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REVERSED LEVELS OF PROCESSING EFFECTS ON A PERCEPTUAL IMPLICIT MEMORY TASK: THE ROLE OF INVOLUNTARY AWARE MEMORY

by

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Abstract

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The present study provided an examination of memory processes governing a reversal of the level of processing (LOP) effect shown with implicit memory tasks. In two experiments, participants performed an LOP study task, then a word-stem completion task. The shallow (perceptual) task required counting syllables and the deep (conceptual) task required rating words for pleasantness. Results showed in both experiments a reversal of the LOP effect (RLOP) for the implicit processing groups. The RLOP effect was limited to the condition where words presented at test differed from those presented at study. In Experiment 2, the reversal was eliminated when participants performed semantic tasks with enhanced perceptual processing at study. These results are in line with the encoding specificity principle and transfer appropriate processing theory in that responses using an implicit memory task are in part mediated by the similarity in processing demands during encoding and retrieval.

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Reversed Levels of Processing Effects on a Perceptual Implicit Memory Task: The Role of Involuntary Aware Memory

It has been held for the last two decades that in human memory there is a dissociation between explicit memory (also known as conscious memory, declarative memory, or memory with awareness) and implicit memory (also known as non conscious memory, non-declarative memory, or memory without awareness: e.g., Hamberlandt, 1999; Neath, 2003).

According to Haberlandt (1999), explicit memory refers to the conscious recall of information, while implicit memory refers to the role of memory in the processing of items presented repeatedly. Neath and Surprenant (2003) distinguishes between explicit and implicit memory in terms of experimental method - explicit memory shown with direct memory tests that facilitate awareness of specific prior learning by instructing participants to rely on previously seen material, and implicit memory shown with indirect memory tests in which memory is expressed without awareness of specific prior learning by measuring performance changes (Warrington & Weiskrantz, 1970). Bjork and Bjork (1996) have made the distinction between test types and memory types with direct versus indirect tests defined by the instructions given to participants, and explicit versus implicit memory referring to memory with or without awareness, respectively.

Despite slight variations in the definition of these memory systems (or, according to Schacter & Tulving, 1994, expressions of memory), a consistently stated distinction between explicit and implicit memory has been the presence and absence of conscious awareness of the study-test relationship, respectively. Studies (see Mace, 2003a, 2003b, 2004) have pointed to an amelioration of memory performance in a priming task due to the awareness of the study-test relationship in the absence of intentional strategizing. Even in the wake of study-test awareness (see Mace, 2003b), an LOP manipulation has often been found to produce differences in memory performance between explicit and implicit memory procedures manifesting as better memory performance for more semantically encoded material than nonsemantically encoded material with explicit tests. With implicit tests, there is generally no benefit gained to semantically processing material, especially when awareness of the study-test relationship exists (Mace, 2003b). The present study examined the role of awareness of the study-test relationship on explicit, and in particular, implicit memory with manipulations of processing (LOP) during a priming task to determine the differential and possible interaction effects of this study-test awareness.

Evidence for the distinction between explicit and implicit memory is based on a variety of direct and indirect methods that are intended to affect one of the two forms of memory. In an explicit memory task, informing participants to intentionally recall material presented during a prior study episode generally facilitates awareness of the study-test relationship. These studies may require retrieval of target items in a serial or free recall manner, or an old/new word-recognition task. Of necessity, these tasks explicitly ask participants for recall of items studied.

With an implicit memory task, reducing awareness of the study-test relationship is accomplished by providing instructions that do not make reference to the study list. This has often been shown in studies that involve one of three forms of learning: priming, acquisition of motor skills, and classical conditioning (Baddeley, 1998; Squire, Knowlton, & Musen, 1993; Warrington & Weiskrantz, 1970). Priming is most widely used and first presents participants with a word list at study (e.g., HORSE, WALNUT, etc.). During testing, participants are presented with part of the words, or letters from words, presented in the study list (e.g., word-stem completion, WAL_; or word-fragment completion, W_L_UT; for WALNUT). The purpose of presenting partial words is to provide retrieval cues while preventing any deliberate recall or spontaneous awareness of the study-test relationship. Reducing the possibility of participant awareness of the study-test relationship is presumed to result in a "pure" implicit task. Researchers have assumed that when participants are unaware that they are performing a memory task they are not using intentional recall strategies (Baddeley, 1997). Evidence for implicit memory is confirmed by the facilitative effect a previously seen stimulus has on subsequent memory performance (i.e., the amount of priming) participants exhibit for target words. Stimuli that are presented at study generally result in greater identification of target items at test than when no stimuli are presented.

Before describing the present hypotheses based on theoretical accounts of explicit and implicit memory, a set of empirical criteria is required to specify appropriate levels of inference about explicit and implicit memory. More specifically, criteria for distinguishing between memory processes and memory systems are required. In line with the aforementioned multiple definitions of explicit and implicit memory, different terminology has been used to describe the cognitive constructs surrounding these forms of memory (see Neath, & Surprenant, 2003, pp 464) defines a memory system as "a theoretical structure that is responsible for retaining a specific type of information and is functionally distinct from other memory processes."

Empirical criteria for determining the presence of separate memory systems were proposed by Sherry and Schacter (1987) as well as by Schacter and Tulving (1994) who claim that to define different memory systems there must first be evidence of different brain structures (neural substrates) that mediate each process followed by functional dissociations (i.e., having an effect on one variable, but no effect or interaction with another variable). Further, performance that taps into one memory system that cannot be associated with performance that would tap into another memory system is part of their criteria. And finally, something that Sherry and Schacter call "functional incompatibility" in which two different types of memory cannot be encoded, stored, or retrieved, by the same memory system. Schacter and Tulving actually propose five memory systems (see Table 1) and at least 12 memory subsystems. A discussion of each theoretical memory subsystem is beyond the scope of this project; however, a detailed explanation of the perceptual representation system (Tulving & Schachter, 1990; discussed below) coincides with the purpose and theoretical implications of the present study.

Other theorists (e.g., Blaxton, 1989) point to dissociations in the type of memory processes (e.g., forms of encoding, storage & retrieval) that govern different forms of memory, rather than dissociations between memory systems. One processing based model, the transfer appropriate processing model (TAP; Blaxton; Roediger, Weldon, & Challis, 1989), is similar to the encoding specificity principle. TAP is based on four assumptions. The first is that certain types of encoding lead to differential performance in memory depending upon the amount of transfer of processing (e.g., positive or negative) between study and test. In other words, performance at test is ameliorated when the cognitive operations exercised at study are duplicated at test (positive transfer) and attenuated when those operations aren't (negative transfer). Their second assumption is that direct and indirect memory tests (explicit and implicit, respectively) necessitate different retrieval strategies; explicit being a controlled or voluntary process and implicit as a more automatic or involuntary process. Third, and of most importance for the current study, indirect (implicit) tests of memory operate on a presemantic basis (e.g., procedures that are processed using structural information of stimuli, see Jacoby, 1983), and, the fourth is that direct (explicit) tests of memory rely on semantic information of a word (i.e., word meaning).

One or more memory processes can be constituents of either a single "system" or of several "systems." Differences in memory performance along a given memory measure, in the absence of the aforementioned empirical criteria for different memory systems, would lead to a theoretical model with a single memory system that mediates two or more memory processes (e.g., Kolers, 1976). Several researchers have used a processing approach to distinguish explicit from implicit memory (e.g., Craik, 1983; Graf & Mandler, 1984; Light, 1991; Masson & McCleod, 1992). For example, Roediger & Srinivas (1993) argue that conceptual and perceptual encoding processes govern the distinction between explicit and implicit memory. They state that conceptual encoding better mediates explicit memory performance and perceptual processing better mediates implicit memory performance. The present study will pursue the explicit-implicit dichotomy via a processing perspective that is in line with Roediger and Srinivas (1993). Finally, a memory system should not be confused with a memory task, i.e., what is generally required of the participant in terms of instructions and performance. An analysis of explicit and implicit memory is presented below.

Explicit Memory: Awareness and Intentionality of Retrieval

More than half a century ago, human memory was compartmentalized or fragmented into different systems. The first distinction in memory processes, drawn by Hebb (1949), proposed that short-term and long-term stores existed in human memory. Short-term memory (STM) is defined as a representation of a limited amount of information (Milner, 1966) that is currently in active use (Atkinson & Shiffrin, 1968). Information in STM is forgotten without additional processing of the material such as maintenance/elaborative rehearsal or other mnemonic techniques (e.g., chunking information or association). Information that does receive additional processing is stored in a long-term memory (LTM) store. LTM has shown no limits in capacity or in duration of information storage. Retrieval is the process of drawing information from memory. The two types of retrieval tasks are recall and recognition. In free recall, a general cue is used to retrieve information associated with the cue (e.g., as when we attempt to recall a name associated with a face or when we answer an essay question). For recognition, an item is presented that is either the same as or different from stored information. The participant determines whether the item was a member of the previously presented stimulus set by responding yes or no (e.g., as when we recognize a face we have seen before or answer multiple-choice questions on a test).

Evidence for the distinction between STM and LTM was derived from the serial position effect (Glanzer & Cunitz, 1966) and from studies demonstrating that information is rapidly forgotten (memory decay) when rote memory strategies are prevented from being used (Brown, 1958; Peterson and Peterson; 1959). For example, the serial position effect reliably shows that during free recall of a previously presented word-list, participants show greater memory for the first few words presented and the last few words presented than those in the middle of the list. It is generally assumed that memory for the first few words in the list reflects active processing of those words (e.g., via rote memory, the primacy effect) that results in the storage of those words in LTM, and memory for the last few words in the list reflects the storage of those words in STM at the time of testing (i.e., the recency effect). Items in the middle of the list are not recalled as frequently due to interference.

Additional evidence leading to a fragmentation view of STM and LTM was derived from studies involving patients with neuropsychological disorders. For example, patients with classic amnesic syndrome typically show no deficits in STM tasks but evidence marked impairment in LTM tasks (Baddeley & Warrington, 1970; Milner, 1966).

Research with amnesic patients also provides initial evidence for the further fragmentation of memory. In one such study, Tulving and Donaldson (1972) delineated two systems still referred to as semantic and episodic memory. Tulving (2002) defines semantic memory as our basic factual knowledge about the world (e.g., names of objects, simple math skills, impersonal information, etc.) and episodic memory as an autobiographical record of personal experiences connected to a time and a place. The distinction between the two seems to be one based on the effort that goes into retrieval of either type. Tulving argues that semantic memory involves a more automatic process and episodic memory involves a more active process. Furthermore, context, or the circumstances under which one encodes these memories, seems to be lost with semantic memories. For instance, an individual would be hard pressed to recall when or where addition had been learned $(2 + 2 = 4)$, a decidedly semantic memory. With episodic memories, context remains intact (e.g., a personal event such as recalling one's first kiss). Tulving and Donaldson determined that amnesic patients clearly showed a deficit in retrieval of newly formed episodic memories in the absence of deficits for semantic information. More recent studies have shown that amnesic patients successfully perform on semantic tasks that don't require recollection of a prior learning experience, but show a complete lack of insight on episodic tasks that do require such recollection (Schacter & Tulving, 1994; Squire, Knowlton, & Musen, 1993). Collectively, episodic and semantic memory have been dubbed declarative or explicit memory (Schacter & Tulving).

