ACADEMIC PRESS

Journal of Memory and Language 47 (2002) 273–291

Journal of Memory and Language

www.academicpress.com

The orthographic distinctiveness effect on direct and indirect tests of memory: delineating the awareness and processing requirements ☆

Lisa Geraci* and Suparna Rajaram

State University of New York at Stony Brook, Stony Brook, NY, USA

Received 19 December 2000; revision received 2 July 2001

Abstract

We examined the processing and awareness requirements that mediate superior memory for distinct items in long-term memory by studying the effects of orthographic distinctiveness. Orthographically distinct words are remembered better than common words on the direct test of free recall but not on the indirect test of perceptual identification. These results suggest that the orthographic distinctiveness effect requires test awareness. But interestingly, this distinctiveness effect has also been reported in one indirect test, that of word fragment completion (Hunt & Toth, 1990). We examined the locus of the orthographic distinctiveness effect in the indirect test of word fragment completion and the direct tests of word fragment cued recall and free recall and assessed the role of awareness (Experiment 1) and conceptual processes (Experiments 2a–2c) in mediating this effect. Our results support the proposal that the distinctiveness effect depends on direct reference to the study context and further specify that this effect is mediated, to a large extent, by comparative processes even when distinctiveness emerges from surface-level differences.

Several studies attest to the intuitive belief that people have very good memory for novel or unusual information, often called the distinctiveness effect. The von Restorff effect (superior memory for isolated items) is cited most often to demonstrate that distinctiveness aids memory (see Hunt, 1995, for details of von Restorff's dissertation). However, the term "distinctiveness" has also been applied to a variety of other phenomena, including superior memory for nude pictures (Ellis, Detterman, Runci, McCarver, & Craig, 1971), bizarre sentences (McDaniel, Dunay, Lyman, & Kerwin, 1988), distinct faces (Light, Kaya-Stuart, & Hollander, 1979), atypical category members (Schmidt, 1985), and words with unusual orthographies (Hunt & Elliott, 1980; Hunt & Mitchell, 1978, 1982; Hunt & Toth, 1990). Despite an abundance of studies demonstrating that unusual or distinct information is remembered well, it remains unclear exactly *how* distinctiveness aids memory (see Schmidt, 1991).

☆ This research was done in partial fulfillment of the first author's doctoral dissertation and was supported by NIH Grant R29MH57345-01 given to the second author.

* Corresponding author. Present address: Department of Psychology, Washington University, One Brookings Drive, Campus Box 1125, St. Louis, MO 63130-4899, USA.

E-mail address: lgeraci@artsci.wustl.edu (L. Geraci).

PII: S0749-596X(02)00008-6

The following experiments are designed to address this question by exploring the nature of the processing at encoding and retrieval that mediates the distinctiveness effect in long-term memory. Experiment 1 examines the necessary retrieval conditions for obtaining the distinctiveness effect and tests whether the effect can be obtained using an indirect test of memory. Experiments 2a–2c explore the nature of the processing at encoding that could explain the effect of distinctiveness on memory tests that differ in their processing demands.

We explore these issues using one particular type of distinctiveness effect, the orthographic distinctiveness effect. This effect refers to the finding that words with unusual letter combinations, such as "subpoena," are remembered better than words with more common letter combinations, such as "sailboat" (Hunt & Elliott, 1980; Hunt & Mitchell, 1978, 1982; Hunt & Toth, 1990; Zechmeister, 1969, 1972). We chose to study this distinctiveness effect because the reported pattern of data on orthographic distinctiveness has important implications for two influential theories of memory: the distinctiveness hypothesis advanced by Hunt and colleagues (Hunt, 1995; Hunt & McDaniel, 1993; Hunt & Smith, 1996; Smith & Hunt, 2000) and the transfer appropriate processing framework advanced by Roediger and colleagues (Roediger, 1990; Roediger, Weldon, & Challis, 1989).

The findings of central interest come from research examining the effect of orthographic distinctiveness on direct (or explicit) and indirect (or implicit) tests of memory (Hunt & Toth, 1990). This research shows that orthographically distinct words, such as "subpoena," are remembered better than orthographically common words, such as "sailboat," using a direct test of free recall (Hunt & Toth, 1990). This work also shows that the advantage of completing fragments (e.g., s_ _l b_a t) for studied words compared to nonstudied words, a measure termed "priming" (Graf & Schacter, 1985; Tulving, Schacter, & Stark, 1982), is greater for orthographically distinct words than for orthographically common words on an indirect test of word fragment completion (Hunt & Toth, 1990). Interestingly, although orthographically distinct words show an advantage on the indirect test of word fragment completion, they do not show such an advantage in priming on another indirect test of perceptual identification, in which participants are required to identify words that are flashed briefly on a screen (Hunt & Toth, 1990).

We first consider the implications of these findings for the transfer appropriate processing framework (Roediger et al., 1989). According to this framework, performance on both direct and indirect memory tests benefits to the extent that the conceptual or perceptual processing at test recapitulates the same conceptual or perceptual processing that occurred at study. Much research supports this view (see Roediger & McDermott, 1993 for a review). For example, perceptual manipulations involving changes in modality of presentation (visual versus auditory) at study and test influence performance on indirect tests, such as the fragment completion test, which rely on the perceptual features of the stimulus (Blaxton, 1989; Graf & Mandler, 1984; Jacoby & Dallas, 1981; Rajaram & Roediger, 1993; Srinivas & Roediger, 1990), but not on indirect tests that rely on the meaning of the stimulus (Blaxton, 1989; Challis & Sidhu, 1993; Srinivas & Roediger, 1990). Conversely, conceptual manipulations, such as levels of processing where participants study words either for their semantic or phonemic properties, influence indirect tests that rely on meaning, but not perceptually driven indirect tests such as word fragment completion (e.g., Blaxton, 1989; Hamann, 1990; Srinivas & Roediger, 1990).

Performance on direct tests also demonstrates the importance of the match in processing. For example, free recall, which relies, for the most part, on generative or elaborative processes, is influenced by conceptual manipulations, such as the levels of processing (Craik & Tulving, 1975) and the generation of an item (Jacoby, 1978; Slamecka & Graf, 1978) but not by perceptual manipulations, such as changes in modality (Rajaram & Roediger, 1993). While most direct tests of memory are largely driven by conceptual processing, some direct tests, such as fragment cued recall, in which the percept is partially available at test, are influenced by both conceptual (Roediger, Weldon, Stadler, & Riegler, 1992) and perceptual processes (see Blaxton, 1989; Challis & Sidhu, 1993).

The reported pattern of the orthographic distinctiveness effect across various memory tests (Hunt & Toth, 1990) is inconsistent with the transfer appropriate processing framework because it shows the effect of an ostensibly perceptual variable such as orthography on a conceptual test but not a perceptual test. For example, orthographic distinctiveness influences free recall, which is considered to be a conceptually driven test, but not perceptual identification, which is considered to be a perceptual or data-driven test. However, the word fragment completion data are consistent with the transfer appropriate processing framework because they do show an effect of orthographic distinctiveness using a test that is classified as data-driven.

Interestingly, the data from the indirect word fragment completion test are inconsistent with a recent version of Hunt and colleagues' theory of distinctiveness (Hunt, 1995; Hunt & McDaniel, 1993; Hunt & Smith, 1996; Smith & Hunt, 2000). This theory proposes that the distinctiveness effect requires direct reference to the study episode and, therefore, should not be obtained on an indirect test, such as word fragment completion. According to Hunt and colleagues (Hunt, 1995; Hunt & McDaniel, 1993; Hunt & Smith, 1996; Smith & Hunt, 2000), distinctiveness effects are highly dependent on the organizational context provided by the study list and the subsequent retrieval of this context. At study, the organizational context provided by the study list is important because it provides the necessary context against which the different item can become distinct **(Einstein & Hunt, 1980; Epstein, Phillips, & Johnson, 1975; Hunt, 1995; Hunt, Ausley, & Schultz, 1986; Hunt & McDaniel, 1993; Hunt & Seta, 1984). Furthermore, Hunt and colleagues (Hunt & Smith, 1996; Smith & Hunt, 2000) propose that the organizational context established by the study list is not only important at the time of study but is also critical at the time of retrieval. They suggest that the organizational context provided by the study episode must be explicitly cued at test for the distinctiveness effect to occur (Smith & Hunt, 2000). Accordingly, this view predicts that the distinctiveness effect will not be obtained on tests that do not directly reinstate this context. Because indirect tests, by definition, do not make reference to the study context, the distinctiveness effect should not be obtained using indirect tests.

