groups did not differ on Nonsemantic study, $F < 1.0$, while they did on Semantic study, $F(3, 92) = 8.47$, $MSE = 0.35$, $p < .001$. The LSD statistic (.08) revealed no differences among the aware groups and the intentional recall group, while the unaware group differed significantly from them. These findings show that once again awareness influences were limited to semantic study (where the aware-ignore group is not differing from the aware group, indicating similar influences), and the unaware group again shows good performance on nonsemantic study, relative to all other groups.

Analysis of Questionnaire Data

As in Experiment 1, an assessment of the awareness question was also carried out on the data from the questionnaire responses for the unaware group. This was conducted in the same manner as Experiment 1, where the data for the unaware subjects were the same as those reported in the main analysis above (see Table 6), and the data for spontaneously aware subjects were based on a random selection of 24 of the 36 subjects who reported awareness and no strategic recall (in compliance with the counterbalancing requirements, only 24 of the 36 could be used in the analysis). Table 8 shows these data as a

Table 8

Mean Proportions of Items Correctly Completed on the Word Stem Completion Task in Experiment 2 as a Function of LOP and the Awareness Response on the Post-test Questionnaire

	LOP		
Response	Nonsemantic	Semantic	*n*
Unaware	.26	.13	24
Spontaneously Aware	.22	.26	24

function of LOP. Once again, the results for spontaneously aware subjects in this analysis seem to be consistent with an influence of awareness, where they appear to be dissociating from the unaware subjects on the LOP variable. A 2 (Response: unaware vs. spontaneously aware) X 2 (LOP: nonsemantic vs. semantic) ANOVA confirmed that spontaneously aware subjects did dissociate from unaware on LOP, since Response and LOP significantly interacted ($F[1, 46]= 15.46$, $MSE= 0.17$, $p < .001$), and the LSD (.06) for this analysis indicated a null LOP finding for the spontaneously aware subjects. These findings also support the awareness influence view, since once again the results from subjects reporting awareness on the questionnaire were very similar to those receiving the awareness instruction in the aware group.

Summary and Conclusions

All of the analyses of Experiment 2 supported the view that awareness influences performance on an implicit memory task. With the exception of the intentional recall group, the findings for the aware and unaware groups mirrored those of Experiment 1. That is, the aware group dissociated from the unaware on the LOP variable, reinforcing the awareness argument. The unaware group showed no significant priming following semantic study, as well as a reversal of the LOP effect, thus strengthening the view that these are robust implicit memory results. On the other hand, it is not entirely clear why intentional recall subjects failed to show a significant LOP effect. It is possible that some (or many) of these subjects failed to use recall strategies throughout the task.[2] It is also possible that the elimination of the distractor task had the effect of increasing performance on nonsemantic study, thereby nullifying LOP (see Table 6). In addition, the aware-ignore group answered an important additional question: since the findings for this group were virtually indistinguishable from the aware group, it suggests that awareness, and not the type of instructions, was responsible for change in performance. While this finding ruled out the possibility that awareness effects were due to a demand characteristic, it also allowed for a number of other conclusions.

The most glaring conclusion seems to be that task awareness will influence performance even when subjects may be actively trying not to think about it. The spontaneous nature of these influences seems to support the notion that involuntary explicit memory processes are at work here. Since this says that neither cognitive process nor instructions can prevent awareness influences from

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[2] In debriefing intentional recall subjects in Experiment 2, some had indicated that they had sometimes forgot to respond strategically.

occurring, it argues against the use of a test-informed method as means for controlling explicit memory influences in implicit memory studies.

Experiment 3

Experiment 3 was designed for a single purpose: to replicate the unaware-aware dissociative effects within subjects. While Experiments 1 and 2 provided robust support for the awareness influence claim, it could be argued that the dissociative effects found between unaware and aware subjects were a result of selecting for a variety of subject factors in the unaware group. For example, since unawareness was based on post-experimental subject reports, it is possible that unawareness was correlated with some sort of inherent performance deficit on the implicit task. If true, the nonsignificant semantic study priming and the LOP reversal may have been due to simple performance deficits and not the unawareness.

While the good performance of unaware subjects on nonstudied and nonsemantic items in both experiments seems to weaken this argument considerably, it is still possible that the chance performance of unaware subjects on the implicit task resulted in their unawareness. Imagine that subjects' high or low performance in semantic study is a purely random event, then it is possible that subjects who experience low performance (by chance) are more likely to be unaware since performance on nonsemantic items is generally not well correlated with recollection.[3] In this setting, nonsignificant semantic priming and the LOP reversal could have been due to a chance event that was selected for in the unaware group by the self-reporting method. While it seems reasonable to suggest that these same subject factors were present in the aware groups, the issue here is that they may have been solely selected for in the unaware group, since the self-report method only retained subjects who reported unawareness. If these subject factors are real, and were selected for in the previous experiments, it could imply that the observed differences between unaware and aware groups may have been due to subject selection factors.

This experiment addressed these possibilities by examining the awareness influence question with a within-subjects design. After studying words under the same LOP conditions used in the previous experiments, subjects received the word stem completion task. However, this time subjects received both the unaware and the aware instructions (thus constituting the unaware-aware within-subjects manipulation). This was done by first administering the unaware instruction (in test 1), and then administering the aware instruction (in test 2).

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[3] However, the nonsemantic task (syllable counting) used in this study generally produces good recognition memory performance (see Lockhart & Craik, 1990).

The reasoning behind using the within-subjects test design to assess the subject factor argument was as follows: If it is assumed that awareness has no influence on performance in an implicit task, then according to the subject factors argument, the effects observed in the previous experiments were due to these factors being over represented in the unaware group because of the self-report method. Now, since the same self-report method was used in test 1 here to select unaware subjects, then it follows that the same subject factors should have been selected for. If subject factors were responsible for the observed effects previously, then this predicts that these effects will appear on tests 1 and 2 for these subjects, since the awareness instruction is assumed to be an inert factor in test 2, but the subject factors should continue to be active. Thus, it was reasoned that seeing an LOP reversal on both tests 1 and 2 would tend to support this view. However, observing findings on tests 1 and 2 that are similar to those previously found with the unaware and aware groups, should eliminate the subject factors argument.