Schacter (1989) has referred to explicit memory as the intentional recollection, or volitional retrieval, of material presented during a learning episode indexed by performance on typical recall and recognition tasks. The participant operates with awareness of the relationship between the material presented at study and later at test. Awareness of the study-test relationship is generally facilitated for the participant by way of retrieval instructions (e.g., subjects are instructed to try to recall or recognize items that were previously seen), and by tasks that require additional processing of the study list during its presentation. The latter tasks vary in the degree of cognitive processing demands. Some tasks place few cognitive processing demands on the participant (e.g., counting the number of vowels in a word, or the number of syllables). Tasks such as these have been termed perceptual tasks. Other tasks place greater cognitive processing demands on the participant (e.g., determine whether a word represents a living thing or nonliving, or rate a word for pleasantness based on its meaning). Tasks such as these have been termed conceptual tasks (Roediger & Srinivas, 1993). Blaxton (1989) and others (e.g., Jacoby, 1983; Roediger, 1990) state that in an effort to consciously retrieve material, participants will draw on conceptually meaningful information from the stimuli presented. This notion is primarily based on explicit memory studies with normals who demonstrated greater memory performance under conceptual than perceptual tasks.

However, continued probing into amnesic patients using priming and other implicit memory procedures have led investigators (e.g., Squire, 1992) to the discovery of memory in the absence of conscious retrieval strategies. These patients are assumed to be using implicit memory. Research that describes implicit memory is discussed below. This is followed by a comparison between the effects of conceptual and perceptual tasks on explicit and implicit memory tests.

Implicit Memory

Evidence of implicit memory has been demonstrated via studies that have attempted to prevent participants from becoming aware of the study-test relationship (e.g., a priming task). To accomplish this, participants are instructed to perform a task that allows for a measure of memory without drawing the participants' attention to information presented at study.

Research on the effects of priming has contributed substantially to the implicit memory literature. For example, with a word-fragment priming task, amnesic patients show greater retention than with a basic recall task (e.g., Milner, 1966; Warrington & Weiskrantz, 1968; 1970). In these studies, the patients were not able reliably to recall the list of words. However, when given a word-stem completion task (e.g, HOR__, for HORSE), participants were able to complete the stems with words from the original list.

Similar priming effects have also been shown in normals (e.g., Brown & Mitchell, 1994; Challis & Brodbeck, 1992; Roediger & McDermott, 1993). Participants are typically given limited cues at test (as in the word-stem completion task), and then they are instructed to respond with the first thing that comes to mind. The degraded stimulus (e.g., word-stem or word-fragment) seems to activate neural underpinnings of memories for which the participant is unaware. According to Brown & Mitchell (pp 533), "The measures used in implicit memory tests, along with their results, have included decreased relearning time, lowered perceptual threshold, faster naming and reading latencies, and increased likelihood of word-puzzle solutions (word-fragments, word-stems, and anagrams)".

Another, quite salient, feature of implicit memory is that it is considered to be based on the processing of the form and structure of a word, rather than a word's meaning (see Schacter, 1996). This process is evident for example, in reading, i.e., the faster recognition of frequently experienced written material without the same level of effort required with explicit processing (i.e., intent to retrieve material). Schacter and Tulving (1994) argue that this form of nonsemantic processing is mediated by a perceptual representation system (PRS).

Schacter, Wagner, and Buckner (2000) argue that the PRS operates on a non-declarative (implicit) level. "This [separate] system is important in the identification of words and objects but is non-declarative in the sense that it is involved in non-conscious operations," (Neath & Surprenant, 2003, p. 153). Schacter (1994) proposes that the PRS consists of three subsystems: visual-word-form, auditory-word-form, and structural description (Schacter & Tulving, 1994). All of these systems are assumed to operate on a presemantic basis, without awareness of previously presented material. In comparison, more direct, or explicit tests of memory are assumed to operate on a semantic basis, with awareness of previously presented material.

The visual-word-form system is most pertinent to the current study, in which visual stimuli are presented to participants. One line of evidence for the existence of the visual-word-form system, comes from data collected with amnesic patients (Graf, et al., 1984). Studies like Graf et al. and Warrington and Weiskrantz (1974) reveal priming in patients for visually presented word pairs and familiar words. That is, amnesics perform at the same level as normal participants on stem and fragment completion tests, despite performance deficits in explicit processing tests (i.e., direct recognition or recall tests). Other studies with normals (Bowers & Schacter, 1990; Craik & Tulving, 1975; Graf & Mandler, 1984; Jacoby & Dallas, 1981; Roediger, et al., 1992), manipulated levels of processing with a visual implicit memory test (e.g., stem completion). Results showed no benefit (i.e., enhanced priming) of processing words deeply (conceptually). In explicit memory tests, this same manipulation does show a consistent benefit of a deep, or conceptual task (e.g., rating the word for pleasantness based on its meaning) versus a shallow, or perceptual task (e.g., counting the number of syllables in a word). Assuming that the PRS subsystems rely on presemantic processing, these findings, taken together, suggest that the expression of implicit memory (e.g., priming) is also presemantically processed (Schacter & Tulving, 1994).

Consistent with TAP, studies that examine different types of encoding (conceptual versus perceptual) and different memory tests (e.g., direct versus indirect) find that when encoding and retrieval processes match, memory performance improves (e.g., Blaxton, 1989). The TAP model predicts that the type of encoding process is as important as the type of test used. For example, Fisher and Craik (1977) found that a rhyming task at study, followed by a rhyme cue at test, resulted in better memory performance than a semantic task at study followed by a rhyme cue at test. The rhyming task at study may ask a participant to rhyme "METAL" with "KETTLE," the target word (i.e., perceptual processing). Later, at test, the participant may be asked to rhyme "PETAL" with the target word, "KETTLE." This is in comparison to the semantic task (e.g., "The _________ of tea began to whistle," calling upon conceptual processing). The preceding example indicates that perceptual encoding (the rhyming task) versus the semantic task enhances priming for a presemantically driven test (the rhyme cue).

Likewise, Fisher and Craik (1977), and others (Morris, Bransford, & Franks, 1977; Tulving & Thomson, 1973), have found a benefit of deeply (conceptually) encoding material (e.g., "The ________ of tea began to whistle.") on measures of explicit memory, further supporting the TAP theory. It should be noted that no one type of processing (i.e., either perceptual or conceptual) will lead to the best performance on every test. The point is that encoding and retrieval processes need to be comparable with each other. According to Bransford, Franks, Morris, and Stein (1979), encoding activity is transferred to retrieval activity and the greater the positive transfer of activity, the better memory performance will be. Positive transfer means that is if a similar cognitive process is used during both encoding and during retrieval, memory performance is enhanced in a memory task.

Tulving's (1983) encoding specificity principle encapsulates a similar notion in that the degree of match between cued and studied events largely determines the probability of memory retrieval. For instance, Tulving has shown that for some tests (e.g., recognition versus recall with a paired-word-associates paradigm), a weak cue leads to better memory performance than a strong cue. For example, GLUE was paired with CHAIR at study, a decidedly weak association. In a recognition test, a stronger cue to CHAIR (e.g., TABLE) was provided. Participants failed to recognize that CHAIR was on the study list. However, with a recall test, when the weak cue (e.g., GLUE) was provided, participants successfully retrieved the word CHAIR. These findings are consistent with the encoding specificity principle suggesting that it was the match of processing (be it perceptual or conceptual) between encoding and retrieval, and not the semantic level of processing that enhanced memory performance. The current study aims to further support these theories (i.e., TAP, encoding specificity principle, and PRS) by showing amelioration of memory performance for perceptually processed material.

One weakness in testing hypotheses based on the TAP and the encoding specificity principle is the presence of spontaneous awareness of the study-test relationship in certain participants (see Neath & Surprenant, 2003). While appropriately matched processes seem to facilitate memory performance, different levels of encoding (see Lockhart & Craik, 1990) material have also shown differential effects on explicit and implicit memory. The following section provides a comparison of LOP effects between explicit and implicit memory tests. This is followed by a discussion of the role of awareness in implicit memory tests.

Levels of Processing: A Functional Dissociation Between Explicit and Implicit Memory

The explicit-implicit dichotomy is often found in studies that vary LOP during presentation of a study list by instructing participants to perform different tasks (e.g., Brown & Mitchell, 1994). During an LOP manipulation participants may be given verbal important as the type of test used. For example, Fisher and Craik (1977) found that a rhyming task at study, followed by a rhyme cue at test, resulted in better memory performance than a semantic task at study followed by a rhyme cue at test. The rhyming task at study may ask a participant to rhyme “METAL” with “KETTLE,” the target word (i.e., perceptual processing). Later, at test, the participant may be asked to rhyme "PETAL" with the target word, “KETTLE.” This is in comparison to the semantic task (e.g., "The _________ of tea began to whistle," calling upon conceptual processing). The preceding example indicates that perceptual encoding (the rhyming task) versus the semantic task enhances priming for a presemantically driven test (the rhyme cue).

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Tulving's (1983) encoding specificity principle encapsulates a similar notion in that the degree of match between cued and studied events largely determines the probability of memory retrieval. For instance, Tulving has shown that for some tests (e.g., response latencies. Participants spent more time retrieving perceptually processed material.

The LOP effect however is not reliably found with implicit measures (although priming is still shown in most studies). For instance, word-stem completion has often failed to exhibit an LOP effect for implicit tests (Graf & Mandler, 1984; Graf, Squire, & Mandler, 1984; Jacoby & Dallas, 1981; Richardson-Klavehn & Bjork, 1988; Roediger & McDermott, 1993; Shimamura, 1986; Tulving & Schacter, 1990). Graf, et al. (1982) clearly illustrated this by manipulating LOP conditions (e.g., counting vowels versus rating words for pleasantness based on their meaning). Participants were given either a word-stem completion task (implicit test) or a free recall task (explicit test) and as anticipated, only the free recall group showed an LOP effect. Other implicit studies have shown a significant LOP effect (see Brown & Mitchell, 1994; Challice & Brodbeck, 1992; Hamann & Squire, 1996).

One reason for the mixed LOP effects in implicit tasks can be understood in terms of the TAP theory and the encoding specificity principle. Unlike explicit memory procedures that present either perceptual (presemantic) or conceptual (semantic) tasks at study and conscious recall at test, implicit memory procedures present either perceptual or conceptual tasks during study and unintentional recall at test (Roediger & Snivinas, 1993). According to the encoding specificity principle and TAP, the LOP effect shown with explicit tasks (i.e., greater memory for conceptually than perceptually processed words) results from a better match between processing at encoding and processing at retrieval for the words that are conceptually processed than those that are perceptually processed (Tulving & Osler, 1968). Accordingly, the absence of a reliable LOP effect in implicit memory tasks results from a mismatch between the processing demands at encoding and retrieval for conceptually processed words. Unlike explicit memory tests, no gain is seen with words conceptually processed at study, because implicit tests call on the participant to tap into a differently driven system at test (i.e., perceptual processes at encoding).