Smith and Hunt (2000) provide empirical support for the hypothesis that the distinctiveness effect cannot be obtained using indirect tests. In this study, distinctiveness was manipulated at study by having participants judge how an exemplar (e.g., table) is either different from or similar to other exemplars (e.g., chair, desk, and couch) within the same category. At test, participants were given either a direct test of cued recall or an indirect test of word association or category exemplar production. In the direct cued recall test, participants were given a category label, such as "furniture," and were asked to recall a set number of items from that category that were presented in the study list. In the indirect word association test, participants simply wrote words that were associated with the category label (e.g., furniture), and in the indirect category exemplar test, participants listed exemplars in response to the same cue. Results demonstrated a distinctiveness effect, i.e., better memory for exemplars processed for difference than for similarity, only on the direct test of cued recall and not on the indirect tests of word association and category exemplar production.

These data support Smith and Hunt's (2000) hypothesis that the distinctiveness effect cannot be obtained unless the study episode is directly reinstated. However, as previously described, other data do show an effect of distinctiveness using an indirect test (Hunt & Toth, 1990). Because the indirect word fragment completion test, by definition, did not require a reinstatement of the study context and yet yielded greater priming for orthographically distinct words, these data are inconsistent with Smith and Hunt's (2000) theory and empirical evidence. We explore this discrepancy in Experiment 1 with the goal of elucidating the specific retrieval conditions under which the distinctiveness effect can be obtained.

Before we describe our Experiment 1, we note that there are possibly two alternate explanations for the presence of a distinctiveness effect using an indirect test in one case (Hunt & Toth, 1990) and the absence of the effect using an indirect test in the other case (Smith & Hunt, 2000). First, it is possible that the disparate effects using indirect tests were a function of the way in which distinctiveness was manipulated in the two studies. A review of the literature on distinctiveness (Schmidt, 1991) suggests that there are several different types of distinctiveness effects. First, an item can have primary distinctiveness because the item differs from other items in its immediate context, such as a study set. Here, the incongruent item is distinct only with respect to the other items in the study set. By this definition, the distinctiveness manipulation used in Smith and Hunt's (2000) study could be classified as a primary distinctiveness manipulation. In this study, the target exemplar was only distinct with respect to the study context because participants noted the way in which it differed from the other exemplars in the study set. In contrast to primary distinctiveness, an item can have secondary distinctiveness if it differs from the general set of items in its class in long-term memory. Schmidt (1991) classifies the orthographic distinctiveness as a secondary distinctiveness manipulation because the words are unusual in their own right and not just in comparison with the other items in the study list.

It is possible that primary and secondary distinctiveness effects differentially depend on direct reference to the study list. Because items with primary distinctiveness are only distinct with respect to the study list, these effects may depend on directly referring to this context. However, because items with secondary distinctiveness are distinct with respect to general knowledge, these effects may not depend on reference to the study list to the same extent as primary distinctiveness effects. If this is the case, then one might expect that secondary, but not primary, distinctiveness effects would be obtained on indirect memory tests, as was the case with the orthographic distinctiveness effect on the indirect word fragment completion test (Hunt & Toth, 1990).

Two considerations weaken this hypothesis. First, several studies have shown that secondary distinctiveness effects also depend on the structure of the study list. For example, the orthographic distinctiveness effect is only obtained using mixed-list designs and not between-subject designs (see Hunt & Elliott, 1980; Hunt & Mitchell, 1982). Similarly, superior memory for bizarre sentences, which is also categorized as a secondary distinctiveness effect (Schmidt, 1991; Waddill & McDaniel, 1998), is obtained only using mixed-list designs (Waddill & McDaniel, 1998). The fact that only secondary distinctiveness effects seem to occur when people study lists that also include common items, suggests that even secondary distinctiveness effects rely on the structure of the study list and, in turn, may require direct reference to the study context. Second, the effects of orthographic distinctiveness have not been obtained using another indirect test of perceptual identification (Hunt & Toth, 1990) in which participants were not required to refer back to the study context to perform the task. If secondary distinctiveness effects do not depend on reference to the study list, then this view would predict that the orthographic distinctiveness effect should be obtained on the perceptual identification test too.

Given these considerations, we turn to the second, alternate, hypothesis that may explain the discrepant effects of distinctiveness using indirect memory tests. It is possible that the orthographic distinctiveness effect was obtained on the indirect test of word fragment completion because, contrary to instructions, participants employed explicit memory strategies to perform the task. As mentioned earlier, in an indirect fragment completion test, participants are simply told to complete the fragment, "s_ _l b_a t" ("sailboat"), with the first word that comes to mind. As is always a possibility, participants may have become aware of the connection between study and test in some cases and, subsequently, engaged in explicit memory strategies by referring to the study list to complete the fragments.

The following features of Hunt and Toth's (1990) design could allow for this possibility. First, participants encoded words at study with the intention of taking a subsequent memory test. Although it is not uncommon to use intentional memory instructions, they may have allowed participants to become aware of the connection between study and test and to engage in explicit memory strategies. Second, the study list was fairly short, consisting of a total of 16 words, half of which were common and half of which were distinct. It is possible that participants' memory may have been so good that they recognized many of the solutions to the fragments as having been presented in the study phase (note that priming scores were fairly high,. 63 for distinct and. 44 for common words). Third, the indirect fragment completion test immediately followed the study session. Although the test was presented as an unrelated task, the fact that it followed immediately after the study session may have enabled participants to complete the fragments with reference to the studied items. These procedural details left open the possibility of explicit contamination.

There is preliminary support for the hypothesis that the orthographic distinctiveness effect on word fragment completion (Hunt & Toth, 1990) may result from explicit contamination. Kinoshita and Miller (2000) replicated this effect in word fragment completion, and on the basis of posttest questionnaire data, reported that all of their participants were test aware. Furthermore, their findings indicate that the orthographic distinctiveness effect is mediated by controlled and not automatic processes. Although these findings support the explicit contamination hypothesis, they do not rule out the possibility that the orthographic distinctiveness effect may also be obtained in test-unaware participants. Therefore, Experiment 1 tests the role of conscious awareness by first attempting to reduce contamination from explicit strategies, and second by analyzing the data for test aware and unaware participants separately.

Experiment 1

Experiment 1 explored the role of the retrieval test in mediating the orthographic distinctiveness effect. The goal of this experiment was to determine if, under conditions designed to reduce contamination, we would obtain the orthographic distinctiveness effect. If the orthographic distinctiveness effect is still obtained, then this outcome will provide support for the hypothesis that the two types of distinctiveness manipulations, primary and secondary, differ with respect to their reliance on direct reference back to the study episode. However, if reducing explicit contamination eliminates the distinctiveness effect, then this outcome will be consistent with Smith and Hunt's (2000) hypothesis and resolve the empirical discrepancy. A resolution of this discrepancy is important because it will help elucidate, in general, the role of retrieval in mediating the distinctiveness effect.

To reduce the possibility of explicit retrieval strategies, we incorporated the following procedural changes to Hunt and Toth's (1990) design. One, we gave participants incidental study instructions instead of intentional instructions. Participants were told that they were participating in a reading time study and therefore were not expecting a subsequent memory test. Two, we presented the test list a half an hour after the study list, instead of immediately after the study list. Three, we structured the test list such that only one-third of the fragments could be completed with studied words to make explicit retrieval a less effective test strategy. Finally, to assess the possibility that participants might become aware of the connection between the study and test and engage in explicit retrieval strategies despite the measures taken, we gave participants a posttest questionnaire to assess awareness of the study–test relationship and test-taking strategies. This step enabled us to analyze the performance of participants who were completely unaware of the connection between study and test separately from those who may have become aware of this connection. We also included a direct memory task of word fragment cued recall to systematically replicate the distinctiveness effect within one study. Following the retrieval intentionality criterion (Schacter, Bowers, & Booker, 1989), this task was identical to the indirect word fragment completion test, except that the participants were given direct memory instructions and told to complete the fragments only with studied words.

Method

Participants. Two hundred SUNY Stony Brook students participated in return for research credit. Participants were either tested individually or in groups of 2 to 3. Participants were randomly assigned to either the direct or indirect test conditions. Sixty-four participants were given the direct version of the test and 136 participants were given the indirect version. Based on the responses to the posttest questionnaire, participants in the indirect test version were subsequently divided into "aware" (72 participants) and "unaware" (64 participants) groups, and the data from these two groups were analyzed separately.

Design and materials. Two study lists were constructed from a pool of 56 critical words, half of which were orthographically common and half of which were orthographically distinct (see Appendix). These words were taken from Hunt and Toth (1990) and from Rajaram (1998). The common and distinct words were matched for the first letter, word frequency, and word length.