Method

Subjects, Design and Materials

Fifty-six subjects were recruited from the same source used in Experiments 1 and 2, again all receiving course credit for their participation.

The experimental design consisted of a 2 (Test Instruction: unaware [test 1] vs. aware [test 2]) x 2 (LOP: nonsemantic vs. semantic) factorial arrangement, where both factors were manipulated within-subjects. The Test Instruction factor for the unaware (test 1) and aware (test 2) conditions was identical to those used for the aware and unaware groups in Experiments 1 and 2. The LOP study manipulation was identical to Experiments 1 and 2 (syllable counting and pleasantness rating).

The design and materials for the study phase were the same as Experiments 1 and 2. However, to reduce the number of counterbalancing requirements, only one of the two study lists was used. The word stem task was identical to the previous experiments, however, the overall design and administration had to be changed to accommodate the purpose of this experiment. This consisted of dividing the test phase into two parts (test 1, unaware, and test 2, aware), where one-half of the targeted studied items were assigned to each test. In the hopes of reducing overall awareness levels, only 12 of study items were included in each of the two tests (this was the same method used by Bowers & Schacter, 1990). Each test also contained 20 nonstudied filler items. This new design for the word stem task required an additional counterbalancing procedure, where all study items had to serve equally often in both tests 1 and 2. Otherwise, all other design features and counterbalancing requirements were equivalent to Experiments 1 and 2.

The post-test questionnaire methods used in Experiments 1 and 2 for the screening of awareness and intentional recall were extended to the within-subjects design. This involved only retaining subjects who indicated unawareness in test 1 (the equivalent of the previous unaware groups) and no recall strategies in test 2 (the equivalent of the previous aware groups). Thus, these selection procedures completely matched those in the previous experiments. Testing for this experiment continued until at least 24 subjects were able to meet these requirements. As before, this was conducted in a manner to comply with the counterbalancing requirements for this experiment.

Procedure

The study phase was identical to Experiments 1 and 2. Following this phase, test 1 of the testing phase began. In test 1, subjects were engaged in the word stem completion task. They were given the same unaware instruction that was used for the unaware groups in Experiments 1 and 2. After they completed this test, the awareness questionnaire (Appendix B) was administered. Immediately following this, test 2 began for all subjects. In test 2, subjects were once again given the word stem completion task. This test began with the same awareness instruction used for the aware groups in Experiments 1 and 2. Finally, when this test finished, the strategic recall questionnaire (Appendix C) was administered. As in the previous experiments, all test stimuli were presented individually on the computer screen (centered in standard upper case font), where a test trial was limited to 15 s, and all responses were entered on the keyboard. In each test, studied and nonstudied filler items were presented randomly, with a unique order for each subject.

Results and Discussion

Analysis of Questionnaire Responses

Of the 56 subjects participating in this experiment, 30 (54%) indicated that they were unaware of the study-test relationship. This rate is similar to Bowers and Schacter (1990), and it was also considerably greater than the rates of unawareness reported in the previous two experiments (where it ranged from 36% to 38%). This increase in unawareness is inconsistent with the notion that unawareness is due to the selection of subject factors, while it is consistent with an idea that unawareness is a function of a various design features (see discussion below).

Using the same data exclusion procedures employed in Experiments 1 and 2, only the data from the 30 unaware subjects were retained for the analyses of test 1 (unaware instruction) and test 2 (aware instruction). Since six of the 30 unaware subjects admitted using recall strategies in test 2, only 24 of these subjects were used. Thus, all of the analyses below were based on these 24 subjects, where the counterbalancing criteria were also satisfied.

Main Analyses

Table 9 displays the results of Experiment 3. Shown are the mean proportions of studied and nonstudied items correctly completed on the word stem task as a function of LOP and Test Instruction. It appears from an examination of this table that the results are very similar to the results of Experiments 1 and 2, where the between-subjects unaware-aware design was used.

Priming Analysis. For the priming analysis, the nonstudied completion rate was generated from 24 subjects from Experiments 1 and 2. Even though nonstudied items for all groups in these experiments did not differ, these rates were generated from the unaware subjects. The average completion rate for these items was .14. To assess priming, a one-way (Item Status: nonstudied vs. unaware, semantically studied vs. aware, semantically studied vs. unaware, nonsemantically studied vs. aware, nonsemantically studied) ANOVA was carried out. The ANOVA revealed significance for this factor, $F(4, 115) = 8.36$, $MSE = 0.19$, $p < .001$. Following

Table 9

Mean Proportions of Items Correctly Completed on the Word Stem Completion task in Experiment 3 as a Function of LOP and Test Instruction

	LOP		
Test Instruction	Nonsemantic	Semantic	Nonstudied
Unaware (Test 1)	.32	.21	.14
Aware (Test 2)	.37	.39	.14

up on this effect, the LSD statistic (.10) showed that all study conditions were significantly greater than the nonstudied (or chance) condition, with the exception of the unaware, semantic study condition. This shows once again that priming following semantic study was not significant when subjects were unaware, but was when subjects were aware, indicating an effect of awareness. However, in accord with the purpose of this experiment, since this change from nonsignificant to significant semantic study priming has now occurred with the same subjects, it argues against the view that this effect and the ones reported previously were due to the selection of a subject factors, thus leaving the awareness explanation.

LOP Analysis. Assessing these questions with performance on the LOP study variable, a 2 (Test Instruction: unaware [test 1] vs. aware [test 2]) X 2 (LOP: nonsemantic vs. semantic) ANOVA was conducted. The ANOVA showed a significant effect of Test Instruction, $F(1, 23) = 7.27$, $MSE = 0.26$, $p < .02$, and a nonsignificant effect of LOP, $F(1, 23) = 2.19$, $MSE = 0.13$, $p > .05$., qualified by a significant Test Instruction X LOP interaction, $F(1, 23) = 4.68$, $MSE = 0.13$, $p < .05$. As can be seen in Table 9, it appears that the basis of the interaction is a LOP reversal for the unaware condition (test 1) and a null LOP finding for the aware condition (test 2). The LSD (.08) did in fact show that there was no effect of LOP for the aware condition, while there was a significant LOP reversal for the unaware condition. This replicates the same dissociative pattern on this variable that has been previously attributed to awareness effects. Also, it appears that the major thrust of the awareness effect is again across the semantic study conditions (test 1 to test 2), where performance is nearly doubled for the aware test (see Table 9, t statistics were: $t(23) < 1.0$, nonsemantic; $t(23) = 3.41$, $p < .01$, semantic).