Another explanation for the mixed results in LOP effects with an implicit memory task may be the circumstances under which participants are tested. Although implicit tasks are designed to differ from explicit tasks by reducing awareness of the study-test relationship, it is not unlikely that some participants determine that the information in the study list is relevant to responding in the retrieval phase (Brown & Mitchell, 1994; Schacter, 1989). Thus, the inconsistent LOP findings with implicit memory tests, may reflect a variability in the proportion of participants that become aware of the study-test relationship across studies. A discussion of this phenomenon follows below.

Involuntary Aware Memory: A Potential Contamination of Implicit Measures

An increase in the probability that participants use intentional recall during an implicit memory task has been called explicit memory contamination (e.g., Mace, 2000; 2003a). This spontaneous awareness of the study-test relationship may lead participants to employ deliberate recall strategies, and hence not perform the task implicitly. However, it should be noted that conscious awareness of the study-test relationship does not necessarily result in the use of such strategies (see Mace, 2003b). The following is a discussion of research examining the role of study-test awareness in implicit memory studies.

Owing to the aforementioned concerns over the purity of implicit tasks, researchers have investigated factors that may result in conscious awareness in such tasks (Bowers & Schacter, 1990; Mace, 2000; 2003a; 2003b; 2004; Richardson-Klavehn, Gardiner, & Java, 1994; Roediger & Blaxton, 1987b; Roediger & McDermott, 1993; Schacter, Bowers, & Booker, 1989). Consistent with explicit memory performance, Bowers and Schacter found that aware subjects evidenced an LOP effect on implicit measures while the unaware subjects did not when performing a word-stem completion task (e.g., REA__, for REASON). Half of their participants were given intentional study instructions at test (test aware group), and the remaining half were never informed that their memory was to be tested (test unaware group). In relation to traditional LOP findings with implicit measures, their interpretation of this study was that aware subjects must have modified their retrieval strategy from an automatic, implicit process to one of intentional retrieval. This conclusion was based on an assumption without having empirically confirmed that participants indeed switched retrieval modes (i.e., participants were never asked if they adopted intentional recall strategies).

In the prior mentioned study, Bowers and Schacter (1990) separated unaware from aware groups on a word-stem completion task. Their condition, the test-informed group, advised participants of the study-test relationship but admonished them from using intentional recall strategies. The purpose was to render study-test awareness in these participants, but prevent them from explicitly contaminating the implicit task. The results of this manipulation yielded no significant LOP effects for either test-informed or the unaware groups as compared to their explicit (i.e., intentional retrieval) group. Their conclusion was that mere study-test awareness lacks an independent influence over task performance (i.e., any LOP effects found in implicit tasks are attributed to explicit contamination). A number of studies have reported a small trend toward LOP effects with implicit measures (e.g., Graf & Mandler, 1984; Graf, Mandler, & Haden, 1992; Jacoby & Dallas, 1981). As stated earlier, one implication is that participants become spontaneously aware of the study-test relationship and begin to employ deliberate recall strategies (explicit contamination). This intentionality of recall contaminates the intended implicit nature of such tasks. Richardson-Klavehn, et al. (1994), have referred to the spontaneous awareness for the study-test relationship as "involuntary conscious memory." Others (e.g., Kinoshita, 2001) have coined the term, "involuntary aware memory," (IAM).

Mace (2004) defines IAM as the re-experiencing of the study episode at test that interacts with the test cues during a priming task such that more studied items are automatically brought to mind. Based on the work of Bowers & Shacter (1990), Mace (2000; 2003a; 2003b; 2004) has extensively addressed the concern that normal participants frequently report becoming aware of the study-test relationship. Mace (2003b) used a post-test questionnaire to determine if aware participants did use intentional recall strategies on priming tasks. The main objective in Mace (2003b) was to compare the aware participants who did not elect to use intentional recall to the unaware participants (those who were given standard implicit instructions) on a conceptual priming task (e.g., generation of categories). This comparison was accomplished via the post-test questionnaire in which participants were asked if deliberate memory strategies were employed. Those participants who reported using a memory strategy were excluded from analyses. Aware participants showed more priming in the semantic processing condition than did unaware participants. This is consistent with Bowers and Schacter

(1990) for aware subjects. However, at post-test the questionnaire of aware participants revealed that no intentional retrieval strategies were knowingly employed.

A similar finding was shown in Experiment 1 of Mace (2003b) with a perceptual priming (i.e., word-stem completion) task in that the aware group evidenced more priming for semantic (e.g., rating words for pleasantness) than nonsemantic (e.g., counting syllables) processing. Again, a post-test questionnaire was employed, which determined that aware participants did not adopt intentional retrieval strategies. Mace (2003a; 2003b) compared three groups of participants, all selected with the post-test questionnaire method; those who remained unaware of the study-test relationship, those who became spontaneously aware, and those who were test-informed (i.e., told that items from study would reappear at test). Mace (2003b) found that both the informed and aware groups showed significantly more priming than the unaware group. Mace (2003b) has interpreted these findings to suggest that awareness of the study list may occur independently of the conscious effort to remember, or in combination with intent to remember, despite instructions to avoid such strategies or the claim made at post-test by participants that no intentional strategies were used. The effect of spontaneous awareness indicates the necessity to better understand and control for this factor in implicit memory studies.

The most unexpected finding in Mace (2003b) was shown by the unaware group who displayed a new pattern of priming not previously reported in the literature: they had enhanced priming effects for the nonsemantic task over the semantic one, an actual reversal of the LOP effect (discussion in detail below).

Spurred on by the work of several researchers (e.g.; Richardson-Klavehn, et al., 1994; Schacter, et al., 1989), Mace (2000; 2003a; 2003b; 2004) has investigated the phenomenon of IAM as a distinct memorial process of explicit memory. Unlike the classic Warrington and Weiskrantz (1968; 1970) studies with amnesic patients who show no awareness of a prior learning episode while they evidence priming, normals in the above-mentioned studies report awareness of the study-test relationship. Spontaneous awareness may also account for the reason that some studies report a small (albeit nonsignificant) LOP effect in implicit tasks (see Brown & Mitchell, 1994). In two recent studies, Mace (2003a; 2003b) compared priming among three types of groups: participants who reported spontaneous word recollection (study-test aware), those participants who reported no spontaneous word recollection (study-test unaware), and those who were told a priori that they might experience spontaneous word recollection during a priming task (study-test informed). In both studies, only the study-test aware and study-test informed groups showed significantly greater priming as compared to the study-test unaware group. Further, participants in the study-test unaware group (Mace, 2003b) failed to show priming for words presented in the semantic study condition. These results indicate that IAM plays a causal role in priming and suggests that priming may not occur without the benefit of spontaneous awareness.

Most researchers (Rajaram & Roeidger, 1993; Richardson-Klavehn, Clarke, & Gardiner, 1999; Richardson-Klavehn & Gardiner, 1998; Weldon, Rodiger, Beitel, & Johnston, 1995;) would agree that participants in implicit memory tasks frequently do become spontaneously aware of the study-test relationship but evidence shows that intentional strategies are not always used as a result of this awareness (see Kinoshita, 2001). For example, Mace (2003b; 2004) found that response latencies were not significantly longer for aware participants than for unaware subjects and don't even approach the reaction times for those individuals participating in explicit memory tasks. Longer reaction times are generally indicative of effortful and intentional retrieval strategies (see Mace, 2003b). Accordingly, the findings in Mace (2003b) suggest that aware participants did not use such strategies, in addition to the questionnaire responses they gave.

Mace (2003b) was able to replicate Bowers and Schacter's (1990) outcome for aware participants (i.e., there was no significant LOP effect, but there was significantly more priming). However, one of the concerns Mace had for his earlier work (2003a; 2003b) was that no experimental manipulation was used to control for study-test awareness. Methods currently used to study IAM determine awareness status with questionnaires administered after the priming task. Limiting the selection of participants based purely on a post hoc basis potentially contaminates the results with a participant selection bias. For example, participants who evidenced little priming might have reported study-test unawareness (and visa versa) because of subjective monitoring of their performance on the test. In other words, they may have claimed not to have become spontaneously aware of the study-test relationship in retrospect (i.e., upon responding to questionnaire items) simply because they performed with low priming rates. On the flip side, those participants who evidenced higher priming rates may have subsequently claimed spontaneous awareness because of their completion rate. This methodology has created lingering doubts as to the causal function IAM has on priming tasks.

To investigate participant awareness in a more empirical manner, Mace (2004) adopted a novel experimental manipulation whereby one condition duplicated the study events by presenting participants with the exact study list at test (same-list condition), and another condition reducing awareness by using a different list (different-list condition; refer to Appendix B of the current investigation). By maximizing word recognition for the same-list group (called the old-whole-word group), and minimizing it for the different-list group (called the new-whole-word group) Mace found a higher completion rate for the same-list participants versus the different-list participants (i.e., the aware group showed higher priming rates for semantic processing) replicating a pattern seen in studies using post-test questionnaire methods (Bowers & Schacter, 1990; Mace, 2003a; 2000b). This is analogous to spontaneous study-test awareness that has been reported in the literature because the participant is literally "re-experiencing" the study environment. Through this manipulation, the laboratory analogue to spontaneous awareness should theoretically have the same effect on priming as it does in post-test approaches.

To ensure that his participants were not using intentional recall strategies in the same list condition, Mace (2004), in a second experiment, varied word frequency. In the explicit memory literature, words with lower frequency are not as readily recalled as high frequency words. His contention was that if the implicit group (termed the involuntary-retrieval group) was using voluntary retrieval strategies, they would evidence more priming for high frequency words on a word-stem-completion task (as would be consistent with the voluntary/explicit group), but they did not. While he found no priming differences with the implicit measure for high versus low frequency words, he did replicate the findings in the first experiment. The same-list participants exhibited a higher priming rate than did different-list participants. Hence, Mace was successful in experimentally manipulating levels of awareness (2004) and replicating the findings of greater priming for the same-list participants versus the different-list participants on implicit tests (2003b). This is important because it lends credibility to the notion that IAM is likely to play a functional role in priming, and the priming enhancement is probably not due to voluntary retrieval strategies.

What is of note in Mace's work (2003b) and deserves further attention is the reversed levels of processing (RLOP) effect found with unaware participants. This RLOP effect (and the influence of awareness on this effect) serves as the basis for the present study and is discussed in the next section.

Reversed Levels of Processing: A New Finding in Implicit Memory Studies

In an analysis of the role of awareness in implicit-memory studies, Mace (2003a) investigated the likelihood that aware participants might be contaminating implicit memory procedures with explicit retrieval processes. This came to light from the use of an LOP manipulation and a category generation priming task. Following testing, aware participants who reported using intentional retrieval strategies were excluded from analysis. Awareness of the study-test relationship in this study revealed that IAM enhances priming on a conceptually driven implicit task such that test-informed and test-aware participants showed more priming on semantic tasks (as compared to nonsemantic tasks and the unaware group).