The test list consisted of 28 (14 common and 14 distinct) fragments with studied solutions, 28 (14 common and 14 distinct) fragments with nonstudied solutions, and 28 filler fragments. The filler fragments were also approximately matched to the common and distinct fragments for first letter, word frequency, and word length. Two study lists were constructed to counterbalance the critical items across studied and nonstudied conditions across participants. Each study list also contained two buffer words at the beginning and two buffer words at the end of the list to blunt the effects of primacy and recency. There were two random orders for each of the two different study lists (a total of four lists) in which neither type of word, common or distinct, appeared in a row three or more times.

All fragments, including fillers, were normed so that the base rate probability of completing any fragment with the target solution was equivalent for fragments with common or distinct word solutions (.29 for common words and. 33 for distinct words), $t(27) = .66$, $SE = .01$. All fragments contained the first letter and were approximately matched for the proportion of letters removed for common (56%) and distinct (57%) solutions; the proportion of vowels (common 39% and distinct 33%) and consonants (common 39% and distinct 40%) removed; and whether they contained the first two, first three, last one, or last two letters. The fragments had multiple solutions.

Procedure

At study, each word was presented for 2 s with 1 s between presentations. Participants were told that the purpose of the study was to record reading times and were instructed to press the space bar as soon as they read the word. They were also told that the words would remain on the screen for a specified amount of time to give everyone a chance to read the word. They were told to keep their eyes on the computer screen for the entire time even if they had already read the word so that they did not miss the onset of the next word. The study phase was identical for all participants regardless of whether they subsequently participated in the direct or indirect memory task. Participants were then given a distracter task that lasted 25 min, in which participants had to list physical properties of objects. This was followed by test instructions that took approximately 5 min.

At test, participants were presented with one of two randomized lists of fragments. The test list consisted of 84 fragments. There were 28 fragments (14 common and 14 distinct) with studied solutions, 28 fragments (14 common and 14 distinct) with nonstudied solutions, and 28 filler fragments. The first 10 fragments presented were fillers, with the remaining 18 fillers randomly appearing throughout the list. Participants were given a maximum of 15 s to complete each fragment.

In the direct test of word fragment cued recall, participants were told to complete the fragments only if they could retrieve the solution from the study list. In the indirect version of the task, participants were told to complete the fragments with the first word that came to mind. Following the indirect test, participants filled out a questionnaire that assessed their possible awareness of the study–test connection and use of intentional memory strategies to complete the fragments. The questions were as follows. What was your general strategy for completing the word fragments? Describe any characteristics you noticed about the sorts of words that you used to complete the fragments. What did you think was the purpose of the fragment completion experiment you just finished? Participants were categorized as "aware" if they indicated for any of the questions that they noticed the connection between the study and test phases. For example, participants were categorized as "aware" if, in response to the first question regarding the characteristics of the words, participants wrote, "Some of them were words I saw earlier." They were also categorized as "aware" if, in response to the second question regarding which strategies they used to complete the fragments, participants wrote, "I used words I saw earlier." Last, if they answered the third question by saying that they thought the word fragment task was a memory test, then they were also categorized as "aware."

Results and discussion

For all analyses, the two-tailed α was set at .05 in this and all subsequent experiments, unless stated otherwise. The mean completion rates for all conditions are presented in Table 1. The dependent variable was the proportion of fragments completed with studied minus nonstudied solutions for common and distinct words in both the direct and the indirect versions of the task. An overall ANOVA examining the effect of the type of test (indirect word fragment completion versus direct word fragment cued recall) on memory for common and distinct words showed a main effect of Word type (common or distinct), $F(1, 198) = 19.45$, $MSE = .03$; and no main effect of Test type, $F(1, 198) = 2.28$, $MSE = .06$. There was no significant interaction between Word type and Test type, $F(1, 198) = .18$, $MSE = .03$, showing that memory for common and distinct words was not differentially influenced by whether the test was direct or indirect. Planned comparisons showed a greater (studied–nonstudied) difference, or more priming, respectively, for orthographically distinct words than common words in the direct, $t(63) = 3.00$, $SE = .03$; as well as in the indirect test, $t(135) = 3.49$, $SE = .02$ (see Fig. 1).

Next, we examined whether explicit memory contamination mediated the orthographic distinctiveness advantage on the indirect test. Interestingly, despite the changes we made to reduce the possibility of contamination from explicit memory strategies, more than half of these participants reported being aware that the word fragment completion task was related to the words presented earlier.[1] An overall ANOVA that

[1] Two independent raters scored the 136 posttest questionnaires, yielding a 96% inter-rater reliability. In all of the eight cases where the raters differed, the answers were ambiguous with respect to awareness such that four cases were labeled as "aware" by one rater and "unaware" by another, and the reverse was true for the other four cases. The inclusion or exclusion of these cases did not change the pattern of results.

Table 1
Completion rates for fragments with common and distinct studied or nonstudied solutions

	Word type			
	Common		Distinct	
	M	(*SD*)	*M*	(*SD*)
Direct				
Studied	.37	(.18)	.52	(.22)
Nonstudied	.11	(.13)	.16	(.14)
Indirect (all)				
Studied	.49	(.17)	.56	(.23)
Nonstudied	.26	(.14)	.25	(.14)
Indirect (aware)				
Studied	.50	(.16)	.60	(.19)
Nonstudied	.27	(.13)	.25	(.13)
Indirect (unaware)				
Studied	.48	(.17)	.52	(.27)
Nonstudied	.25	(.14)	.26	(.14)

examined the effect of awareness on memory for common and distinct words revealed a main effect of Word type (common or distinct), $F(1,134) = 11.57$, $MSE = .03$; but no main effect of Awareness, $F(1,134) = 2.29$, $MSE = .06$, $p = .13$. There was a significant interaction between participants' awareness and priming for fragments with common and distinct solutions, $F(1,134) = 4.52$, $MSE = .03$. Planned *t* tests showed significantly more priming for fragments with distinct solutions than those with common solutions, i.e., the distinctiveness effect, only when participants were aware of the connection between study and test, $t(71) = 4.27$, $SE = .03$. When participants were unaware of the connection between study and test, the effect of orthographic distinctiveness on the indirect test was eliminated,[2] $t(63) = .83$, $SE = .03$ (see Fig. 2). These results support the hypothesis that the previously reported effect of orthographic distinctiveness on word fragment completion with indirect instructions (Hunt & Toth, 1990) was due to participants' use of explicit memory strategies.

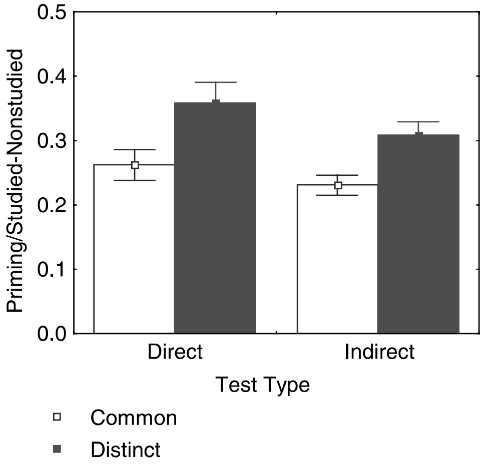

Fig. 1. Priming scores for orthographically common and distinct words using the direct word fragment cued recall test and the indirect word fragment completion test.

Our results have three main implications. First, the absence of an orthographic distinctiveness effect in the "unaware" participants with the simultaneous presence of this effect in the "aware" participants supports Smith and Hunt's (2000) distinctiveness hypothesis that the distinctiveness effect cannot be obtained using an indirect test. Second, the absence of a distinctiveness effect in our "unaware" participants with a secondary distinctiveness manipulation is sim-

[2] A power analysis on the orthographic distinctiveness effect for the "unaware" participants showed that over 1000 participants would be needed to have an 80% chance of detecting an effect size this small (effect size = .16), suggesting that the orthographic distinctiveness effect cannot be obtained under these testing conditions. In contrast, when participants were test "aware," the orthographic distinctiveness effect was large (effect size = .7).