This replication of the previous findings with an unaware-aware within-subjects design appears to put a damper on the subject factors argument. As discussed, if the selection of subject factors produced the LOP reversal in the previous unaware groups, then using the same selection process (i.e., self-reporting of unawareness) here should have resulted in the selection of these same subject factors. This would imply that these subject factors were operating on performance in test 1 (unaware). Since test 2 (aware) is comprised of the same subjects, these factors would be carried over to test 2, where they still should be in operation. Thus, if subject factors were responsible for producing the LOP reversal in test 1, they should have produced this same effect in test 2, since the awareness manipulation here would not have affected them. However, since this did not occur, the LOP reversal nearly turned around in test 2 (where subjects were made aware), it strongly implies that the subject factors explanation is probably not correct. This then leaves the same awareness influence explanation that has been successful throughout, since the only real thing that has changed from test 1 to test 2 was their awareness.

Timing Analysis

Again, an analysis of the mean response times for the word stem task was carried out. Table 10 shows the mean

Table 10

Mean Response Times in Seconds for Items Completed on the Word Stem Completion task in Experiment 3 as a Function of LOP and Group

	LOP			
Test Instruction	Nonsemantic	Semantic	Nonstudied	*M*
Unaware (Test 1)	4.5	4.7	5.2	4.8
Aware (Test 2)	4.4	4.8	5.3	4.8
M	4.4	4.7	5.2	

response times on the word stem task in both tests 1 and 2 for nonstudied and studied items. It appears from the table that response times on the word stem task did not change from test 1 to test 2. The response time data were analyzed in a 2 (Test Instruction: unaware [test 1] vs. aware [test 2]) X 3 (Item Status: nonstudied vs. nonsemantically studied vs. semantically studied) ANOVA. This analysis showed that Test Instruction and Test Instruction X Item Status were not significant (F's < 1.0), indicating no differences in latencies across tests. Item Status was significant

($F[2, 46] = 14.12$, $MSE = 0.508$, $p < .001$), with the LSD statistic showing that latencies for nonstudied items were significantly longer than both nonsemantic and semantic studied items (LSD = 0.4).

This analysis seems to indicate that subjects did not begin to respond strategically when they were given the aware instruction in test 2. This extends the conclusion that awareness effects may have been due largely to involuntary processes.

Summary and Conclusions

The results of this experiment seem to rule out a subject factors explanation for the previous awareness findings. The subject factors view suggests that the differences between unaware and aware groups were not due to differences in awareness, but to differences in the selection of subject factors that resulted from the between-subjects awareness manipulation. However, when the same selection process was used with a within-subjects awareness manipulation, the same dissociative findings that were previously found with a between-subjects manipulation were found. This finding was critical evidence against the subject factors view because this view predicts that subject factors would have produced the same effects on both tests 1 and 2. In addition, the 54% rate of reported unawareness in this experiment was also a strong indicator of the unlikelihood of the subject factors view. An increase in unawareness is consistent with the idea that unawareness (or awareness) is generally a function of design features, and thus not necessarily determined by subject factors.

Some Cross-Experiment Observations on the Nature of Unawareness

There were a number of indicators in Experiment 3 that made the subject factors view an unlikely explanation. First, in that experiment, and in Experiments 1 and 2, unaware priming performance on nonsemantically studied items was robust. This result seems to argue against the notion that unaware subjects possessed some sort of performance deficit, since there is no reason why such a deficit would have reduced performance for semantically studied items only. Second, some 54% of the subjects in Experiment 3 reported unawareness. This is inconsistent with the subject factors view, since it is hard to imagine how such phenomena (performance deficits and chance responding) would be present for some one-half of all subjects participating in an implicit memory study. Third, this 54% represented a considerable increase in unawareness, where it was 38% and 36% in Experiments 1 and 2 (respectively). This is also inconsistent with the subject factors view since it would predict these rates should remain constant. However, this change in unawareness is consistent with a notion that unawareness (and thus awareness) is a function of elements of the experimental design.

While Bowers and Schacter (1990) reported a 50% rate of unawareness, many reports have shown unawareness rates to be near zero (e.g., Mace, 2000a; Richardson-Klavehn, Lee et al., 1994). This variability in unawareness seems to be related to a design feature that varied across these studies, the proportion of studied items used in the implicit task. These studies varied considerably along this dimension, where Bowers and Schacter used some 12% and Richardson-Klavehn, Lee et al. (1994) used up to 75% of their study items in the implicit task. This may be why unawareness varied in the three experiments reported here, since some 45% of the studied items were used in the word stem task in Experiments 1 and 2, while some 16% of them were used in Experiment 3 (similar to Bowers & Schacter who also obtained similar rates of unawareness). This suggests that unawareness may be due to various design features, like proportion of study items used in the implicit task, where such features may either increase (or decrease) the likelihood that subjects will notice the relationship between study and test items.

General Discussion

There is a long standing belief among implicit memory researchers that awareness has no effect on performance in implicit memory tasks (e.g., Bowers & Schacter, 1990; Richardson-Klavehn, et al., 1999; Richardson-Klavehn, et al., 1996). This view was based on a single set of results reported in Bowers and Schacter (1990), where overall levels of priming and the effects of LOP study did not differ on a word stem task between subjects who reported unawareness on post-experimental questionnaires and subjects who were made aware of the study-test relationship at the outset of the implicit task. The view has gained such wide influence that it has found its way into standard undergraduate texts on learning and memory (see most recently, Terry, 2000). However, the results of the present investigation question this view, by showing that awareness affected both the level of priming following semantic study and LOP study on a word stem completion task.