Another study (Mace, 2003b) also manipulated LOP and measured the effects of IAM on a word-stem completion task [e.g., counting syllables for each word (nonsemantic task) or rating words for pleasantness (semantic task)]. Mace replicated the enhanced priming for semantic study in a study-test aware group (see Mace, 2003a), but this time in a perceptual implicit task. An unexpected result of this study was a significant LOP reversal (RLOP) for the unaware participants. That is, participants who claimed at post-test not to have become aware of the study-test relationship showed an enhanced priming effect for nonsemantic processing over semantic processing. The only prior report of an RLOP trend (i.e., not significant) was discussed in the meta-analysis of Brown and Mitchell (1994). While neither study of Mace (2003a; 2003b) used an a priori manipulation of awareness, differential LOP effects were found as a result of awareness status (i.e., traditional explicit LOP type for aware participants and RLOP effect for unawares, respectively). The implications of such findings are that certain types of memory can be facilitated with the aid of perceptual encoding and if that presemantic processing is missing, or even deficient, memory may even be attenuated (i.e., as evidenced by no benefit to semantic processing in the current study due to lack of perceptual encoding).

LOP manipulations use nonsemantic versus semantic encoding tasks (e.g., counting syllables and rating words for meaning, respectively). A distinct advantage has been found as higher priming rates for semantic processing over nonsemantic processing in explicit memory tests - - tests that also rely on semantic processing. This benefit is generally lacking with implicit memory tests (or those that rely on nonsemantic processing) primarily because encoding and retrieval strategies in these cases are mismatched. As has been seen in Mace (2003b) there is a benefit to nonsemantically encoding information over semantically encoding it with implicit tests if the participant is wholly unaware of the study-test relationship (i.e., the RLOP effect). The interpretation for this pattern of results is that unaware participants are operating on an unintentional basis when performing implicit tests. This automatic process matches the automatic encoding strategy used at study and ameliorates memory performance at test. The same – versus different-list manipulation (used in Mace, 2004; and below in the current study) provides a laboratory analogue to what participants experience with spontaneous awareness versus remaining unaware of the study-test relationship. If encoding and retrieval strategies are matched, then using the awareness manipulation should replicate Mace's (2003b) RLOP finding in a priming task. A succinct discussion below based on the preceding sections will briefly outline the two experiments conducted for the current study.

The purpose of Experiment 1 of the present study was to further test the reliability of the RLOP effect using a perceptual task (counting syllables) and a conceptual task (pleasantness rating) as shallow and deep levels of processing, respectively. However, rather than solely relying on a post-test questionnaire to separate aware and unaware participants, the current study presented participants with words at test that either facilitated or hindered awareness of the study-test relationship. This was accomplished by presenting a list of words at test that was either the same (aware) or different (unaware) than the list presented at study. Mace (2004) used this method to determine whether awareness of the study list in the absence of intentional memory strategies affects priming in an implicit memory task. Results of that study showed that aware participants evidenced more priming than unaware participants; thus, demonstrating the effect of involuntary aware memory on priming effects. In addition, examination of the explicit contamination theory showed that aware participants are probably not using intentional recall strategies based on priming rates for high and low frequency words and (also in

Mace, 2003b), for response latencies. Response times of aware (test-informed) participants were nearly identical to those of unaware participants (Experiment 3, Mace 2004), which is consistent with what Mace showed in 2003b. For the same purpose, response latencies were also recorded in the present study (see an introduction of Experiment 1 & Experiment 2 for more details).

The intent of Experiment 1 in the present study was to replicate the RLOP effect with an experimental manipulation that clearly shows a priming effect for awareness status. The importance of this replication was two-fold. First, by using the awareness manipulation, the replication would serve to show the RLOP effect as a distinct memorial process within the implicit memory framework and not as a chance finding in Mace (2003b). Second, the replication would extend the PRS account, the TAP theory, and the encoding specificity principle of human, implicit memory. The import of this finding is that it better supports and is more consistent with all three theories than the typical null LOP findings reported in the implicit memory literature do.

It was predicted in this study that the implicit different-list group (see Mace, 2003b) would evidence an RLOP effect and no such reversal would be found in the same-list group or the voluntary retrieval group. In controlling awareness status by randomly assigning participants to the same- versus the different-list conditions, I hope to support the notion that the presence or absence of IAM has differential effects on priming and LOP manipulations. Evidence that enhanced priming is seen in different-list participants who process both study items and test items on a purely perceptual basis is in line with both TAP and the encoding specificity principle and the existence of the PRS (i.e., nonsemantic processing is a beneficial encoding condition for implicit memory).

Therefore, the purpose of Experiment 2 of the present study was to examine whether the RLOP effect results from the relation between task demands at encoding and at retrieval, from the perspective of TAP and the encoding specificity principle. An encoding specificity interpretation of the RLOP effect in the different-list group is that enhanced priming in a perceptual task (relative to a conceptual task) results from greater overlap in the type of processing between study (encoding) and test (retrieval). Thus, priming is enhanced in the nonsemantic (perceptual) LOP task. Based on this logic, the RLOP effect should be extinguished if different-list participants are required to increase their level of perceptual processing for words at study that typically only require conceptual processing. This was accomplished in Experiment 2 of the present study by providing the participants with an additional component (counting syllables) to the semantic task (pleasantness rating).

By adding a perceptual component to the semantic study task, I hope to increase the match between encoding and retrieval for this task and wash out the RLOP effect. In other words, with more perceptual processing, the presemantically driven implicit test will result in better memory performance for semantically studied words. Extinguishing the RLOP effect in this manner has major implications for the study of implicit memory, as well as explicit memory for the type of processing (i.e., tasks used at study) and tests used in the investigation of different memory systems and subsystems. A detailed explanation of the import of the RLOP effect and its elimination follows in the coming two chapters of Experiments 1 and 2.

Experiment 1

The question of whether the RLOP effect can be understood as a true phenomenon of memory and or as a post hoc selection bias based on experimental factors was investigated in Experiment 1. This experiment consisted of four phases. In Phase 1, for each word presented in the study list, participants performed one of two encoding strategies that differed in difficulty [i.e., counting the number of syllables in each word (a nonsemantic task) and rating the words for pleasantness (a semantic task)]. Phase 2 consisted of a task filled retention interval in which each participant was presented with a distractor task (i.e., determining whether each item in a list of geographic locations was a country or not). In Phase 3, each participant performed the nonsemantic and semantic tasks used in Phase 1 in addition to an embedded word-stem completion task. Participants were divided into an explicit group (voluntary retrieval) and an implicit group (involuntary retrieval). In the involuntary retrieval groups, participants were told to complete 12 word-stems with the first word that came to mind while participants in the voluntary retrieval groups were told to complete the word-stems with words they had seen on the study list (i.e., typical explicit task instructions). The purpose of this manipulation was to procedurally validate the experimental methods by replicating the LOP effect usually demonstrated in the literature using explicit memory tasks (e.g., Blaxton, 1989; Craik & Tulving, 1975; Jacoby, 1983). Phase 4, a four-item questionnaire, was administered to participants in the implicit group (see Method section for detailed description). Thus, a direct relation between proportion of correctly completed word-stems and LOP was predicted for the explicit group such that I expected higher priming rates for semantic than nonsemantic encoding tasks, and a RLOP effect was predicted for the involuntary group (see explanation below).

A null LOP effect would be consistent with the findings of several implicit memory studies (Bowers & Schacter, 1990; Reingold & Toth, 1996; Richardson-Klavehn, et al., 1994) for the involuntary retrieval groups, and would suggest that previous examples of RLOP might represent a post hoc selection bias. An inverse relation between proportion of words recalled and LOP indicative of an RLOP effect would systematically replicate the results in Mace (2003b), further supporting a TAP and/or an encoding specificity principle interpretation of RLOP (i.e., implicit processing at test is ameliorated by perceptual processing at encoding). A reversal of the direction of the LOP effect between explicit and implicit groups would suggest that the two forms of memory operate as separate systems, supporting the PRS view (Schacter, 1994).

Half of the participants in each group were presented with the same study list that was presented in Phase 1 (same-list condition) during Phase 3 of the experiment, and the remaining participants were presented with a different study list (different-list condition). This manipulation was meant to either maximize or minimize the likelihood of word recognition, respectively. For the involuntary retrieval group, the presence of an RLOP effect with the different word list only would suggest that the RLOP effect represents a perceptual phenomenon exclusive to an implicit memory system (i.e., perceptual encoding with implicit processing at retrieval). No RLOP effect was expected for same-list conditions, based on the assumption that a second presentation of the word list indicates to participants that the target words are from the study list, and would increase the likelihood that they would become aware of the study-test relationship (i.e., they would show more overall priming, see Mace 2003a; 2003b; 2004). It was however predicted that participants presented with the different-list would be operating on a solely perceptual basis at encoding and should therefore remain unaware of the study-test relationship throughout the test resulting in the RLOP effect (as in Mace, 2003b).

Method

Participants and Design

One hundred participants were recruited from the University of New Haven's introductory psychology subject pool for course credit in Introduction to Psychology. The participants were tested individually with a paper and pen method.

The experimental design for involuntary retrieval participants was a 2 (list context: same-list versus different-list) X 2 (LOP: nonsemantic versus semantic) mixed arrangement. The context factor was manipulated between groups and the LOP factor was a within groups manipulation. The design for voluntary retrieval participants was also a 2 (context: same-list versus different-list) X 2 (LOP: nonsemantic versus semantic) mixed arrangement. The context factor for these participants was also manipulated between groups and the LOP factor was a within groups manipulation.

Forty participants each were tested in the voluntary and involuntary retrieval groups. Within each of the retrieval groups, 20 were in the same-list condition and 20 were in the different-list condition. All 80 participants received both a nonsemantic and a semantic study task. Twenty participants served as controls and did not participate in the study list phase of the experiment.

Materials

One study list containing 60 words was presented to participants. This list was broken into a nonsemantic block of 30 words and a semantic block of 30 words. LOP tasks were counterbalanced across participants such that half of the participants received the nonsemantic processing block first and half received the semantic one first, with the words fully rotated across the LOP conditions. The stimuli were presented on four page booklets as a single column for the words and an adjacent single column for participants' responses. Each stimulus (see Appendix A) varied in length from six to 10 letters and from two to four syllables. All words (taken from various sources, see Mace, 2003b) were of moderate frequency.

All 100 participants were given a country decision task (e.g., CALIFORNIA, PARIS, GREECE, etc.) that served as a distractor task for the 80 experimental participants. Finally, the entire 100 participants completed an LOP, word-stem completion task that measured priming in the 80 experimental participants and served as a baseline for the 20 control participants.

Twelve items from the study list reappeared at test as an embedded word-stem completion task (see Appendix B). Six of the target items had appeared on the semantic task and six on the nonsemantic task. Each of the word-stems (e.g., WAL_, for WALNUT) had a minimum of five possible completions, increasing the level of difficulty to correctly complete each stem.

Procedure

All materials were given to subjects on paper and each task was self-administered, in small groups of between four and 20 participants. Verbal instructions were given to each group of participants tested and written instructions were provided for specific tasks.