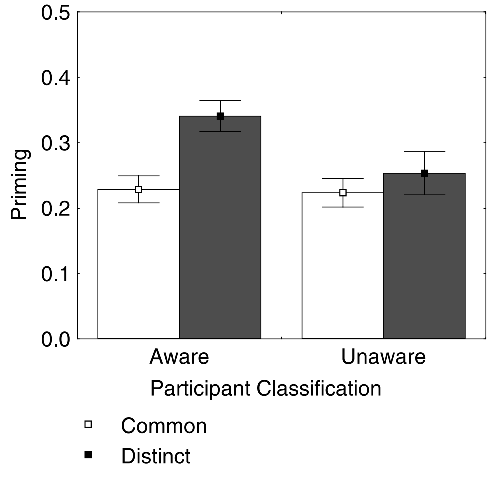

Fig. 2. Priming scores for orthographically common and distinct words on the indirect word fragment completion test for participants who were categorized as "aware" or "unaware."

ilar to the absence of this effect reported by Smith and Hunt (2000) with a primary distinctiveness manipulation. Therefore, while there may be some differences between these two types of distinctiveness (see Schmidt, 1991), our data suggest that, at least with respect to indirect tests, these two classes of distinctiveness share underlying mnemonic processes. Third, the absence of an orthographic distinctiveness effect in our "unaware" participants is seemingly at odds with the tenets of the transfer appropriate processing framework (Roediger et al., 1989) that postulates that perceptual manipulations at study should benefit performance on subsequent data-driven tasks. It is this issue that we explore in Experiments 2a–2c.

To understand why changes in orthography do not influence performance on data driven indirect tests, it is important to consider the following pattern of results. The orthographic distinctiveness effect is obtained on the direct test of free recall (Hunt & Toth, 1990) and recognition (Zechmeister, 1972), but not on indirect tests that rely on perceptual processes as in perceptual identification (Hunt & Toth, 1990) or word fragment completion (present Experiment 1). The consideration that conscious retrieval of study material is necessary to observe the orthographic distinctiveness effect (Smith & Hunt, 2000) nicely accounts for these results. Our aim in Experiments 2a–2c is to understand the processing requirements of the distinctiveness effect that might mediate conscious retrieval in order to explain why orthographic distinctiveness does not influence indirect data-driven tests.

Toward this end, we consider two different accounts of distinctiveness effects. According to one account, the advantage for perceptual manipulations such as orthography results from automatic extraction of perceptual information (Hunt & Elliott, 1980; Hunt & Mitchell, 1978, 1982; Hunt & Toth, 1990). If superior memory for orthographically distinctive words is a result of this process, then the failure to observe better priming for the orthographically distinctive words than common words in tasks such as perceptual identification and word fragment completion is clearly problematic for the transfer appropriate processing account. However, according to another account, even a seemingly perceptual manipulation of distinctiveness influences memory performance via processing that could be characterized as conceptual or comparative in nature (Fabiani & Donchin, 1995).

Fabiani and Donchin (1995) examined the ERP components of the distinctiveness effect using an isolation manipulation in which one item was physically isolated (printed in large font) and one item was semantically isolated (from a different category). Results showed that only the P300 component, which is associated with encoding rare events, where rarity may be manipulated either physically or semantically, reliably predicted superior recall of the isolated item. Interestingly, this was the case for both the physical and the semantic isolates. This finding suggests that both physical and semantic isolation effects are mediated by similar processing. Fabiani and Donchin characterized the processing associated with P300 as conceptual in nature, and suggested that "... the stimulus representation is compared with an ongoing memory representation..." (1995, p. 237) and that it is these comparative processes that predict superior memory for an isolated item.

If we assume that, as with the font manipulation in Fabiani and Donchin's (1995) study, orthographically distinct words are remembered better because participants engage in higher level comparative processing of the common and distinct words at study, and invoke these comparative processes at test, then the entire set of findings for orthographic distinctiveness are consistent with the transfer appropriate processing account. Specifically, these data show that the orthographic distinctiveness effect emerges on memory tests that allow for this comparative processing of distinct words that took place at encoding. This match in processing is possible in conceptually driven tests such as free recall, but not in perceptually driven indirect tests. Therefore, the failure to obtain the orthographic distinctiveness effect on these perceptual indirect tests may be attributable to comparative or evaluative processing, rather than automatic extraction of perceptual information, at study.

We tested this counterintuitive hypothesis in Experiments 2a–2c by manipulating the extent to which people are allowed to engage in conceptual or comparative processes at study. To do this, we used a divided attention manipulation at study, in which participants are required to perform a secondary digit-monitoring task while studying the list of words. We used a divided attention manipulation to test the hypothesis that the orthographic distinctiveness effect is mediated by conceptual processing because dividing attention at study with the digit-monitoring task has been shown to selectively reduce people's ability to engage in conceptual or elaborative processing (Craik, 1982; Eysenck & Eysenck, 1979).

Several studies have confirmed that the secondary task of digit monitoring during encoding produces selective negative effects on memory performance in direct and indirect tests that rely largely on conceptual or elaborative processes. For instance, dividing attention at study impairs performance on direct tests, such as free recall (Baddeley, Lewis, Eldridge, & Thomson, 1984; Johnston, Greenberg, Fisher, & Martin, 1970; Johnston, Wagstaff, & Griffith, 1972; Macht & Buschke, 1983; Martin, 1970; Park, Smith, A, Dudley, & Lafronza, 1989), cued recall (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Craik & McDowd, 1987; Park et al., 1989), and recognition (Craik & McDowd, 1987; Jacoby, 1991; Jacoby, Woloshyn, & Kelley, 1989). Similarly, dividing attention at study using the digit-monitoring task impairs priming on indirect tests that are classified as conceptual in nature, such as category exemplar association, word association, and general knowledge production (Culp & Rajaram, 2001; Mulligan & Hartman, 1996). However, dividing attention at study does not generally influence performance on data-driven indirect tests such as word fragment completion or picture identification (Mulligan & Hartman, 1996; Parkin, 1989; Russo & Parkin, 1993).[3] Thus, the use of a divided attention manipulation at study will allow us to examine whether the orthographic distinctiveness effect results, at least in part, from processes at encoding that require elaboration. If a divided attention task eliminates the advantage of orthographically distinct words over common ones, then this will lend support to the hypothesis that distinctiveness effects, even those that are perceptually manipulated such as the orthographic distinctiveness effect, are also mediated by elaborative or comparative processing at encoding. This finding would fit nicely with our results from Experiment 1, which demonstrate that the distinctiveness effect is not obtained on a perceptual indirect test of word fragment completion. However, if dividing attention at study does not reduce the orthographic distinctiveness effect, then the advantage of orthographically distinct words would have to be explained as the result of automatic extraction of perceptual features at study. This result would be consistent with previous hypotheses (Hunt & Elliott, 1980; Hunt & Mitchell, 1982) that interpret the orthographic distinctiveness effect as resulting from automatic perceptual processing. This finding would, in turn, challenge the transfer appropriate processing framework (Roediger et al., 1989) and suggest that the distinctiveness effect cannot be obtained using indirect tests for reasons other than the match in processing.

The influence of divided attention on memory for orthographically common and distinct words was examined in three experiments using direct memory tests of free recall (Experiment 2a and 2b) and word fragment cued recall (Experiment 2c). We selected the free recall test and the word fragment cued recall test because the orthographic distinctiveness effect is reliably obtained on these tests (Hunt & Toth, 1990; present Experiment 1). We predicted that in the full attention condition, we would replicate previous findings and obtain the orthographic distinctiveness effect in free recall

[3] We note that recent studies (Mulligan & Hornstein, 2000; Rajaram, Srinivas, & Travers, 2001; Stone, Ladd, Vaidya, & Gabrieli, 1998) have shown deleterious effects of Stroop encoding, which creates conditions of divided attention on perceptual tasks as well. However, our reasoning here is restricted to those conditions of divided attention that produce deleterious effects only on conceptual processing, not perceptual processing (e.g., the secondary task of digit monitoring).

(Hunt & Toth, 1990) and word fragment cued recall (present Experiment 1). In the divided attention condition, we predicted that we would obtain overall diminished memory performance for both types of words but that performance for orthographically distinct words would suffer more than the performance of the orthographically common words on both tests.

Experiment 2a

Method

Participants. Forty-eight SUNY Stony Brook students participated for research credit.

Design and materials. The design was a $2 \times 2 \times 2$ repeated measures. Study status (studied and nonstudied), Word type (common and distinct), and Attention condition (divided and full attention) were manipulated in a within-subject design. Attention at study was manipulated in a blocked fashion and the order of blocks was counterbalanced. The distinct and common words were intermixed within each block. All of the study materials were the same as those used in Experiment 1; however, 14 of the 28 words (7 common and 7 distinct) were studied under full attention instructions, and the remaining 14 words were studied under divided attention instructions. Items were counterbalanced across participants for Study status and Attention condition.