In all three experiments, following semantic study, unaware subjects showed negligible priming while aware subjects showed robust priming. In all three experiments, unaware subjects showed robust LOP reversals, while aware subjects showed null LOP outcomes. These effects occurred even when aware subjects were given suppression instructions.

These results are divergent from Bowers and Schacter (1990). Contrary to that study, the relative differences between unaware and aware subjects for semantic study showed that level of semantic study priming was influenced by awareness. The relative differences between unaware and aware subjects on the LOP variable showed that awareness had significantly influenced the results for this variable. It seems clear, then, that such relative differences show that, contrary to the prevailing view, awareness does influence performance on implicit tasks.

Bowers and Schacter (1990): What went wrong?

At the outset of this study it was remarked that it was not clear why Bowers and Schacter (1990) had obtained results that indicated that awareness had no effect on implicit memory performance, when several preliminary findings had indicated that it did (e.g., Mace, 1996; Mace, 2000a, b). It was suggested that their results may have been a single anomaly, possibly as a result of some unforeseen design flaw.

One possibility here is that the results for Bowers and Schacter's (1990) test-informed group may have been produced by a subject-mediated suppression effect. That is, the present investigator's experience with debriefing subjects following their participation in implicit tasks has shown that they often seem to confuse the concept of deliberate recall with spontaneous recollection. If this confusion occurred more than occasionally in Bowers and Schacter's test-informed subjects, they may have suppressed some of the responses that they had recognized from study, thinking that they were not to recall such words, as their test instructions indicated. Such a suppression effect would have resulted in the suppression of more semantic items than nonsemantic (since semantically studied items would be better recognized), thereby making their result look more like the unaware group. This conscious suppression may not have occurred for the aware subjects in this study, since test instructions may have prevented (or reduced) the likelihood of its occurrence (i.e., subjects were told never to suppress or consider the source of a response).

Whether Bowers and Schacter's (1990) results were due to this phenomenon, or this and some other factors, it is certainly possible that awareness effects might have been uncovered if further testing had been done. There is actually a hint of this possibility in Bowers and Schacter. In some of the later experiments they reported associative priming that was not significant for unaware subjects, while it was for aware subjects. For various reasons, Bowers and Schacter did not think that this finding represented an influence of awareness. However, in retrospect, it seems now that it probably was.

Indeed, the history of research into the effect of awareness is a curious one. Usually, when one gets a null finding, there is a quick return to the laboratory, armed with new methods, in search of positive results. It seems that the implications of awareness effects in the study of implicit memory may have made Bowers and Schacter (1990), and many other implicit memory researchers (including the present investigator), all too eager to overlook potentially positive findings in favor of a single negative result.

Awareness and the Task Purity Problem: Methodological Issues

> The problem with incidental tests [implicit] is not to rule out subjective awareness of past events, but to rule out contamination by voluntary retrieval strategies. We suggest, with others (e.g., Bowers & Schacter, 1990; Roediger & McDermott, 1993), that the surest method for minimizing the role for voluntary retrieval strategies in incidental tests is to inform subjects of the study-test relationship... but to emphasize that they should nevertheless adopt an

involuntary retrieval strategy. (Richardson-Klavehn et al., 1996, p. 147)

Although this viewpoint is certainly questionable now, it must be remembered that it was based on the results of Bowers and Schacter (1990). At that time, the issue of task purity was just beginning to be seriously considered in the literature. To be sure, the goal of all implicit memory researchers was to obtain as pure a measure of implicit memory as possible. It was well known that threats of contamination from explicit memory could come from the use of strategic recall. It was not known how awareness would affect implicit performance when subjects did not use recall strategies. The Bowers and Schacter report seemed to answer this question by showing that the effects of awareness were probably inert, leading researchers to believe that contamination threats came only from strategic recall. Thus, the test-informed method was born.

However, the evidence reported here suggests that awareness does influence performance on implicit tasks. And, since the differences between unaware and aware subjects on the various indices reported here were major, it seems clear that these influences are not trivial. This suggests that rather than decreasing explicit memory contamination, the test-informed method probably serves to increase it, since the instructions to subjects in this study not to use recall were either not effective or awareness had its own set of effects. It also seems clear that the influences of awareness are far too powerful for the test-informed method to have any chance of working, since robust awareness effects were obtained even under awareness suppression instructions.

Given the pervasive status of awareness in implicit memory studies (e.g., Richardson-Klavehn, Lee et al., 1994), it is probably now fair to say that awareness has regularly influenced the outcomes of many studies. The findings reported here give us some indication of that. The present finding for the unaware subjects (significant LOP reversals and nonsignificant semantic study priming) has not been reported elsewhere, unlike the findings for the aware subjects in this study which are routinely found (see Brown & Mitchell, 1994, for a review). In fact, while LOP never reached statistical significance for aware subjects here, LOP has often been reported as significant in the literature. This seems to suggest that awareness has had as much of an influence in past research as in the present study. Thus, it would seem that radically different methods for studying implicit memory should be given serious consideration.

Recently, it was remarked in the literature that the use of samples comprised solely of unaware subjects was probably too extreme a method for controlling explicit memory contamination (e.g., Mulligan, Guyer & Beland, 1999). On the contrary, the results of this study have shown that this would probably not be too extreme a method, since the case has now been made for the relative pureness of such samples as measures of implicit memory. Thus, considering all of the foregoing discussion, it would seem "that the surest method for minimizing the role" of awareness and deliberate recall strategies in implicit tasks may be to solely use unaware subjects. This may not be all that difficult a task.

For example, in Experiments 1 and 2, testing 71 to 78 subjects had yielded 27 to 28 unaware subjects. In Experiment 3, the testing of fewer subjects (56) had yielded even more unaware subjects (30). It was reasoned that these changes in the rates of unawareness (i.e., from approximately 33% to 54%) made it unlikely that unawareness was due to the adverse selection of subject factors, but appeared to be a likely function of various design features. That is, there are elements of the overall design that probably are more likely to make subjects think about their responses, and there are elements that probably distract them from these thoughts. There are also elements that probably make it more or less likely that subjects will spontaneously recognize that they are responding with studied items. While only one of these elements was varied here (proportion of study items used in the implicit task), many more can probably be identified (e.g., word frequency, use of distractor tasks, etc). However, since this element alone yielded 54% unawareness, it seems that combining this design element with other design elements could possibly increase rates of unawareness well beyond this level, so that the number of subjects that would need to be tested to secure an unaware sample would be greatly reduced. All of these considerations seem to make the idea of using unaware subjects a viable method.