Study Phase. Each of the 80 experimental participants received a list of 60, common words. They were told to rate 30 of those words for pleasantness (semantic condition) and for the remaining 30 were asked to count syllables (nonsemantic condition). The pleasantness ratings ranged from 1 to 7 with 1 being very unpleasant and 7 being very pleasant. Participants were required to answer with a 0 if they were unsure of a word's meaning and a 4 for neutral pleasantness. Each group of participants tested was told to begin with the first item on the list and to work sequentially, not skipping around, and not going back to any items. When each task was completed, participants were asked to turn their papers over and wait for the rest of the group to finish. This task lasted about 15 – 20 minutes.

Distractor Phase. After each experimental participant had completed the study phase, they all received a country decision task. A list of 120 countries, states, and cities was presented and participants were asked to determine which of those items are countries. They were told to respond with a "Y" (for yes) if an item was determined to be a country, an "N" (for no) if not, and a "U" (for uncertain) if they were unsure. This task took approximately ten to 15 minutes. The 20 control individuals began their participation with this phase of the experiment.

Testing Phase. After the distractor task had been completed, participants were again given a list of 60, common words to rate for pleasantness and count syllables (half of the list for each LOP task). Amongst those 60 words, 12 word-stems were presented to participants (see Appendix B). Semantic and nonsemantic blocks were counterbalanced across participants as in the study phase. Participants were required to first complete the stems, then to either rate the words for pleasantness or to count syllables (depending upon the block there were working on at the time). An example of a word-stem completion was provided (e.g., "WAL_" for WALNUT). All 12 of these stems appeared at study; six of these were embedded in the pleasantness-rating task and six appeared on the syllable counting task.

Each of the 80 experimental participants was told that some words they would encounter appeared on the study list and some did not. Forty of the participants (involuntary retrieval group) were asked to simply perform the LOP and word stem completion tasks with the first word that came to mind. The other 40 (voluntary retrieval group) were specifically told to remember words they had encountered at study, only completing word stems with words they remembered from study. For both the involuntary and voluntary groups, 20 participants were presented the exact list they saw at study (same-list context) and 20 received a different list (different-list context), with the exception of the 12 target stems.

The 20 control participants were given instructions to rate words for pleasantness, to count syllables for other words, and to complete stems, then rate for pleasantness or count syllables for the words they had just created. Half of these controls received the same context list and the other ten received the different context list.

Questionnaire Phase. Only the 40 participants in the involuntary group completed a written questionnaire. The purpose of the post-test questionnaire was to exclude those participants who elected to use intentional recall strategies (see Appendix C). On this questionnaire, participants were asked if they experienced words from the first part of the experiment (study phase). They were further asked to report any recall strategies used in the test phase of the experiment

Data Analysis. For each word to be recalled in which a stem was provided, a response was scored as correct only if the study word was written without spelling errors.

The proportion of correctly completed word stems in Phase 3 was calculated for each participant. For the voluntary and involuntary retrieval groups, the mean proportion of correctly completed word stems was calculated across participants for each level of LOP and list context. These descriptive statistics were used for subsequent inferential analyses.

Results

Involuntary Retrieval Analysis

Twenty different-study list and 20 same-study list participants from the involuntary retrieval group were used in the main analysis after completing the post-test questionnaire and having asserted that no intentional retrieval strategies were used. The priming effect was significant under all conditions, relative to control participants (*t* tests, $p < .05$) with the exception of the semantic, different list context group that showed no significant priming effect.

Mean proportion of correctly completed word-stems are provided as a function of LOP and list context for the involuntary retrieval group in Table 2. An LOP (nonsemantic versus semantic) x context (same-list versus different-list) analysis of variance (ANOVA) of proportion of stems correctly completed was performed. Table 3 shows the results of this analysis. Neither the LOP nor the context factors were significant. There was a significant LOP x list context interaction. Analysis of proportion of correctly completed word-stems at each context level showed no LOP effect for the same-list condition, but the predicted RLOP effect was found for the different-list condition, whereby priming was enhanced in the nonsemantic condition versus the semantic condition.

A least significant difference (LSD) test was used to examine priming as compared to controls for the different-list group. Subjects in the different-list group performed at a rate of .32 (SD = .13) for words processed nonsemantically which is significantly above baseline (LSD=.07). This suggests that priming was enhanced for shallowly processed words and is in contradiction to typical implicit memory findings. In fact, more priming was evidenced in the nonsemantic, different-list group than in any other group (see Table 2). Variability in all groups appears to be nearly identical.

Control Group Analysis

A one-way ANOVA (i.e., control versus all four experimental conditions) was also conducted. As is typical, and was expected, the control group showed no higher hit rates than the priming rates in either the voluntary or the involuntary retrieval groups [e.g., mean proportion correct = .18, ANOVA: $F(4, 95) = 3.25$, $p = .015$] for the word-stem completion task. The LSD analysis for this F value was .08, which indicates a significant difference for all control versus experimental comparisons with the exception of the different-list context, semantic condition (consistent with findings in Mace, 2003b; 2004).

Voluntary Retrieval Analysis

There were 20 voluntary retrieval subjects analyzed in the same list group and 20 in the different list group. Mean proportion of correctly completed word stems are provided as a function of list context and LOP for the voluntary retrieval group in Table 4. An LOP x context ANOVA of correctly completed word stems was conducted. The results of the ANOVA are shown in Table 5. Consistent with explicit memory findings and (see Craik & Lockhart, 1972; Craik & Tulving, 1975; Graf et al., Lockhart & Craik, 1990; Mace 2003a), the LOP factor was significant with a greater proportion of correctly completed word-stems for the semantic condition than the nonsemantic condition. There was no significant effect of list context and there was no LOP x list context interaction.

Discussion

The purpose of Experiment 1 was to examine RLOP effects in implicit memory by controlling for awareness of the study-test relationship while participants completed the word stems. This was accomplished by providing half of the participants with whole words during test that were identical to those presented during study (same-list group) while the other half of participants received words that differed from those presented during study. Post-hoc questionnaires were used to further screen out participants who implemented a recall strategy. Proportion of correctly completed word-stems for these groups was compared to those of participants that received no study list (control group). Both of these groups were also compared to participants that received instructions to specifically use the study list to perform the word stem completion test (explicit memory group). As predicted, the explicit group demonstrated the typical LOP effect with a greater proportion of correctly completed word-stems with the deep LOP task (rating words for pleasantness) than with the shallow LOP task (counting syllables).

Of particular interest was the memory performance of participants in the implicit memory groups. As anticipated, participants of the implicit groups produced a greater proportion of correctly completed words stems than controls. Most importantly, participants in the different study list condition produced a greater proportion of correctly completed word-stems for the shallow LOP study task than the deep LOP study task. These results provide a demonstration of the RLOP effect without relying solely on post-test questionnaires to select participants who report a lack of study-test awareness, as awareness was manipulated here. The replication of Mace (2003b) in the current study suggests that TAP and the encoding specificity principle are accurate in explaining the RLOP effect and that perceptual encoding is a beneficial encoding strategy that enhances priming (i.e., that the RLOP effect is not a selection artifact or an example of explicit contamination).

Although priming was evidenced, participants in the same study list condition did not produce an LOP effect of any kind. This result was in keeping with most implicit memory findings (see Tulving & Schacter, 1990) and was a predicted outcome for the current study. One plausible interpretation of the absence of an RLOP effect for this group is that appropriate transfer from encoding to retrieval suffered as a function of the participants' awareness status. In other words, IAM has been shown to increase overall priming in implicit tasks (see Mace, 2003a; 2003b; 2004). Experiment 2, which follows, will attempt to support the argument that this definition of the RLOP phenomenon is accurate by augmenting the match between encoding and retrieval and thereby washing out the RLOP effect.

Experiment 2

Experiment 1showed that the RLOP effect was absent in the voluntary retrieval group, but as predicted, the different-list, involuntary retrieval group evidenced the RLOP effect for nonsemantic information. Why is this reversal occurring in direct contradiction to traditional implicit memory findings? Mace (2000) argued that participants may indeed be a "truly implicit" sample. By that, Mace is implying that when participants are ignorant of the study-test relationship, their retrieval processing functions on a purely perceptual basis. Given that implicit tests operate on perceptual encoding processes, it is logical to assume that an advantage can be found for stimuli processed perceptually (i.e., the nonsemantic LOP task) over those processed conceptually (i.e., semantically) and is in line with the TAP and encoding specificity principle. All participants in Experiment 1 performed both tasks and a distinct advantage for nonsemantic information over semantic information was found for the different-list group. This benefit was indexed by significantly higher priming rates for the syllable counting task versus the pleasantness-rating task. If Mace's contention for the RLOP effect is accurate, then increasing the perceptual processing on a semantic task (as in pleasantness-rating) should result in an attenuation of the RLOP effect. Experiment 2 attempts to wash out this reversal effect by adding a perceptual component to the semantic task.

Participants were divided into two groups, and were each exposed to three experimental phases under one of two conditions. One condition was a direct replication of Experiment 1 (reversed level of processing group, RLOP group) for all three Phases. The other condition (perceptually enhanced group, PE group) was identical to the RLOP group with the exception that the PE group included an additional encoding strategy for each LOP task. In adjunct with the syllable counting and pleasantness rating tasks, participants in this group were instructed to perform a second task for each item presented. A perceptual component was added to both the nonsemantic and semantic tasks. The decision to enhance both LOP tasks was made to ensure that each item on the study list would be encoded an equal number of times. It was predicted that the presence of the additional encoding strategy would result in an enhancement of the priming effect (relative to the RLOP group) under both levels of processing. This priming effect may or may not be accompanied by an RLOP effect. The relative amount of added priming under the nonsemantic and semantic LOP conditions would determine whether an RLOP effect would be present. If the presence of the new encoding strategy enhanced the priming effect equally under both levels of processing, or more for the nonsemantic LOP task than for the semantic LOP task, then an RLOP effect would be predicted. This prediction is plausible but unlikely, because the added encoding strategy (counting syllables) to the semantic LOP task (rating for pleasantness) increases the amount of perceptual encoding for this task. Thus, adding the syllable counting task to the pleasantness rating task may reduce the difference in performance between the two levels of processing, counteracting the RLOP effect. Consistent with this notion, if the magnification in priming resulting from the added encoding strategy is greater for the semantic LOP task than for the nonsemantic LOP task, then no RLOP effect is expected. The absence of an RLOP effect would indicate that the effect is limited to conditions in which relatively few perceptual resources are required by an encoding strategy. Further, it would indicate that a sufficient match between appropriate perceptual encoding is indeed a benefit to memory performance. In other words, the RLOP effect only occurs with shallow levels of processing. Participants in this experiment were presented stimuli via computer on an apriori basis to analyze RT (no such opportunity was available for Experiment 1). It was predicted that RT's would be nearly identical between all groups (i.e., RLOP versus PE and same- versus different-list conditions).

Method

Participants and Design

One hundred and sixty participants were recruited from Queens College's introductory psychology subject pool for course credit in Introduction to Psychology. All study, test, and testing materials were presented on a computer.

The experimental design for the perceptual enhancement group (PE group) was a 2 (context: same-list versus different-list) X 2 (LOP: nonsemantic versus semantic) mixed design. The context factor was manipulated between participants and the LOP factor was a within participants manipulation. The design for the reversal group (RLOP group) also was a 2 (context: same-list versus different-list) X 2 (LOP: nonsemantic versus semantic) mixed design. The context factor for these participants also was manipulated between groups and the LOP factor was a within groups manipulation. Each of these participants was selected at random (including the control group).