Procedure. The procedure was the same as the procedure used in Experiment 1, with the following exceptions. First, based on pilot work, the words were presented for a longer period of time than in Experiment 1 (now 4.5 s with a. 5-s ISI) to avoid floor effects. Second, each participant was tested individually because of the divided attention procedure.

At study, attention was divided by having participants perform a digit-monitoring task (e.g., Culp & Rajaram, 2001; Craik, 1982; Jacoby, 1991) while reading the words on the computer screen. Participants were told to perform both the reading time and the digit monitoring tasks equally well. For the digit-monitoring task, participants heard a series of random digits played on a tape recorder at a rate of 1.5 s and were required to make a check mark on a sheet of paper when they heard a sequence of 3 odd digits played in a row. The experimenter recorded the accuracy of the responses and alerted the participant when a response was incorrect by saying, "miss." There were five target sequences randomly distributed throughout 33 digits, with a minimum of 1 digit and a maximum of 4 digits between each target sequence. No more than 2 even numbers occurred consecutively in the list. Each participant completed a practice run with the digit-monitoring task before beginning the study phase of the experiment.

Following the study phase, the experimenter engaged the participants in a conversation for a couple of minutes to eliminate their reliance on short-term memory. We used a shorter delay in this experiment than the 30-min delay used in Experiment 1 for two reasons. First, unlike Experiment 1, we did not need to be concerned about minimizing explicit contamination and, second, we wanted to avoid floor effects in the performance on free recall. At test, participants were given 7 min to write down as many words as they could remember from the study list.

Results and discussion

The mean proportions of common and distinct words recalled are presented in the top section of Table 2. To ensure that participants' attention was divided, the acceptable level of performance on the secondary task of digit monitoring was set at a minimum of 80% accuracy. The one participant's data whose digit monitoring performance fell below this level was not analyzed. A 2×2 ANOVA using Word type (common/distinct) and Attention condition (full/divided) showed that words studied under full attention were recalled more than words studied under divided attention, $F(1,46) = 65.36$, $MSE = .01$. There was also a main effect of Word type, $F(1,46) = 32.58$, $MSE = .02$, showing that orthographically distinct words were recalled better than orthographically common words. Contrary to our prediction, dividing attention did not significantly reduce recall for distinct words more than common words, $F(1,46) = 2.36$, $MSE = .02$ (see top of Fig. 3).

Because the divided and full attention conditions were manipulated in blocks, we also examined the effect of block order on recall of the common and distinct words. Results showed that block order did not influence recall of words studied under full attention, $F(1,46) = .27$, $MSE = .02$. However, interestingly, there was a significant effect of block order on the recall of common and distinct words studied under divided

Table 2
Effect of dividing attention at study on memory for orthographically common and distinct words for Experiments 2a–2c using free recall and word fragment cued recall tests

	Word type			
	Common		Distinct	
	M	(*SD*)	*M*	(*SD*)
Experiment 2a: Free recall (within subjects)				
Full attention				
All	.19	(.14)	.31	(.18)
First	.25	(.12)	.36	(.16)
Second	.13	(.14)	.26	(.20)
Divided attention				
All	.04	(.08)	.11	(.10)
First	.05	(.09)	.08	(.09)
Second	.03	(.07)	.14	(.09)
Experiment 2b: Free recall (between subjects)				
Full attention	.15	(.12)	.28	(.14)
Divided attention	.05	(.05)	.11	(.07)
Experiment 2c: Word fragment cued recall				
Full attention				
Studied	.44	(.13)	.63	(.17)
Nonstudied	.11	(.10)	.11	(.11)
Divided attention				
Studied	.36	(.17)	.47	(.19)
Nonstudied	.16	(.14)	.19	(.18)

attention, $F(1,46) = 5.90$, $MSE = .01$. Planned comparisons showed better memory for distinct than common words that were studied under divided attention only when the divided attention block was presented second (after the full attention block), $t(22) = 4.03$, $SE = .03$; but not when it was presented first (before the full attention block), $t(23) = .97$, $SE = .02$ (see the bottom section of Fig. 3).

These results suggest that having the full attention condition first may have contaminated the subsequent divided attention condition encoding because people became aware of the distinctiveness of the words in the full attention block and were, therefore, more likely to subsequently notice the distinctiveness of the words even when attention was divided. One way to assess the increased attention to the distinct words when the divided attention block came second would be to examine possible decrements in the secondary task performance. However, we had set the accepted rate of performance at 80%, thereby leaving the range of errors (one of a possible five sequences) too narrow to test this possibility. An alternate empirical way to test the likelihood that participants who received the divided attention block second consciously noted the distinct versus common word differences would be to conduct the full and divided attention manipulation in a between-subjects design. This was the goal in Experiment 2b.

Experiment 2b

Method

Participants. Sixty-four participants took part in return for research credit. Participants were randomly assigned to either the full or divided attention condition.

Design. The design was a $2 \times 2 \times 2$ mixed factorial. Study status (studied and nonstudied) and Word type (common and distinct) were manipulated within subjects, and Attention condition (divided versus full attention) was manipulated between subjects.

Procedure. Experiment 2b was identical to Experiment 2a, except that participants studied the entire list of 28 words (14 common and 14 distinct), as opposed to half the list, under full or divided attention.

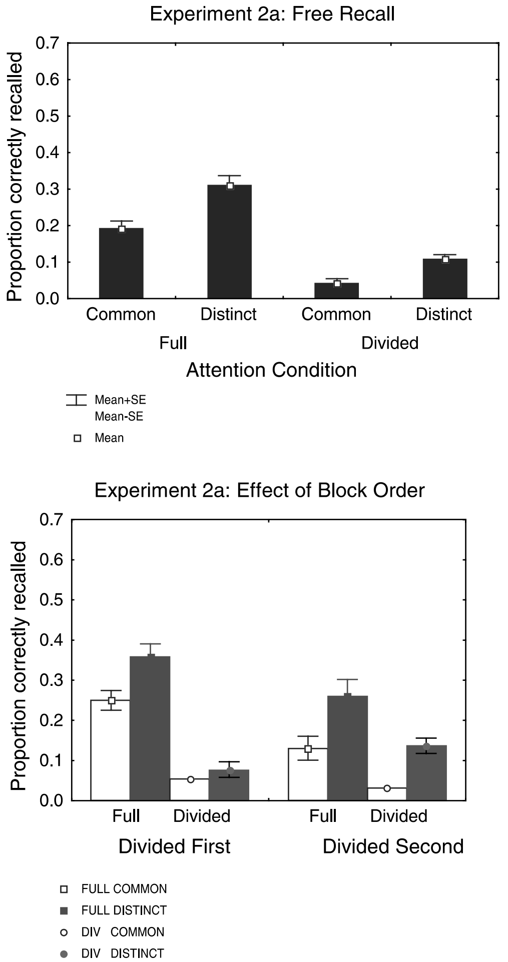

Fig. 3. Effect of dividing attention on free recall of orthographically common and distinct words.

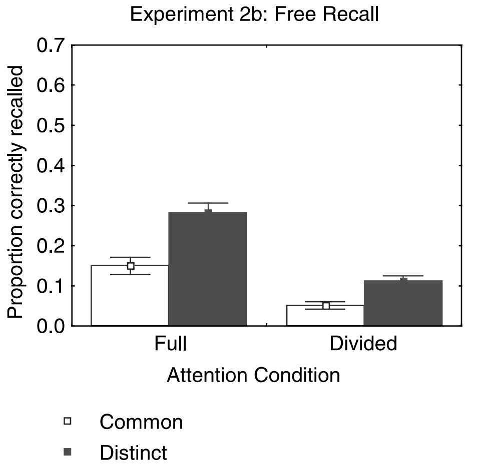

Fig. 4. The effect of dividing attention on free recall.

Results and discussion

The mean proportions of common and distinct words recalled are presented in Table 2. Again the acceptable level of performance on the secondary task was set at a minimum of 80% accuracy. Five participants' scores fell below this level and were replaced. We replicated the main effect of Attention condition (full or divided), $F(1,62) = 42.10$, $MSE = .01$, and found that people recalled more words under full than divided attention. We also obtained a main effect of Word type (common or distinct), $F(1,62) = 39.91$, $MSE = .01$, and found that people recalled more distinct than common words. Results showed a significant interaction between Attention condition (divided versus full) and Word type (common and distinct) on free recall, $F(1,62) = 5.07$, $MSE = .01$, indicating that distinct items were affected more by divided attention at study than were common items (see Fig. 4). Although, orthographically distinct words were recalled better than common words under both the full attention condition, $t(31) = 4.77$, $SE = .03$; and the divided attention condition, $t(31) = 4.63$, $SE = .01$; this effect was larger in the full compared to divided attention condition, as suggested by the interaction.