Another method that may be used is an approach that was developed some time ago by Jacoby and colleagues (Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993), the *process dissociation procedure* (PDP). The PDP is a modelling approach where the influences of explicit and implicit memory are estimated from a collection of different testing conditions. However, the problem with this approach is that it has been the subject of numerous controversies ever since its inception; thus it has never been adopted as a standard for implicit memory testing (for reviews, see Reingold & Toth, 1996; Richardson-Klavehn et al., 1996). Also, considering the novelty of the current awareness findings, it is not clear how involuntary awareness influences may be handled by this approach. It may be better, if not more practical, for researchers who would consider using this method over the unaware method advocated above, to wait until some of these issues have been resolved.

Finally, the use of unaware samples appears to be theoretically intuitive. Recall that the concept of implicit memory was originally established with amnesic subjects (e.g., Warrington & Weiskrantz, 1970). Unawareness was a basis for the development of implicit memory theory since amnesic subjects are generally incapable of awareness of the study-test relationship, hence the term "memory without awareness" (see Milner, 1968, 1970 for poignant examples involving the patient H.M.). In fact, under a limited set of circumstances, in some of the early studies involving normal subjects unawareness was reported (e.g., Eich, 1984; Jacoby & Witherspoon, 1982). What is attractive about using the unaware samples method is that not only does it tend to more strictly comply with the criteria for establishing implicit memory, it also appears to emulate amnesia in normal subjects.

Awareness Influences: The Sources of Awareness Effects

As discussed at the outset of this study, it was reasoned that there were a number of possible accounts for the awareness effects. One broad account assumes that awareness has a causative role in the retrieval process that is independent of intentional recall. The other broad account assumes that awareness does not play a causative role in retrieval that is independent of intentional recall.

To reiterate the first account, there are two views where awareness can be seen as a post-retrieval or pre-retrieval event. The post-retrieval view is the current formulation of involuntary conscious memory (e.g., Richardson-Klavehn, Gardiner, et al., 1994; Schacter et al., 1989), where awareness that follows the retrieval of an item may indirectly affect the retrieval of items appearing later on the list. On the other hand, in the pre-retrieval view, awareness is seen as preceding item retrieval, thus being more capable of directly affecting it. In addition to the relative position of awareness, these views are also somewhat different in terms of the type of awareness they represent.

The post-retrieval view is recollective awareness (or memorial awareness), where I know that the response MONKEY to the stimulus MON_ was a word experienced earlier at study. The pre-retrieval view is nonrecollective awareness, where I know that the stimulus MON_ refers to a word experienced earlier at study. In the latter view, nonrecollective awareness can be seen as setting a context that acts on item retrieval at the point of the test stimulus, while in the former view, recollective awareness can be seen as setting a context that acts on item retrieval more globally.

To illustrate how the nonrecollective type of awareness may initiate retrieval, take the general semantic case where the knowledge that the stimulus MON_ refers to the name of a city triggers the automatic, unintended retrieval of MONTREAL. Now imagine the episodic case (as in implicit memory studies), where the knowledge that the stimulus MON_ refers to a word experienced at study triggers the automatic, unintended retrieval of MONKEY. In the case of recollective awareness, recognizing that MONKEY was a word experienced earlier may bring other studied words to mind, making it more likely that succeeding word stems will be completed with such words. In addition, recognizing a word from study may also set a global episodic context where potentially all of the words experienced at study can be reactivated, thereby increasing the likelihood that all word stems will be completed with studied words.

Concerning the second broad account, it was suggested that awareness effects may result from some subjects using intentional recall strategies, despite the contrary instructions. There were two views here: One, the

Machiavellian view, suggests that subjects surreptitiously use intentional recall, and then they are not truthful about it on a questionnaire. The second view suggested that subjects may not surreptitiously use intentional recall, but are unaware that they actually used recall strategies, because they are either confused about their nature, or they are unable to recognize having used such processes when they involve a low level of strategy. We may add one more to this list. Unlike the Machiavellian view, aware subjects may not be able to control their own recall processes. They may find that they cannot control themselves well, or from time to time, they find themselves using recall, only to stop themselves after it is too late.

As mentioned earlier, the views stated above are not mutually exclusive. Therefore, it is possible that any and all of them may be responsible for awareness effects. That is, we may imagine that all of the above phenomena act as a set to produce awareness effects. Or, we may imagine that awareness effects may be due to any number or combination of these phenomena. While the awareness effects reported in this investigation do not provide any evidence that would allow us to pick and choose between these various accounts, they may allow us to reach some fairly broad conclusions as to their relative contributions.

The fact that timings for the unaware and aware groups were similar to one another, and different from the longer intentional recall group timings, suggests that aware subjects were treating the task more like unaware subjects than intentional recall subjects. This seems to lend credibility to the view that involuntary memory processes contributed more to awareness effects than did strategic processes, since this looks more like implicit responding than it does strategic recall (because use of strategy should have increased overall response latencies).

The findings for the aware-ignore group also seem to suggest these conclusions. That is, if we believe that these subjects were largely successful at suppressing their awareness thoughts, then this infers that there must have been very little strategic recall occurring for this group. Since this group still showed a fairly large effect of awareness, we might further conclude that involuntary memory processes played a larger role in producing awareness effects than did strategic processes. We may even extend this idea to the aware group since the differences between this group and the aware-ignore group were negligible.

Thus, these observations seem to suggest a larger role for involuntary processes. Although they cannot suggest an exclusive role for involuntary processes, they do seem to argue against the suggestion that awareness effects are due exclusively to strategic processes. While they may suggest a larger role for involuntary processes, they do not allow us determine among the involuntary views. What is more, we may want to consider extending the boundary of involuntary processes to include unwanted and uncontrollable strategic recall processes. While this narrows the field in terms of volitional or intentional recall processes, it does not in any way suggest that strategic recall did not occur, only that their role was probably a smaller one.