Seventy participants each were tested in the PE and the RLOP groups. Within each of the retrieval groups, 35 were in the same-list context condition and 35 were in the different-list context condition. All 140 participants received both a nonsemantic and a semantic study task. Twenty participants served as baseline controls and did not participate in the study list phase of the experiment.

Materials

One study list containing 60 words was presented to all experimental participants. This list was broken into a nonsemantic block of 30 words and a semantic block of 30 words. LOP tasks were counterbalanced across participants such that half of them received the nonsemantic processing block first and half received the semantic one first, with the words being fully rotated across the LOP conditions. The words in each block were presented on a computer screen in random order to each participant. This study list was identical to that used in Experiment 1 (see Appendix A).

As in Experiment 1, all 160 participants were given a country decision task that served as a distractor task for the 140 experimental participants. Finally, the entire 160 participants completed an LOP, word-stem completion task. This task was designed to measure priming in the 140 experimental participants and served as a baseline for the 20 control participants (refer to Appendix B).

For each participant twelve items from the study list reappeared at test as an embedded word-stem completion task. Six of the target items appeared on the semantic task and six appeared on the nonsemantic task.

Procedure

All stimuli were presented to participants on a computer screen. Verbal instructions were given to each participant tested and written instructions were provided just prior to each specific task.

Study Phase. Each of the 140 experimental participants received a list of 60, common words. The 70 participants in the PE group were asked to determine if there was an "E" in each of 30 words and then told to count the syllables in each word (nonsemantic condition). For the remaining 30 words, they were told to count the syllables in each word and then rate those words for pleasantness (semantic condition). The 70 RLOP participants (a direct replication of Experiment 1, involuntary group) were given 30 words for which they counted syllables (nonsemantic condition) and for the remaining 30 words rated words for pleasantness (semantic condition).

The pleasantness ratings ranged from 1 to 7 with 1 being very unpleasant and 7 being very pleasant. Participants were asked to answer with a 0 if they were unsure of a word's meaning and a 4 if they wanted to give a neutral rating to the stimulus. Participants' responses on the keyboard cued them to the next item and all items had limited presentation duration.

Distractor Phase. All experimental participants received a country decision task (identical to that in Experiment 1) immediately after completing the study phase. A list of 120 countries, states, and cities were presented and participants were asked to determine which of those items are countries. They responded on the keyboard with a "Y" (for yes) if an item was determined to be a country, an "N" (for no) if not, and a "U" (for uncertain) if they were unsure. The 20 control individuals began their participation with this phase of the experiment.

Testing Phase. After the distractor task was completed, participants again were given a list of 60, common words to rate for pleasantness and count syllables (half of the list for each LOP task). Amongst those 60 words, 12 word-stems were presented to participants. They were told to first complete the stems, then to either rate for pleasantness or count syllables. An example of a word-stem completion (e.g., WAL_ for WALNUT) was provided. All 12 of these stems appeared at study, six in the pleasantness-rating task and six in the syllable counting task.

All 140 experimental participants were told that some words had been encountered on the study list and some had not. They were further told to simply perform the LOP and word-stem completion tasks with the first word that came to mind. For both the PE and RLOP groups, 35 participants were presented the exact list they saw at study and 35 received a different list, with the exception of the 12 target stems.

The 20 control participants were given instructions to rate words for pleasantness, to count syllables for other words, and to complete stems. Half of these control participants received the same-list context and the other ten received the different-list context.

Questionnaire Phase. All 140 experimental participants completed a post-test questionnaire, presented on computer. As in Experiment 1, the purpose of the questionnaire was to exclude data for those participants who admitted to having used deliberate recall strategies. On this questionnaire, participants were asked if they experienced words from the first part of the experiment (study phase). They were further asked to report any recall strategies used in the test phase of the experiment. All told, 60 participants were dropped from analyses for admitting to having used intentional recall strategies. Eighty participants, balanced across both experimental conditions, were included in the main analyses.

Data Analyses. The analyses of proportions of correctly completed word-stems were identical to those of Experiment 1. In Experiment 2 additional analyses were conducted on response latencies. For each trial response latencies were recorded and for each participant the mean latencies were calculated across trials for each level of processing. The mean latencies were also calculated across participants for each level of group and study list.

Results

Means and standard errors of proportions of correctly completed word-stems and reaction times are presented for each group (RLOP group, PE group, and control group), study list context (same versus different) and LOP (semantic versus nonsemantic) in Table 6. Twenty different study list and 20 same study list participants from the RLOP group and from the PE group were used in the main analysis following the post-test questionnaire and excluding those participants who reported engaging in intentional retrieval strategies. For both groups, the priming effect was significant, relative to controls (*t* tests, $p < .05$) with the exception of the semantic different-list group that showed no significant priming effect.

A study list X LOP ANOVA of proportion of correctly completed word-stems was conducted for the RLOP, PE, and control groups. Table 7 shows the results of the analysis. The only significant LOP effect was shown for the RLOP group where proportions of correctly completed word-stems were greater for the nonsemantic target words than the semantic target words. The PE group showed no significant effect of LOP. The LOP X study list interaction was significant for the RLOP group. For this group, dependent t-tests comparing proportion of completed word-stems between LOP levels (semantic and nonsemantic) were conducted separately for the same and different study list groups. There was no significant effect of LOP for the same-list group [t (19) < 1]. There was a significant RLOP effect for the different-list group with a greater proportion of correctly completed word-stems for the nonsemantically processed words [t (19) =

3.53, $p = .002$]. Analysis of the control group showed no significant main or interaction effects.

Reaction times were analyzed using a group X study list X LOP ANOVA. The results of the ANOVA are shown in Table 8. There were no significant main or interaction effects.

Discussion

The main purpose of Experiment 2 was to examine the differential priming effects across LOP, as reflected by the obtained RLOP effect, from the theoretical perspective of TAP and the encoding principle. According to these perspectives, memory is enhanced under the condition in which encoding and retrieval processes are similar. TAP theorists (e.g., Blaxton, 1989) refer to this similarity as positive transfer. Priming was evident for both of the implicit groups of Experiment 2 (RLOP and PE groups) as proportion of correctly completed word-stems was greater for these groups than for controls. Further, the RLOP effect found in Mace (2003b) and in Experiment 1 of the current study was systematically replicated for participants in the different-list condition, suggesting that nonsemantic processing at study aides the participant with implicit retrieval at test during a priming task. No such effects were shown for the PE and control groups.

Of greater import in Experiment 2 is that the perceptual enhancement to the semantic study task yielded an elimination of the RLOP effect, as predicted by both the TAP theory and the encoding specificity principle. Simply put, the advantage seen in Experiment 1 in the different-list condition for nonsemantic over semantic processing was lost once a nonsemantic component was added to the semantic task. The addition of a nonsemantic (or perceptual) element to the semantic task increased the likelihood that cognitive processing at test would match the encoding process used at study, thereby ameliorating priming for these target words.

For both the RLOP and PE groups, the test phase (retrieval stage) required implicit processing, verified by screening via a post hoc questionnaire and RT data analysis. According to TAP and the encoding specificity principle, the RLOP effect was shown by group RLOP, different-list, because the nonsemantic LOP condition involved perceptual processing at study (encoding stage), resulting in enhanced memory performance relative to the semantic LOP condition in which information was encoded on a conceptual level. For the PE group, both of the LOP levels consisted of implicit processing at study and at test. Accordingly, the amount of positive transfer between encoding and retrieval stages for this group was more similar than for the RLOP group. This similarity between encoding and retrieval processes among levels of LOP negates the advantage previously shown for the shallow LOP condition, resulting in no RLOP effect.

General Discussion

LOP effects have been manipulated and investigated for some 30 years in both the explicit and implicit memory literature. Recently, a new pattern of LOP effects was serendipitously discovered by Mace (2003b) who investigated the role of awareness in implicit memory tasks. Mace showed a reversal of the LOP effect such that memory performance was ameliorated for nonsemantic processing over semantic processing for participants who remained unaware of the study-test relationship. During his examination of IAM on implicit memory tasks, Mace inadvertently revealed that a relationship exists between implicit encoding strategies and retrieval processes such that, when similar, these strategies ameliorate memory performance on a word-priming test. The current study aimed to determine the contribution of encoding and retrieval similarity on the RLOP effect by using a novel experimental manipulation of awareness status.

The RLOP Effect: Artifact or Memory Phenomenon?

One purpose of Experiment 1 of the present investigation was to replicate a long-standing relationship between explicit and implicit testing and the differential priming rates found between the two forms of testing as a function of the LOP manipulation. This was primarily done to ensure that a proper priming protocol was used. The voluntary retrieval group (explicit group) in this study demonstrated a typical association between LOP and priming whereby an advantage was held for semantic encoding over nonsemantic encoding (see Brown & Mitchell, 1994; Craik & Lockhart, 1972; Lockhart & Craik, 1990; Schacter, 1989). That is, priming was higher for words that were processed semantically (e.g., rating words for pleasantness) than for words that were processed nonsemantically (e.g., counting syllables).

Awareness was also manipulated in this experiment by using two list conditions in the word-stem task to determine the effect of the study-test relationship on priming. The manipulation of study-test awareness was accomplished by either recreating the study experience for one group of participants (i.e., the same-list condition), facilitating their awareness of the study-test relationship, or by hindering awareness by presenting at test a different list than participants saw at study (different-list group). The awareness manipulation was used to allay concerns raised in Mace (see 2003a; 2003b) that participants' awareness status needs to be manipulated a priori via random assignment. In those studies, Mace used a common post-test questionnaire to determine level of awareness. This post-hoc selection method has been criticized as introducing participant selection effects into the results of implicit priming studies. By minimizing or maximizing word recollection with different context conditions, the current investigation obtained experimental control over awareness of the study-test relationship. This manipulation was imperative in order to replicate the RLOP effect.

Mace (2004) also points out that practical issues arise when using the questionnaire method. The post-hoc selection generally results in a very heterogeneous group of respondents. In other words, a majority of implicit memory participants become spontaneously aware of the study-test relationship and a very large N needs to be recruited in order to obtain a "pure" sample of unaware participants. For example, in Experiment 2 of Mace (2003b), 77 people were tested to yield 24 study-test unaware participants (31% of those tested).

The experimental approach used in the current study randomly assigned participants to study-list conditions (i.e., same- versus different-list). A post-hoc questionnaire was also used in the present study, but only to confirm awareness status (i.e., to rule out strategizers). This method was meant to address the concerns in Mace (2003a; 2003b).

In Experiment 2 of the current study, 57% of the different-list participants tested were used in the data analysis. Thus, a much more homogeneously unaware group was obtained with the manipulation. There was no effect of list condition on priming for the voluntary group. Given that participants in that group were instructed to recall words they had seen on the study list, it was not anticipated that list condition would affect their priming rates, because they were essentially all aware of the study-test relationship.