This pattern of data is not easily interpreted because it is possible that the differential effect of dividing attention on recall of distinct words was merely a result of overall poor memory performance in the divided attention condition. In other words, the overall low memory level in the divided attention condition may have artificially flattened out a potentially larger difference between the common and distinct words in the divided attention task, thus making it appear as though dividing attention differentially reduced memory for distinct words. To address this issue, we divided the participants into two groups of high and low scorers based on their overall level of performance to see if both groups show the same interaction between Word type (common and distinct) and Attention condition (full and divided). We found that both the high and low scorers produced a larger orthographic distinctiveness effect in the Full attention condition (Low scorers = .13; High scorers = .14; Combined = .13) than the Divided attention condition (Low scorers = .05; High scorers = .08; Combined = .07). The larger orthography distinctiveness effect in the Full attention condition almost reached statistical significance for the Low group, $F(1,30) = 3.9$, $p = .06$, two-tailed; though not in the High group, $F(1,30) = 1.51$, $p = .23$. This lack of significance may be attributable to half as many participants in each of these analyses as in the overall analysis. Importantly, this analysis shows a very similar pattern of results for both groups, and this pattern mimicked the overall pattern of data. Nonetheless, because of our overall low levels of memory and the lack of statistical significance in the High Scorer group, we changed the type of test to determine whether the orthographic distinctiveness effect would remain reduced under conditions of divided attention when the overall level of memory performance is not subject to floor effects. To this end, we used a word fragment cued recall test in Experiment 2c, which generally produces higher levels of overall memory than free recall. The use of this test allowed us to determine whether the orthographic distinctiveness effect would remain reduced under divided attention when floor effects do not complicate the interpretation of the data. Therefore, if under conditions of increased memory, we again obtain a reduction in the orthographic distinctiveness effect under divided attention, we can have greater confidence in the conclusion that the orthographic effect is mediated to a large extent by conceptual processes. On this reasoning, the following experiment examines the effect of dividing attention on memory for orthographically common and distinct words using a word fragment cued recall test.

Experiment 2c

Method

Participants. Sixty-four people participated for research credit. Participants were randomly assigned to either the full or divided attention condition.

Design. Again, the design was a $2 \times 2 \times 2$ mixed factorial. Study status (studied and nonstudied) and Word type (common and distinct) were manipulated within subjects and Attention condition (divided versus full attention) was manipulated between subjects.

Procedure. The procedure for Experiment 2c was the same as that for Experiment 2b, except participants were given a word fragment cued recall test instead of a free recall test. The word fragment cued recall test was the same as in Experiment 1.

Results and discussion

The mean proportions of common and distinct words recalled are presented in the bottom section of Table 2. The dependent variable was the proportion of fragments completed with studied minus nonstudied common and distinct solutions. As predicted, a 2×2 ANOVA found a main effect of Attention condition (full vs divided) [$F(1,62) = 22.06$, $MSE = .05$], showing that people completed more word fragments with words studied under full versus divided attention. There was also a main effect of Word type [$F(1,62) = 20.54$, $MSE = .03$], showing that people completed more word fragments with distinct than common word solutions. The interaction between the Attention condition (full or divided) and Word type (common or distinct) was again found to be significant [$F(1,62) = 4.04$, $MSE = .03$] (see Fig. 5). Planned comparisons showed that in the full attention condition people had better memory for the distinct words ($M = .52$) than the common words [($M = .34$); $t(31) = 5.28$; $SE = .03$]. However, unlike the previous experiment that used a free recall test, in this experiment, memory for distinct (.28) and common words (.21) did not differ in the divided attention condition [$t(31) = 1.61$, $SE = .05$].[4] There was no difference in the baseline completion rates across fragments with common and distinct solutions, either in the full attention condition [common $M = .11$ and distinct $M = .11$ [$t(31) < 1$] or the divided attention condition [common $M = .16$ and distinct $M = .19, t(31) = 1.10$].

The main finding of interest showed that dividing attention eliminated the distinctiveness effect when we used a word fragment cued recall test. Taken together, the results from Experiments 2b and 2c show that dividing attention differen-

[4] We conducted a power analysis with the orthographic distinctiveness effect of .19 in the Full attention condition as our reference value. The goal was to determine whether there was sufficient power to detect the orthographic distinctiveness under the conditions of this experiment. The orthographic distinctiveness effect in the full attention condition yielded a large effect size of 1.26. Under these conditions, 30 participants are needed to achieve 100% power, and in our study we tested 32 participants in each of the attention conditions, Full and Divided. Therefore, it is unlikely that our failure to obtain a significant orthographic distinctiveness effect in the divided attention condition is attributable to power issues.

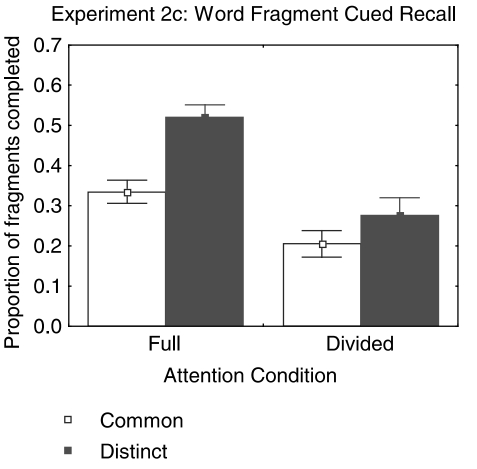

Fig. 5. The effect of dividing attention on word fragment cued recall.

tially reduces the distinctiveness effect using direct memory tests that have different processing demands.

General discussion

We examined the role of conscious awareness and the nature of the processing requirements that mediate the orthographic distinctiveness effect. Experiment 1 used an indirect word fragment completion test to examine whether conscious reference to the study episode is necessary for obtaining the orthographic distinctiveness effect. Results showed that the orthographic distinctiveness effect was obtained only when participants consciously referred back to the study list, as in the case of the participants given the direct test and those given the indirect test that were classified as "aware" of the study–test relationship. This finding replicated previous work that has demonstrated the orthographic distinctiveness effect on other direct memory tests of free recall (Hunt & Mitchell, 1978; Hunt & Toth, 1990), cued recall (Hunt & Mitchell, 1978), and recognition (Zechmeister, 1972). Interestingly, when participants given the indirect test were unaware of the relationship between the study and test phases, there was no effect of orthographic distinctiveness. This result is consistent with the earlier finding showing that the orthographic distinctiveness effect is not obtained using another indirect test of perceptual identification (Hunt & Toth, 1990). The word fragment completion data support our hypothesis that the previously reported distinctiveness effect using an indirect test of word fragment completion (Hunt & Toth, 1990) resulted from contamination from explicit memory strategies.

Experiments 2a–2c tested two different interpretations of the orthographic distinctiveness effect with the goal of understanding the lack of this effect on an indirect test of word fragment completion reported in Experiment 1. One hypothesis suggests that the orthographic distinctiveness effect is mediated by perceptual processing (Hunt & Elliott, 1980; Hunt & Mitchell, 1978, 1982; Hunt & Toth, 1990). Alternately, we hypothesized that this effect may be mediated by comparative processing that could be classified as higher level or conceptual in nature. To directly test these hypotheses, we used a divided attention task that has been shown to selectively reduce conceptual processing. Results from Experiments 2b and 2c showed that dividing attention at study selectively reduced memory for distinct words in free recall and further reduced it in word fragment cued recall, thus supporting the hypothesis that the effect is mediated, considerably, by conceptual processing. The fact that dividing attention differentially reduced the orthographic distinctiveness effect on two different tests with conceptual processing requirements provides converging evidence for the hypothesis that comparative, higher level processes are also involved in mediating better memory for perceptually distinctive information.

We now consider our results and interpretation in the context of prior research on distinctiveness. The view that the orthographic distinctiveness effect is mediated by conceptual comparative processing is inconsistent with previous interpretations that propose that the orthographic distinctiveness effect is mediated by more extensive sensory processing of distinct than common words (Hunt & Elliott, 1980; Hunt & Mitchell, 1878, 1982; Hunt & Toth, 1990). Support for the perceptual processing explanation of the orthographic distinctiveness effect comes from studies showing that when the orthographically common and distinct words are studied under auditory presentation, there is no memory advantage for the distinct words (Hunt & Elliott, 1980; Hunt & Toth, 1990). Similarly, studies have shown that when the orthographically common and distinct words are presented in all capital letters, the distinctiveness advantage is eliminated (Hunt & Elliott, 1980). We agree that under these conditions, the words do not appear unusual. However, we propose that while it is necessary for the items to appear as different from the other more common items and that this perceptual information is the prerequisite for an orthographic distinctiveness effect to emerge, it is the higher order, conceptual interpretation of this difference that leads to better memory for the distinct items. In this sense, we suggest that all distinctiveness effects, even those that are perceptually manipulated, involve conceptual processing.