Finally, these issues may be elucidated further with future work. At this time the only firm conclusion that can be made is the one that has been made throughout this study: That is, given the involuntary, uncontrollable nature of the phenomena discussed above, it seems fair to say that the study of implicit memory cannot be reliably conducted with aware subjects. However, on a positive note, these phenomena may offer some interesting possibilities for the study of explicit memory. For example, the idea that many involuntary processes may be associated with explicit memory suggests that the role of automaticity and intentional control may need to be rethought. Traditionally, there has been a tendency to place the emphasis on the role of intention in explicit memory. Working in this area may suggest some changes in these traditional viewpoints.

The PRS Account and Unaware Samples: Further Evidence and Extensions

As discussed previously, the PRS account (e.g., Schacter 1990, 1994) holds that various forms of perceptual implicit memory are mediated by a collection of systems whose functions are to setup, represent, and express various types of perceptual information, all operating at a presemantic level. The visual word form system is a PRS subsystems that is responsible for the representation of visual aspects of verbal stimuli. It is believed that priming on tasks such as word stem completion is an expression of both the acquisition and activation of perceptual representations in this system. In addition to the evidence the that PRS account has received from traditional cognitive approaches to implicit memory, it has also gained a considerable amount of independent evidence from neuroscience approaches to implicit memory.

For example, patients who show an inability to comprehend the meaning of written or spoken words (transcortical sensory aphasics, and word-meaning deafness patients), but who otherwise can read or repeat words, have shown intact priming performance on auditory and visual priming tasks such as word stem completion (e.g., Schacter, Rapscak, Rubens, Tharan, Laguna, 1990; Schacter, McGlynn, Milberg, & Church, 1993). Positron emission tomography studies have shown activation of distinct occipital cortex regions when subjects were engaged in visual word stem tasks, but not when they were engaged in explicit tasks (e.g., Buckner, Petersen, Ojemann, Miezin, Squire, & Raichle, 1995; Schacter, Alpert, Savage, Rauch, & Alpert, 1996; Squire, Ojemann, Miezin, Petersen, Videen, & Raichle, 1992). Patients with damage to these same cortical regions showed impaired priming on word stem tasks, but intact performance on explicit tasks (e.g., Carlesimo, Fadda, Sabbadini, & Castagirone, 1994; Gabrielli, Fleischmann, Keane, Reminger, & Morrell, 1996).

The findings for the unaware subjects reported here seem to accomplish two things for the PRS account. First, they appear to offer additional evidence in support of this type of theoretical framework. Second, these findings seem to shed some new light on this account, thus extending the PRS concept.

In the first case, consider that in the LOP study manipulation, the nonsemantic study task (syllable counting) requires that subjects focus more on the perceptual attributes of words than does the semantic study task (making pleasantness decisions). Since this implies that nonsemantic study should then involve a greater activation of perceptual representations than semantic study, the PRS account would predict the LOP reversal over the null LOP effect that has been typically reported. Thus, the LOP reversal found for the unaware subjects here can be considered as an additional piece of evidence for the PRS account. What seems to be important about this finding is that it appears to represent stronger evidence for the account than the null LOP findings that are generally found.

Moreover, in the second case, it seems that the unaware findings may extend the PRS view of implicit memory a bit further. Consider that the LOP study tasks used here probably involved relatively small differences in perceptual processing. However, they led to considerable differences in priming, where the priming effects for semantic study were negligible, relative to robust effects for nonsemantic study. This finding seems to extend the PRS concept, in that it suggests that the type of implicit memory being measured by the word stem task may be far more sensitive to variations in perceptual priming than was originally conceived by this concept (see Schacter, 1994).

Finally, as indicated throughout this study, it seems that the main reason why this type of evidence has not surfaced before is because previous studies were probably considerably contaminated with explicit memory processes. It may also turn out that when findings involving other variables and implicit memory tasks are rechecked with uniformly unaware samples, many more effects suggestive of a

PRS type of view will turn up, perhaps even with tasks that involve implicit memory phenomena that researchers have not considered in this manner.

Conscious Awareness: Looking Back in order to Look Ahead

The results reported here have uncovered some new evidence on an old question: The role of conscious awareness in memory. The findings appear to have implications for the role of awareness in both implicit and explicit memory. For implicit memory they have shown that awareness can influence primed performance on an implicit task. For explicit memory they have suggested some interesting possibilities for the roles of intention and awareness.

Thus, by looking back, this study may have helped to shape the direction of future research. Hopefully, it has given implicit memory researchers some guidelines on how to treat the issue of awareness in implicit memory studies. This may involve the development and refinement of an unaware samples method, or possibly some other method which is capable of managing the effects of awareness. Hopefully, when such methods are used in conjunction with past (and future) programs of research, some new insights into the nature of implicit memory will emerge, thus further enriching an already rich database.

Appendix A

Two study lists used in Experiment 1

Words targeted for the word stem task, filler, and primacy and recency buffer words (* indicates targeted word)

List 1	List 2
* BLOSSOM	* SLIPPER
* BUTCHER	* INSTRUMENT
* ELEPHANT	* PENCIL
* GARMENT	* PEANUT
* HAMMER	* REVOLT
* CABINET	* TORNADO
* MEADOW	* TELESCOPE
* WEAPON	* CAPTAIN
* RATTLE	* MUSICIAN
* COMRADE	* HEREDITY
* HARNESS	* FOREST
* MONARCH	* DESIGN
* MERCHANT	* FAMOUS
* ENVELOPE	* DISEASE
* MOUNTAIN	* SENATE
* INTESTINE	* FRAGRANCE
* SUBMARINE	* COSTUME
* BALLOON	* BRONZE
* ABSENCE	* POTATO
* PLATFORM	* DAMSEL
* SPARROW	* CARAVAN
* VOLUME	* UNICORN
* CULTURE	* OFFICER
* MODERN	* ENGINE
* PATIENT	* OCTOPUS
* SHELTER	* LADDER
* HUSBAND	* ESCALATOR
* BARREL	* LANGUAGE
* PINEAPPLE	* MATERIAL
* CANDIDATE	* PITCHER