When compared to the voluntary retrieval group (whose priming rates across study list were nearly indistinguishable), the involuntary retrieval group of Experiment 1 evidenced a different set of priming rates. For those participants who were in the same-list condition, typical implicit memory results were found. These participants showed priming (relative to controls), but no benefit was seen for either the semantic or nonsemantic study conditions. These findings were in line with the explicit-implicit memory dichotomy that is generally seen in the literature (Graf & Mandler, 1984; Graf, Squire, & Mandler, 1984; Jacoby & Dallas, 1981; Richardson-Klavehn & Bjork, 1988; Roediger & McDermott, 1993; Shimamura, 1986; Tulving & Schacter, 1990). It should be reiterated that a questionnaire was administered after the priming task to rule out voluntary retrieval strategies on the part of these participants. Any participants who claimed to be strategizing during the priming task were excluded from analyses in order to ensure that a true implicit sample was obtained and to thwart any objections raised about the use of strategies.

The RLOP effect shown by Mace (2003b) was replicated for the involuntary, different-list group of Experiments 1 and 2 such that nonsemantic encoding resulted in higher priming rates than semantic encoding did. This was an encouraging finding in that it allows for a new interpretation of the differential relation between level of awareness and LOP among explicit and implicit memory tests. Given an experimental control of study-test awareness, the current findings indicate that the RLOP effect shown here and by Mace (2003b) is the manifestation of a true relationship between level of awareness and priming and not an artifact due to a post-test selection bias. In other words, the RLOP effect appears to be stable and, because of the experimental replication in this study, predictable. These findings also suggest that participants used no unanticipated retrieval strategies, because those participants who reported using mnemonic strategies were excluded from data analysis.

Another advantage of successfully demonstrating an RLOP effect via an apriori manipulation of study-test awareness is that the findings can be discussed in the context of the relationship between encoding and retrieval processes. The RLOP effect in this study is in line with predictions based on the TAP theory and the encoding specificity principle. According to Blaxton (1989), positive transfer occurs when encoding and retrieval conditions are the same. While definitions of implicit memory vary (see Hamberlandt, 1999; Neath, 2003) most researchers would agree (e.g., Schacter & Tulving, 1994) that implicit memory is mediated on a presemantic basis.

The nonsemantic LOP manipulation in Experiment 1 (e.g., counting syllables) relied chiefly on the surface structure of words and all but ignored the meaning of words (i.e., a semantic component of the words). The priming task at test required participants to retrieve words implicitly. Therefore, agreement in cognitive processing demands between encoding and retrieval was achieved for the involuntary, different-list condition. This accord in encoding and retrieval processing demands is consistent with the TAP theory of memory and provides an explanation for the RLOP effect. That is, shallow processing at encoding and unintentional retrieval at test are in line with each other resulting in a benefit in priming of nonsemantic over semantic processing.

Semantic processing fairs poorly in this case because implicit tests are more indirect than explicit ones and tap into different forms of memory. Without agreement between encoding and retrieval, there is no benefit seen with semantic encoding for unintentional retrieval tests. While all involuntary retrieval participants performed both a nonsemantic and a semantic study task, it was the nonsemantic processing for the different-list group that enhanced priming; thus, there was absolutely no significant advantage to deeply processing material. These findings suggest that the similarity between the processing demands of encoding and retrieval outweigh the level of processing demands, and provide further support of the TAP and the encoding specificity points of view.

Both TAP and encoding specificity theory espouse the processing view of memory. However, an argument can be made for a systems view to explain the RLOP findings of the current study. One commonly used systems approach to memory is based on the notion of a perceptual representational system (PRS). The PRS (Tulving & Schacter, 1990) is a set of memory subsystems that relies primarily on presemantic processing (see Schacter, 1994; Schacter, Wagner, & Buckner, 2000). Schacter points out that explicit memory is mediated by declarative systems, but implicit memory (e.g., priming) is driven more by the PRS and is independent of the declarative memory systems. A number of researchers (Schacter, 1990; Squire, 1987; 1992; Tulving & Schacter, 1990) have asserted that implicit memory systems are both functionally and neuroanatomically dissociated from explicit memory systems, especially for priming (two criteria of memory systems). For example, Graf, et al. (1984) and others (e.g., Warrington & Weiskrantz, 1974) have shown that priming occurs in amnesic patients for word pairs and familiar words (i.e., word-stem and word-fragment completion tests) but recall is deficient in these patients. Several studies with amnesic patients have also shown intact priming for pronounceable nonsense words (e.g., LEMDOK) even in the absence of preexisting memory representations (see Schacter for a detailed review of the neuropsychological literature). That is, due to its presemantic nature, new perceptual representations are created by the visual-word form subsystem of the PRS.

Schacter and Tulving (1994) also point out that priming is shown in normal participants and is divergent from measures of explicit memory. This functional distinction provides cogent evidence of the existence of the PRS. Adopting this multiple systems view of memory lends support to the hypothesis in the current study on the RLOP effect. Taken together with TAP and the encoding specificity principle, the RLOP effect can be explained by the presemantic systems of the PRS that are tapped by the type of encoding and priming tasks. Assuming that the awareness manipulation eliminated any participant selection bias, and that a match between cognitive processes (between encoding and retrieval) in fact results in better memory performance, then enhancing the match between encoding and retrieval processes for the semantic condition of the different-list group should negate the RLOP effect. In other words, if nonsemantic processing is increased at study for the semantic task, then retrieval should be maximized on an implicit test such as a priming task. This would be manifested as an augmentation of priming under this condition, or better memory performance on semantic target items than would be seen with the RLOP effect, where there is a mismatch between encoding and retrieval processes. Experiment 2 used such a manipulation and is discussed below.

Enhancement of Perceptual Encoding: An Explanation of the RLOP Effect

Experiment 2 of the current study purported to test the TAP and encoding specificity interpretations of the RLOP effect. This was accomplished by directly replicating the RLOP effect of the different-list group shown in Experiment 1 and to eliminate the RLOP effect in another different-list group who performed an enhanced perceptual set of tasks at study (PE group). The enhancement consisted of first presenting nonsemantic and semantic tasks that were identical to those used in the involuntary retrieval group of Experiment 1. Added to the syllable counting task (nonsemantic) was the instruction to count the number of "E's" for each word presented, and added to the pleasantness-rating task (semantic) was the instruction to count the number of syllables (a form of nonsemantic processing). The rationale for enhancing the perceptual processing demands of the tasks in this experiment was to provide a better match of encoding and retrieval for the semantic condition of the different-list group, and to tap into the visual-word form subsystem of the PRS. Improving the similarity of encoding and retrieval strategies for semantic target words should, according to predictions made by TAP and the encoding specificity principle, ameliorate memory performance. If the perceptual enhancement manipulation was successful, it was predicted that no significant difference would arise between nonsemantic and semantic processing for this group of participants. In other words, there would be a sufficient amount of perceptual processing on the semantic encoding task to benefit participants on the priming task and the RLOP effect would then be extinguished. In line with TAP and encoding specificity theory, the RLOP replication was nearly identical to that of Experiment 1 for the RLOP group, no overall improvement in priming was found between the PE and RLOP groups, and the RLOP effect was successfully eliminated for the PE, different-list group. Enhancing perceptual processing in the semantic task seems to have provided a necessary level of nonsemantic processing to aide in retrieval at test, thereby reducing the magnitude of difference between nonsemantic and semantic study conditions.

In Experiment 2, RT was also analyzed. The purpose of the RT analysis was based on arguments made in the literature regarding implicit-explicit distinctions (e.g., see Mace, 2003b) that RT is directly related to the probability that participants were using a memory strategy. That is, longer response latencies are generally seen in participants who strategize as compared to those participants who don't. Thus, any differences in RT between levels of group, study list, or LOP would indicate the use of memory strategies for the group or condition with the greater RT. There were no main or interaction effects among group, study list, and LOP on RT values in the present study. This finding suggests that participants were most likely not strategizing at test.

In addition, for the PE group, participants of both study-list groups gained no added benefit of double encoding each study item. This benefit would have been seen if the PE group had significantly lower RT's than for those in the RLOP group, yet they did not. The elimination of the RLOP effect that was shown for the different-list participants of the PE group, further advances the notion that a match between encoding and retrieval is of vital importance in memory performance and lends complementary support to the processing and systems views of human memory. Additionally, this fining indicates that perceptual augmentation is a manipulation that successfully alters the similarity between the processing demands of encoding and retrieval.

Conclusion

The present investigation provided a systematic and more empirical replication of the RLOP effect than has been recently demonstrated in the implicit memory literature (Mace, 2003b). The RLOP effect here was shown as a result of experimentally controlling awareness status with test lists that either maximized (same-list condition) or minimized (different-list condition) word recall. A better understanding of the RLOP effect in terms of TAP and the encoding specificity perspectives was gained by reducing the difference between the processing demands of encoding and retrieval (Experiment 2) which resulted in an elimination of the reversal.

In Experiment 1, participants who were told to use the study list as a reference for completing the word-stems during testing (voluntary retrieval group) showed the typical LOP effect (i.e., greater priming for semantic versus nonsemantic tasks) demonstrated repeatedly in the literature (e.g., Lockhart & Craik, 1990) These participants demonstrated the LOP effect when the word list presented during test was either the same or different from the list presented during study. Participants that were told to complete the word-stems with the first thing that came to their mind (involuntary retrieval group) showed a different pattern. That is, participants in the same list condition showed no significant LOP effect at all, but participants in the different list condition demonstrated greater priming in the nonsemantic than semantic LOP condition (RLOP effect). The RLOP effect was a systematic replication of Mace (2003b) who showed an RLOP effect where awareness of the study test relationship was determined via selection based on a post-hoc questionnaire.

The results of Experiment 1 were in line with TAP and the encoding specificity principle that predict a direct relation between priming and the similarity in processing demands between encoding and retrieval. For the voluntary retrieval group in Experiment 1, the processing demands for retrieval were more similar to the processing demands during study for the semantic (deep LOP) condition than for the nonsemantic (shallow LOP) condition as evidenced by higher priming in the semantic condition. Alternatively, for the different-list, involuntary retrieval group, the processing demands of retrieval were more similar to the processing demands during study for the nonsemantic condition than for the semantic condition, which resulted in better performance for the nonsemantic condition. This pattern of results supports the TAP and encoding specificity perspectives on memory.

In Experiment 2, the processing demands during encoding and retrieval were manipulated to further examine the RLOP effect via TAP and encoding specificity theory. This was accomplished by using two implicit memory groups. One group (RLOP group) was a direct replication of the implicit group of Experiment 1. The second group (PE group) was identical to the RLOP group with the exception that an added perceptual component was provided during study under both the semantic and nonsemantic conditions. Thus, for the PE group, more similar processing demands between encoding and retrieval were encouraged across LOP than in the RLOP group. Consistent with encoding specificity theory and TAP, no LOP effects were shown for the enhanced group for either the same- or the different-list groups, as was anticipated. The RLOP effect was replicated for the RLOP group (different-list condition). These results suggest a more comprehensive understanding of the RLOP effect for implicit memory in terms of the processing demands of encoding and retrieval, and the plausibility of encoding specificity as a determinant of both explicit and implicit memory performance.