Longer lexical decision times for distinct words than common words have also been taken as support for the hypothesis that distinct words require more extensive sensory processing (Hunt & Toth, 1990). Results showed that, on average, participants took 783 ms to say that a distinct word was a word, and only 688 ms to say that a common word was a word. However, as Hunt and Toth (1990) also point out, the processing underlying the lexical decision test is not well understood. Therefore, it is possible that factors other than sensory processing could underlie the reported differences in lexical decision times for common and distinct words.

Our divided attention results are also inconsistent with the view that the effect of orthographic distinctiveness is mediated solely by perceptual processing at study that occurs automatically, without attention (Hunt & Elliott, 1980; Hunt & Mitchell, 1982). Hunt and Elliott (1980) showed that under self-paced intentional study conditions, participants studied orthographically distinct words for the same amount of time as orthographically common words. Further, they showed that even though study times were the same for both types of words, orthographically distinct words were still remembered better than common words. In light of the similar study times, Hunt and Elliott (1980) suggested that orthography constitutes item-specific information that is extracted automatically. However, we note that because participants were told to remember the words for a later test and because these study times were relatively long (approximately 10 s for both types), similar study times might simply reflect similar amounts of time participants chose to engage various strategies to remember the words. Instead, our divided attention results suggest that when participants are prevented from paying full attention to the words, the advantage of distinct items is reduced, thus indicating that the processing associated with the orthographic distinctiveness effect is to a considerable extent consciously controlled.

The design of our study does not support a strong version of the hypothesis that distinct items are rehearsed more than common items (Rundus, 1971). We showed that the distinctiveness effect is obtained under incidental study conditions in which participants were under the impression that they were in a reading experiment. And in fact, all but a few participants whose data were replaced believed the cover story and reported not trying to memorize the words at study. Therefore, because our participants did not expect a memory test, there was no apparent need to rehearse the words. This result is consistent with other work that has also obtained the orthographic distinctiveness effect under incidental study conditions (Hunt & Mitchell, 1978) and with work that has shown that differential rehearsal is not necessary for producing the distinctiveness effect in general (Bruce & Gaines, 1976; Dunlosky, Hunt, & Clark, 2000).

It is not clear how well our divided attention data can be accommodated within the bounds of the incongruity theory (Schmidt, 1991). According to this theory, the processing of items that are incongruent with a study context occurs in three phases. In phase 1, distinct items attract attention, but the increased attention occurs automatically and produces a record of information specific to the properties of the individual item. Our divided attention data do not reflect this. Instead we show that the distinctiveness effect is reduced when people are prevented from paying attention to the items. However, it is possible that dividing attention could have influenced the second phase of this process. According to Schmidt (1991), in phase 2, people engage in controlled memory processes that could include elaboration, rehearsal, or noting the relationships between the items in the study set. This theory also makes predictions about the interactive role of the processing in phase 2 and the processing at test that is consistent with our results. Whether the particular processing in this phase aids memory performance, in turn, depends on the participants' strategies and on the retrieval test. Our results support this hypothesis and demonstrate an interaction between the processing at study and the nature of the retrieval test. Moreover, we suggest a specific means by which this occurs. We suggest that the controlled processing is generally conceptual in nature and that to the extent that the test capitalizes on this type of processing, the distinctiveness effect will be obtained.

Similar to the incongruity theory, Fabiani and Donchin (1995) suggest that the processing associated with encoding distinct items can be characterized by both automatic and controlled levels of analysis. The first level is described as occurring relatively early in which incongruent features are extracted automatically, as evidenced by the N400 component and ideally by the negative mismatch component. The other level occurs later and is characterized by more elaborate or conceptual processing of these deviant features. At this level, the stimulus representation is compared to a current context and is updated, as evidenced by the P300 ERP component. They claim that, "the comparison-reorganization process that we believe is manifested by P300 would qualify as a conceptually driven process. Roediger et al. propose that direct memory tests, such as those used in the present study, would be particularly influenced by conceptually driven processes" (p. 237, 1995). Moreover, they showed that only the conceptual processes indexed by the P300 ERP component are associated with superior memory for distinct items, even when distinctiveness was manipulated perceptually, as in the case of capitalizing some words in the study list. Similarly, we suggest that the distinctiveness effect is the product of comparative processes that operate when people evaluate the ways in which an item is different from a standard. Further, we provide behavioral evidence for these processes and show that the effect is obtained under study conditions that support conscious, conceptual processing and not automatic perceptual processing.

Although our data limit us from specifying the exact processes that mediate the distinctiveness effect, our data do support the hypothesis that this process has a substantial consciously controlled component. We hypothesize this consciously controlled component because people evaluate the orthographically distinct item as different from some standard. It is in this sense that we propose the effect is more conceptually driven. We note that this notion of conceptual involvement is distinguishable from the standard notion where conceptual processes are assumed to be involved only when the meaning of individual stimulus items is processed. We have broadened the definition of conceptual processes here and we note that both processing the meaning of a particular stimulus as well as engaging in a controlled, comparative evaluation of a stimulus against its context entail conceptual processes. This, latter, evaluative processing may occur over time, as the context establishes the norm, and may require one to meaningfully compare the information to a standard to make the interpretation that the item is unusual. To do the comparative processing and evaluate the item as "different," one must bring to bear knowledge of a standard and then note that the item is inconsistent with this standard. In this respect, we hypothesize that any comparison process, even one that is motivated by the processing of perceptual differences, requires conceptual processing that involves knowledge of a standard and evaluation of difference. Thus, even though automatic, perceptual processes may be involved in mediating the orthographic distinctiveness effect, our data also point to a substantial involvement of consciously controlled, conceptual processes.

In summary, we examined the locus of the orthographic distinctiveness effect on direct and indirect tests of memory with the goal of examining the role of awareness (Experiment 1) and the processing requirements (Experiments 2a–2c) in mediating this effect. Our results show that the orthographic distinctiveness effect depends on direct reference to the study context and further specify that this constraint may be largely mediated by conceptual or comparative processes, even in cases where distinctiveness emerges from perceptual differences, as in the case of orthographic distinctiveness. These data, in turn, reconcile the predictions from the distinctiveness hypothesis (Smith & Hunt, 2000) and the transfer appropriate processing framework (Roediger et al., 1989).

Appendix

Words	Word fragments
Common	
almond	a l_ _n_
arcade	a r_ _d_
blunder	b_u_d_r
bracelet	b r_c_l e_
cedar	c_d a_
clearance	c_e_ _a n c_
cookie	c_ _k i_
cube	c_b_
elation	e_a t_ _n
entrust	e n_r u_ _
eraser	e_ _s_r
glean	g_ _a n
gloss	g_o_s
grit	g_ i_
kennel	k_n_ _l
loser	l_s e_
mentor	m e n_ _r
mumble	m_ _b_e
platter	p l_ _t e_
postmark	p o_ _m_ _k

Appendix (Continued)

Words	Word fragments
ruler	r u_e_
sailboat	s_ i l_ _a t
seclude	s e_l u_ _
shack	s h_c_
shampoo	s_ _m p_o
trinket	t r_n k_ _
verge	v_ _g e
yeast	y_a s_
Distinct	
afghan	a f_h_ _
asylum	a_ _ _u m
bouquet	b o_ _ _e t
buoyancy	b u_y a_c_
calypso	c_ _y p s_
chauffeur	c_a_f_ _u r
crypt	c_y_t
czar	c_ _r
epitome	e_i t_m_
epoxy	e p_x_
equinox	e q_i n_ _
gawky	g_w k_
gnaw	g n_ _
gnome	g_o m_
khaki	k_a_i
lymph	l y_p_
methyl	m_t_y l
morgue	m_ _g u_
physique	p h_ _ i q u_
pyramid	p_ _a m i_
rhyme	r_y_e
sequoia	s e q_o_ _
sphinx	s_h_ _x
subpoena	s_b p_e_ _
syringe	s_r_n_e
typhoon	t_p_o_n
vinyl	v i_ _l
yacht	y_c h_

References

Baddeley, A., Lewis, V., Eldridge, M., & Thomson, N. (1984). Attention and retrieval from long-term memory. *Journal of Experimental Psychology: General, 113*, 518–540.

Blaxton, T. (1989). Investigating dissociations among memory measures: support for a transfer-appropriate processing framework. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 657–668.