(Appendix A continues)

* CONCERT
* FACILITY
RAILROAD
ANATOMY
HISTORIAN
PLIERS
ACCORDION
INSTRUMENT
TOPCOAT
MAIDEN
UMBRELLA
SILENCE
SHOTGUN
SNOWMAN
SALUTE
BEAVER
DOCTOR
COCONUT
PAINTER
TOASTER
ROCKET
DAYLIGHT
ALMANAC
VICTIM
BICYCLE
SCISSORS
FABRIC
LECTURE
AVOCADO
DOORKNOB
ASHTRAY
KANGAROO
FUNCTION
HELMUT
SAILBOAT
PUMPKIN
MACKEREL
CACTUS
WATERFALL
PYRAMID
NUTRIENT
GIRAFFE

* BASKET
* COTTAGE
RAILROAD
ANATOMY
HISTORIAN
PLIERS
ACCORDION
INSTRUMENT
TOPCOAT
MAIDEN
UMBRELLA
SILENCE
SHOTGUN
SNOWMAN
SALUTE
BEAVER
DOCTOR
COCONUT
PAINTER
TOASTER
ROCKET
DAYLIGHT
ALMANAC
VICTIM
BICYCLE
SCISSORS
FABRIC
LECTURE
AVOCADO
DOORKNOB
ASHTRAY
KANGAROO
FUNCTION
HELMUT
SAILBOAT
PUMPKIN
MACKEREL
CACTUS
WATERFALL
PYRAMID
NUTRIENT
GIRAFFE

Appendix B

Post-test questionnaire for the unaware group in Experiment 1

1. Were you aware that some of the words with missing letters (e.g., COM, in the last experiment) were made from the words you saw earlier in the syllable counting and pleasantness rating experiment?

Circle one:

Yes No

(If subjects responded yes to question 1, they then received the questions below on a separate form.)

2. When did you realize that some of the words with missing letters (e.g., COM) were made from the words you saw in the syllable counting and pleasantness rating experiment?

A. Circle one:

(1) Just now.

(2) After the last experiment was over.

(3) Near the beginning of the last experiment.

(4) Near the middle of it.

(5) Near the end of it.

B. If you circled #'s 3, 4, or 5, please try to recall the word that made you aware that some of the words from the first experiment were in the last experiment. Write your response here: ________________

(ONLY ANSWER QUESTION # 3 IF YOU CIRCLED 3, 4, OR 5 IN QUES. # 2.)

(Appendix B continues)

3. Did you ever try to recall (that is, actively search your memory for) some of the syllable and pleasantness words in order to complete the words with missing letters?

Circle one:

Yes No

Appendix C

Post-test questionnaire for the aware group in Experiment 1

1. When you were completing the words with missing letters, did you ever find yourself actively searching your memory for the words you saw earlier in the syllable counting and pleasantness rating session?

Circle one:

Yes No

If yes, continue with the rest of the questions. If no, go to question # 3 (i.e., skip # 2!).

2. If yes to question # 1, try to estimate how many times you did this:

A. Circle one:

(1) All the time.

(2) 1 or 2 times.

(3) 2 to 5 times.

(4) 5 to 10 times.

(5) 10 to 20 times.

(6) More than 20 times.

3. Did you ever not respond with a specific word that came to mind?

Circle one:

Yes No

If yes, briefly explain.

References

Bowers, J.S., & Schacter, D.L. (1990). Implicit memory and test awareness. Journal of Experimental Psychology: Learning, Memory, and Cognition, 16, 404-416.

Brooks, B.M. (1999). Primacy and recency in primed free association and associative cued recall. Psychonomic Bulletin and Review, 6, 479-485.

Brown, A.S., & Mitchell, D.B. (1994). A reevaluation of semantic versus nonsemantic processing in implicit memory. Memory and Cognition, 22, 533-541.

Buckner, R.L., Petersen, S.E., Ojemann, J.G, Miezin, F.M., Squire, L.R., & Raichle, M.E. (1995). Functional anatomical studies of explicit and implicit retrieval tasks. The Journal of Neuroscience, 15, 12-29.

Carlesimo, G.A, Fadda, L., Sabbadini, M. & Castagirone, C. (1993). Visual repetition priming for words relies on the access to the visual input lexicon: Evidence from a dyslexic patient. Neuropsychologia, 32, 1089-1100.

Challis, B.H., & Brodbeck, D.R. (1992). Levels of processing affects priming in word fragment completion. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18, 595-607.

Craik, F.I.M., & Tulving E. (1975). Depth of processing and retention of words in episodic memory. Journal of Experimental Psychology: General, 104, 268-294.

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

Gabrielli, J.D.E., Fleischmann, D.A., Keane, M.M., Reminger, S.L., & Morrell, F. (1995). Double dissociation between memory systems underlying explicit and implicit memory in the human brain. Psychological Science, 6, 76-82.

Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. Journal of Verbal Learning and Verbal Behavior, 23, 553-568.

Graf, P., Mandler, G., Haden, P. (1982). Simulating amnesic symptoms in normal subjects. Science, 218, 1243-1244.

Graf, P., & Schacter, D.L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11, 501-518.

Graf, P., Squire, L.R., & Mandler, G. (1984). The information that amnesic patients do not forget. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10, 164-178.

Jacoby, L.L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. Journal of Memory and Language, 30, 513-541.

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., Toth, J.P., & Yonelinas, A.P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. Journal of Experimental Psychology: General, 122, 139-154.

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

Lockhart, R.S., & Craik, F.I.M. (1990). Levels of processing: A retrospective commentary on a framework for memory research. Canadian Journal of Psychology, 44, 87-112.

Mace, J.H. (1996). Levels of processing effects in perceptual implicit memory tasks: Testing the deficient processing view. Unpublished Manuscript.

Mace, J.H. (2000a). Explicit memory contamination in implicit memory tasks: Still an unresolved issue. Manuscript in preparation.

Mace, J.H. (2000b). Explicit memory contamination in conceptual implicit memory tasks: Implications for theory. Study in progress.

Milner, B. (1968). Visual recognition and recall after right temporal-lobe incisions in man. Neuropsychologia, 6, 191-210.