An examination of the generality of the RLOP effect is recommended for future research such as the use of stimuli that tap into different sensory modalities. One possibility would be to use pronounceable nonsense syllables in lieu of words. These stimuli could easily be manipulated across LOP conditions (e.g., nonsemantic: XERTFOG, "please count the number of 'E's that you see; semantic: PLUKTOX, "is this an English word?"). In this case, a word-stem completion task would be nearly impossible to complete with any rate of success, but a perceptual identification task (PID) might be suitable for determining differential priming effects (e.g., briefly present a stimulus across the screen of a computer monitor and vary LOP). For example, a task could require participants to determine whether or not an actual word was just flashed and the stimuli presented would be English words and nonsense syllables, using only the nonsense syllables as target items. A same- and different-list condition could be manipulated, much like that used in the present study (i.e., all but target items would vary in the different-list condition). The use of pronounceable nonsense syllables would almost certainly reduce explicit contamination as there would be little opportunity for participants to search their existing lexicon, making it much more difficult for them to use intentional recall strategies. Another purpose of this manipulation would be to show both the causal effects of IAM on priming and to demonstrate the RLOP effect with a perceptual task (e.g., PID) other than the word-stem completion task.

Yet another suggestion to consider as a follow up to the current study would be to determine whether the RLOP effect is consistent across different populations as well as across different experimental paradigms. Schacter (1990) and others (see Squire, 1987; 1992; Tulving & Schacter, 1990), have pointed out that it was converging evidence from studies in normals (both young and aging), amnesics, and other neuropsychological populations that supported the notion of presemantic processing in implicit memory and how it deviates from declarative processing in explicit memory. The findings in the current study on IAM, the RLOP effect, and the PE manipulation would all add to this convergence, by examining each with different patient populations. Such analyses would allow for a better understanding of the potential contribution that IAM, RLOP, and PE manipulations have on understanding implicit memory. Taken together, the outcome of Experiments 1 and 2 bolster the validity of the RLOP phenomenon as a true effect. Moreover, the augmentation of perceptual processing in LOP conditions appears to be an empirically sound manipulation for testing hypotheses based on TAP and encoding specificity theory that should be further explored. These findings have provided an expanded understanding of implicit memory in humans and lend to the necessity for the continued study of the implicit-explicit dichotomy from both a systems and a processing perspective.

Appendix A

Study list used in Experiments 1and 2

ALMANAC	MERCHANT	VOLUME
VICTIM	ASHTRAY	CULTURE
BLOSSOM	ENVELOPE	MODERN
BUTCHER	MOUNTAIN	HISTORIAN
COTTAGE	KANGAROO	PATIENT
SCISSORS	PITCHER	SHELTER
ELEPHANT	ESCALATOR	HUSBAND
FABRIC	INTESTINE	RAILROAD
GARMENT	SAILBOAT	ANATOMY
MANAGER	PUMPKIN	BARREL
CABINET	MACKEREL	PINEAPPLE
PLEASURE	OCTOPUS	CANDIDATE
MEADOW	SUBMARINE	DAYLIGHT
WEAPON	WATERFALL	BASKET
DOORKNOB	PYRAMID	FACILITY
RATTLE	BALLOON	ACCORDION
AVOCADO	ABSENCE	INSTRUMENT
COMRADE	PLATFORM	BUFFOON
HARNESS	SPARROW	TOPCOAT
MONARCH	TUNGSTEN	MAIDEN

Appendix B

Test list used in Experiments 1 and 2, same-list context condition

ALMANAC	MERCHANT	VOL_____
VICTIM	ASHTRAY	CULTURE
BLOSSOM	ENVELOPE	MOD_____
BUTCHER	MOU_____	HISTORIAN
COTTAGE	KANGAROO	PAT_____
SCISSORS	PITCHER	SHELTER
ELE_____	ESCALATOR	HUSBAND
FABRIC	INTESTINE	RAILROAD
GARMENT	SAILBOAT	ANATOMY
MAN_____	PUMPKIN	BARREL
CABINET	MACKEREL	PINEAPPLE
PLE_____	OCTOPUS	CAN_____
MEADOW	SUBMARINE	DAYLIGHT
WEAPON	WATERFALL	BASKET
DOORKNOB	PYRAMID	FACILITY
RATTLE	BAL_____	ACCORDION
AVOCADO	ABSENCE	INSTRUMENT
COM_____	PLA_____	BUFFOON
HARNESS	SPARROW	TOPCOAT
MON_____	TUNGSTEN	MAIDEN

(Appendix B continues)

Test list used in Experiments 1 and 2, different-list context condition

PENCIL	CALYPSO	MOD_____
PEANUT	HEALTH	VALUE
DOCTOR	OCCASION	VOL_____
FIGURE	ELE______	GENERAL
FIREPLACE	DEBRIS	PAT_____
REVOLT	MASSAGE	COLLEGE
SALUTE	ARTIST	CAN_____
SLIPPER	CHEETAH	RAILROAD
LADDER	COCONUT	ANATOMY
BUTTON	SENATE	BARREL
MOU_____	SNOWMAN	PINEAPPLE
TORNADO	LANGUAGE	HUSBAND
MAN_____	TOASTER	DAYLIGHT
TELESCOPE	TABLET	BASKET
PLE_____	BEAVER	FACILITY
CACTUS	BAL_____	ACCORDION
DISEASE	WINDOW	INSTRUMENT
MON_____	CORTEX	BUFFOON
BRONZE	PLA______	TOPCOAT
COM_____	ANSWER	MAIDEN

Appendix C

Post-test questionnaire used for the involuntary group in Experiment 1 and all participants in Experiment 2

1. When you were completing the words with missing letters (e.g., WAL_), did you ever experience words from the first part of this experiment (that is, pleasantness and syllable part) coming to mind?

2. Which best describes how you completed word stems (e.g., WAL_):

   Choose only A or only B

   A. I always wrote the first word coming to mind.

   B. I sometimes wrote the second (or third) word coming to mind.

3. Did you ever try to complete a word stem (e.g., WAL_) by trying to remember a word from the first part of the experiment (the first pleasantness and syllable part)?

   Choose only A or only B or only C

   A. Yes. B. No. C. I'm not sure.

4. What did you know or hear about this experiment before you came today?

Table 1

Major Memory Systems and their Subsystems

Memory System	Alternative Name	Memory Subsystems
Implicit		
Procedural	Nondeclarative	Motor Skills
		Cognitive Skills
		Simple conditioning
		Simple associative learning
Perceptual Representation	Nondeclarative	Visual-word-form
		Auditory-word-form
		Structural description
Primary Memory	Working Memory	Visual
		Auditory
Explicit		
	Declarative	
Semantic	Generic	Spatial
	Factual	Relational
	Knowledge	
Episodic	Personal	
	Autobiographical	
	Even memory	

Source: Adapted from Schacter & Tulving (1994)

Table 2

Mean and Standard Error (in parentheses) of Proportion of Correctly Completed Word Stems for each Level of Processing and Study List for the Involuntary Retrieval Group of Experiment 1

	Study List	
LOP	Different	Same
Nonsemantic	.32 (0.03)	.28 (0.03)
Semantic	.23 (0.04)	.30 (0.03)

Table 3

Study List (same versus different) x Level of Processing (nonsemantic versus semantic) Analysis of Variance of Proportion of correctly completed word stems for the Involuntary Retrieval Group of Experiment 1

Source	*df*	*F*	*p*
		Between subjects	
Study List	1	0.17	.68
S within-group error	38	(1.04)	
		Within subjects	
LOP	1	1.44	0.24
Study List X LOP	1	4.66*	0.04
LOP X S within group error	38	(0.49)	

Note. Values enclosed in parentheses represent mean square errors. LOP = level of processing.

*$p < .05$.

Table 4

Mean and Standard Error (in parentheses) of Proportion of correctly completed word-stems for each Level of Processing and Study List for the Voluntary Retrieval Group of Experiment 1

	Study List	
LOP	Different	Same
Nonsemantic	.28 (0.03)	.23 (0.03)
Semantic	.48 (0.03)	.46 (0.02)

Table 5

Study List x Level of Processing Analysis of Variance of Proportion of Correctly Completed Word Stems for the Voluntary Retrieval Group of Experiment 1

Source	*df*	*F*	*p*
		Between subjects	
Study List	1	1.23	.275
S within-group error	38	(0.11)	
		Within subjects	
LOP	1	13.57	< .001
Study List x LOP	1	0.30	.589
LOP x S within group error	38	(.051)	

Note. Values enclosed in parentheses represent mean square errors. LOP = level of processing.

$*p < .05$.

Table 6

Mean and Standard Error (in parentheses) of Proportion of Correctly Completed Word Stems and Reaction Time for each Level of Processing, Study List, and Group of Experiment 2

RLOP Group

	Study List	
LOP	Different	Same
Nonsemantic	.35 (.04)	.30 (.02)
Semantic	.15 (.03)	.27 (.04)
RT	9.25 (.40)	8.99 (.58)

Enhanced Group

	Study List	
LOP	Different	Same
Nonsemantic	.29 (.04)	.30 (.03)
Semantic	.32 (.03)	.28 (.04)

Table continues

RT	8.70 (.39)	8.77 (.37)

Table 6 continues

Control Group

	Study List	
LOP	Different	Same
Nonsemantic	.17 (.02)	.22 (.02)
Semantic	.20 (.03)	.15 (.03)
RT	8.84 (.58)	9.71 (.21)

Note. RLOP = Reversed Levels of Processing Group. RT = Reaction Time (in seconds). RT values are collapsed across LOP level.

Table 7

Study List x Level of Processing ANOVAs of Proportion of Correctly Completed Word Stems for each Group of Experiment 2

Source	*df*	*F*	*p*
	RLOP Group		
	Between subjects		
Study List	1	0.47	.496
S within-group error	38	(0.04)	
	Within subjects		
LOP	1	9.68**	.004
LOP X Study List	1	5.02*	.031
LOP X S within-group error	38	(0.03)	
	Enhanced Group		
	Between subjects		
Study List	1	0.28	.602
S within-group error	38	(0.02)	

Table 7 continues

	Within subjects		
LOP	1	0.06	.808
LOP X Study List	1	0.54	.468
LOP X S within-group error	38	(0.03)	
	Control Group		
	Between subjects		
Study List	1	<0.01	>.99
S within-group error	18	(0.01)	
	Within subjects		
LOP	1	0.27	.61
LOP X Study List	1	2.41	.14
LOP X S within-group error	18	(0.01)	

Note. Values enclosed in parentheses represent mean square errors. LOP = level of processing.

$^{*}p < .05$, $^{**}p < .01$.

Table 8

Group (RLOP, Enhanced, and Control) x Study List x Level of Processing ANOVA of Reaction Times for Experiment 2

Source	*df*	*F*	*p*
	Between subjects		
Group	2	0.71	.493
Study List	1	3.40	.068
Study List X Group	2	2.04	.136
S within-group error	94	(4.31)	
	Within subjects		
LOP	1	0.38	.537
LOP X Group	2	1.51	.227
LOP X Study List	1	1.16	.284
LOP X Study List X Group	2	0.04	.963
LOP X S within-group error	94	(4.49)	

Note. Values enclosed in parentheses represent mean square errors. LOP = level of processing.

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