Bruce, D., & Gaines, M. T. (1976). Tests of an organizational hypothesis of isolation effects in free recall. *Journal of Verbal Learning and Verbal Behavior, 15*, 59–72.

Challis, B. H., & Sidhu, R. (1993). Massed repetition has a dissociative effect on implicit and explicit measures of memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 115–127.

Craik, F. I. M. (1982). Selective changes in encoding as a function of reduced processing capacity. In F. Klix, J. Hoffman & E. van der Meer (Eds.), *Cognitive research in psychology* (pp. 152–161). Amsterdam: North-Holland.

Craik, F. I. M., Govoni, R., Naveh-Benjamin, M., & Anderson, N. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General, 125*, 159–180.

Craik, F. I. M., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 474–479.

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

Culp, D., & Rajaram, S. (2001). *Effects of divided attention at retrieval on explicit and implicit memory tests: a test of the Component Process model*. Manuscript under revision.

Dunlosky, J., Hunt, R. R., & Clark, E. (2000). Is perceptual salience needed in explanations of the isolation effect? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 649–657.

Einstein, G. O., & Hunt, R. R. (1980). Levels of processing and organization: Additive effects of individual item and relational processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 6*, 588–598.

Ellis, N. R., Detterman, D. K., Runci, D., McCarver, R. B., & Craig, E. (1971). Amnesic effects in short-term memory. *Journal of Experimental Psychology, 89*, 357–361.

Epstein, M. L., Phillips, W. D., & Johnson, S. J. (1975). Recall of related and unrelated word pairs as a function of processing level. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 1*, 149–152.

Eysenck, M. W., & Eysenck, M. C. (1979). Processing depth, elaboration, of encoding, memory stores, and expended processing capacity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 5*, 472–484.

Fabiani, M., & Donchin, E. (1995). Encoding processes and memory organization: a model of the von Restorff effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 224–240.

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

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

Hamann, S. B. (1990). Level-of-processing effects in conceptually driven implicit tasks. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 970–977.

Hunt, R. R. (1995). The subtlety of distinctiveness: What von Restorff really did. *Psychonomic Bulletin Review, 2*, 105–112.

Hunt, R. R., Ausley, J. A., & Schultz, E. E. (1986). Shared and item-specific information in memory for even descriptions. *Memory & Cognition, 14*, 49–54.

Hunt, R. R., & Elliott, J. M. (1980). The role of nonsemantic information in memory: Orthographic distinctiveness effects on retention. *Journal of Experimental Psychology: General, 109*, 49–74.

Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language, 32*, 421–445.

Hunt, R. R., & Mitchell, D. B. (1978). Specificity in nonsemantic orienting tasks and distinctive memory traces. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 4*, 121–135.

Hunt, R. R., & Mitchell, D. B. (1982). Independent effects of semantic and nonsemantic distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8*, 81–87.

Hunt, R. R., & Seta, C. E. (1984). Category size effects in recall: The roles of relational and individual item information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10*, 454–464.

Hunt, R. R., & Smith, R. E. (1996). Accessing the particular from the general: The power of distinctiveness in the context of organization. *Memory & Cognition, 24*, 217–225.

Hunt, R. R., & Toth, J. P. (1990). Perceptual identification, fragment completion, and free recall: Concepts and data. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 282–290.

Jacoby, L. L. (1978). On interpreting the effects of repetition: Solving a problem versus remembering a solution. *Journal of Verbal Learning and Verbal Behavior, 17*, 649–667.

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

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 110*, 306–340.

Jacoby, L. L., Woloshyn, V., & Kelley, C. M. (1989). Becoming famous without being recognized: unconscious influences of memory produced by dividing attention. *Journal of Experimental Psychology: General, 118*, 115–125.

Johnston, W. A., Greenberg, S. N., Fisher, R. P., & Martin, D. W. (1970). Divided attention: A vehicle for monitoring memory processes. *Journal of Experimental Psychology, 83*, 164–171.

Johnston, W. A., Wagstaff, R. R., & Griffith, D. (1972). Information-processing analysis of verbal learning. *Journal of Experimental Psychology, 96*, 307–314.

Kinoshita, S., & Miller, M. (2000). The orthographic distinctiveness effect on fragment completion: not implicit. *Australian Journal of Psychology, 52*, 63–68.

Light, L. L., Kaya-Stuart, F., & Hollander, S. (1979). Recognition memory for typical and unusual faces. *Journal of Experimental Psychology: Human Learning and Memory, 5*, 212–228.

Macht, M. L., & Buschke, H. (1983). Age differences in cognitive effort in recall. *Journal of Gerontology, 38*, 695–700.

Martin, D. W. (1970). Residual processing capacity during verbal organization in memory. *Journal of Verbal Learning and Verbal Behavior, 9*, 391–397.

McDaniel, M. A., Dunay, P. K., Lyman, B. J., & Kerwin, M. E. (1988). Effects of elaboration and relational distinctiveness on sentence memory. *American Journal of Psychology, 101*, 357–369.

Mulligan, N. W., & Hartman, M. (1996). Divided attention and indirect memory tests. *Memory & Cognition, 24*, 453–465.

Mulligan, N. W., & Hornstein, S. L. (2000). Attention and perceptual priming in the perceptual identification task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 626–637.

Park, D., Smith, A, Dudley, W., & Lafronza, V. (1989). Effects of age and a divided attention task presented during encoding and retrieval on memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 1185–1191.

Parkin, A. J. (1989). The development and nature of implicit memory. In S. Lewandowsky, & J. C. Dunn (Eds.), *Implicit memory: Theoretical issues* (pp. 231–240). Hillsdale, NJ: Erlbaum.

Rajaram, S. (1998). The effects of conceptual salience and perceptual distinctiveness on conscious recollection. *Psychological Bulletin Review, 5*, 71–78.

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

Rajaram, S., Srinivas, K., & Travers, S. (2001). Effects of attention on perceptual implicit memory. *Memory & Cognition, 29*, 920–930.

Roediger III, H. L. (1990). Implicit memory: retention without remembering. *American Psychologist, 45*, 1043–1056.

Roediger III, H. L., & McDermott, K. B. (1993). Implicit memory in normal human subjects. In H. Spinnler & F. Boller (Eds.), *Handbook of neuropsychology* (Vol. 8, pp. 63–131). Amsterdam: Elsevier.

Roediger, H. L., Weldon, M. S., & Challis, B. H. (1989). Explaining dissociations between implicit and explicit measures of retention: A processing account. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of* *memory and consciousness: Essays in honor of Endel Tulving* (pp. 3–41). Hillsdale: Erlbaum.

Roediger, H. L., Weldon, M. S., Stadler, M. L., & Riegler, G. L. (1992). Direct comparison of two implicit memory tests: word fragment completion and word stem completion. *Journal of Experimental Psychology: Learning, Memory & Cognition, 18*, 1251–1269.

Rundus, D. (1971). Analysis of rehearsal processes in free recall. *Journal of Experimental Psychology, 89*, 63–77.

Russo, R., & Parkin, A. J. (1993). Age differences in implicit memory: more apparent than real. *Memory & Cognition, 21*, 73–80.

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

Schmidt, S. R. (1985). Encoding and retrieval processes in the memory for conceptually distinctive events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11*, 565–578.

Schmidt, S. R. (1991). Can we have a distinctive theory of memory? *Memory & Cognition, 19*, 523–542.

Slamecka, N. J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Human Learning and Memory, 4*, 592–604.

Smith, R. E., & Hunt, R. R. (2000). The effects of distinctiveness require reinstatement of organization: The importance of intentional memory instructions. *Journal of Memory and Language, 43*, 431–446.

Srinivas, K., & Roediger III, H. L. (1990). Classifying implicit memory tests: category association and anagram solution. *Journal of Memory and Language, 29*, 389–412.

Stone, M., Ladd, S. L., Vaidya, C. J., & Gabrieli, J. D. E. (1998). Word-identification priming for ignored and attended words. *Consciousness and Cognition, 7*, 238–258.

Tulving, E., Schacter, D. L., & Stark, H. A. (1982). Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Human Learning and Memory, 8*, 336–342.

Waddill, P. J., & McDaniel, M. A. (1998). Distinctiveness effects in recall: differential processing or privileged retrieval? *Memory & Cognition, 26*, 108–120.

Zechmeister, E. B. (1969). Orthographic distinctiveness. *Journal of Verbal Learning and Verbal Behavior, 8*, 754–761.

Zechmeister, E. B. (1972). Orthographic distinctiveness as a variable in word recognition. *American Journal of Psychology, 85*, 425–430.