Milner, B. (1970). Memory and the medial temporal regions. In K.H. Pribram & D.E. Broadbent (Eds.), Biology of memory (pp. 29-50). New York: Academic Press.

Mulligan, N.W., Guyer, P.S., & Beland, A. (1999). The effects of levels-of-processing and organization on conceptual implicit memory in the category exemplar production test. Memory and Cognition, 27, 633-647.

Rajaram, S., & Roediger, H.L.,III, (1993). Direct comparison of four implicit memory tests. Journal of Experimental Psychology: Learning, Memory, and Cognition, 19, 765-776.

Reingold, E.M., & Toth, J.P. (1996). Process dissociations versus task dissociations: a controversy in progress. In G.U. Underwood (Ed.), Implicit cognition (pp. 159-202). Oxford: Oxford University Press.

Richardson-Klavehn, A., & Bjork, R.A. (1988). Measures of memory. Annual Review of Psychology, 39, 475-543.

Richardson-Klavehn, A., Clarke, A.J.B., & Gardiner, J.M. (1999). Conjoint dissociations reveal involuntary perceptual priming from generating at study. Consciousness and Cognition, 8, 271-284.

Richardson-Klavehn, A., & Gardiner, J.M. (1995). Retrieval volition and memorial awareness in stem completion: An empirical analysis. Psychological Research, 57, 166-178.

Richardson-Klavehn, A., & Gardiner, J.M. (1996). Cross-modality priming in stem completion reflects conscious memory, but not voluntary memory. Psychonomic Bulletin and Review, 3, 238-244.

Richardson-Klavehn, A., & Gardiner, J.M. (1998). Depth-of-processing effects on priming in stem completion: Tests of the voluntary-contamination, conceptual-processing, and lexical-processing hypotheses. Journal of Experimental Psychology: Learning, Memory, and Cognition, 24, 593-609.

Richardson-Klavehn, A., Gardiner, J.M., & Java, R.I. (1994). Involuntary conscious memory and the method of opposition. Memory, 2, 1-29.

Richardson-Klavehn, A., Gardiner, J.M., & Java, R.I. (1996). Memory: Task dissociations, process dissociations, and the dissociation of consciousness. In G.U. Underwood (Ed.), Implicit cognition (pp. 85-158). Oxford: Oxford University Press.

Richardson-Klavehn, A., Lee, M.G., Joubran, R., & Bjork, R.A. (1994). Intention and awareness in perceptual identification priming. Memory and Cognition, 22, 293-312.

Roediger, H.L.,III, & McDermott, K. (1993). Implicit memory in normal human participants. In F. Boller & J. Grafman (Eds.), Handbook of neuropsychology (Vol. 8, pp. 63-131). New York: Elsevier Science.

Schacter, D.L. (1987) Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 501-518.

Schacter, D.L. (1989). On the relation between memory and consciousness: Dissociable interactions and conscious experience. In H.L. Roediger III & F.I.M. Craik (Eds.), Varieties of memory and consciousness: Essays in honour of Endel Tulving (pp. 3-14). Hillside, NJ: Erlbaum.

Schacter, D.L. (1990). Perceptual representation systems and implicit memory: Toward a resolution of the multiple memory systems debate. In A. Diamond (Ed.), The development and neural bases of higher cognitive functions (pp. 543-571). New York: Annals of the New York Academy of Sciences.

Schacter, D.L. (1992). Understanding implicit memory: A cognitive science approach. American Psychologist, 47, 559-569.

Schacter, D.L. (1994). Priming and multiple memory systems: Perceptual mechanisms of implicit memory. In D.L. Schacter, & E. Tulving (Eds.), Memory Systems 1994 (pp. 233-268). Cambridge, MA: MIT Press.

Schacter, D.L., Alpert, N.M., Savage, C.R., Rauch, S.L., & Alpert, M.S. (1996). Conscious recollection and the human hippocampal formation: Evidence from positron emission tomography. Proceedings of the National Academy of Sciences, 93, 321-325.

Schacter, D.L., Bowers, J., & Booker, J. (1989). Intention, awareness, and implicit memory: The retrieval intentionality criterion. In S. Lewandowsky, J. Dunn, & K. Kirsner (Eds.), Implicit memory: Theoretical issues (pp. 47-65). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schacter, D.L., McGlynn, S.M., Milberg, W.P., & Church, B.A. (1993). Spared priming despite impaired comprehension: Implicit memory in a case of word meaning deafness. Neuropsychologia, 31, 107-118.

Schacter, D.L., Rapcsak, S.Z., Rubens, A.B., Tharan, M., & Laguna, J.M. (1990). Priming effects in a letter-by-letter reader depend on access to the word form system. Neuropsychologia, 28, 195-210.

Shimamura, A.P. (1986). Priming effects in amnesia: Evidence for a dissociable memory function. The Quarterly Journal of Experimental Psychology, 38A, 619-644.

Squire, L.R., Ojemann, J.G., Miezin, F.M., Petersen, S.E., Videen, T.O., & Raichle, M.E. (1992). Activation of the hippocampus in normal humans: A functional anatomical study of memory. Proceedings of the National Academy of Sciences, 89, 1837-1841.

Terry, W.S. (2000). Learning and Memory. Needham Heights, MA: Allyn & Bacon.

Thapar, A., & Greene, R.L. (1994). Effects of level of processing on implicit and explicit tasks. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 671-679.

Toth, J.P., Reingold, E.M., & Jacoby, L.L. (1994). Toward a redefinition of implicit memory: Process dissociations following elaborative processing and self-generation. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 290-303.

Tulving, E., & Schacter, D.L. (1990). Priming and human memory systems. Science, 247, 301-305.

Warrington, E.K., & Weiskrantz, L. (1970). Amnesic syndrome: Consolidation or retrieval. Nature, 228, 629-630.

Wegner, D.M. (1994). Ironic process of mental control. Psychological Review, 101, 34-52.

Wegner, D.M., Schneider, D.J., Carter, S. III, & White, L. (1987). Paradoxical effects of thought suppression. Journal of Personality and Social Psychology, 58, 409-418.