

Incidental retrieval processes influence explicit test performance with data-limited cues

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In two experiments, the influence of incidental retrieval processes on explicit test performance was tested. In Experiment 1, subjects studied words under four conditions (auditory-shallow, auditory-deep, visual-shallow, and visual-deep). One group of subjects received auditory and visual word-fragment completion; another group received auditory and visual word-fragment cued recall. Results indicated that changes in sensory modality between study and test reduced both recall and priming performances; levels of processing significantly affected only the cued recall test. These results indicated that incidental retrieval processes might affect explicit test performance when retrieval cues are data limited. Experiment 2 supported this conclusion by showing an effect of matching study and test modalities on explicit test performance with fragment but not with copy cues. Taken together, these results support Roediger and McDermott's (1993) suggestion that explicit test performance is influenced by incidental retrieval processes when data-limited retrieval cues are used.

A central issue in the study of explicit and implicit memory is to what extent intentional memory processes influence data-driven tests of implicit memory (Roediger, Weldon, & Challis, 1989). Most researchers have agreed that tests of implicit memory do not always measure only incidental retrieval processes (Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993; Toth, Reingold, & Jacoby, 1994); test performance can be influenced by intentional retrieval as well. The reverse situation, incidental retrieval processes affecting explicit tests of memory, has been largely ignored. However, Roediger and McDermott (1993) suggested that the effect of incidental retrieval on explicit tests might be even more prevalent than the commonly studied explicit contamination of implicit tests, at least when data-limited retrieval cues are used. Empirical support for this suggestion was obtained by Jacoby et al. (1993). They found a substantial effect of automatic (incidental) retrieval influences on stem cued recall performance. In the present paper, we present two experiments

that provide further support for the suggestion that incidental retrieval processes affect explicit test performance with data-limited retrieval cues.

EXPERIMENT 1

Experiment 1 was designed to explore the role test instructions play in determining the type of retrieval processes subjects bring to bear on a memory task. To achieve this goal, we held all other variables constant (including retrieval cues) and only manipulated test instructions (cf. Schacter, Bowers, & Booker, 1989)—implicit instructions for one group of subjects and explicit instructions for another. To assess the contributions of intentional and incidental retrieval processes to each memory task, we manipulated two study variables, one sensitive to incidental retrieval processes and the other sensitive to intentional retrieval processes. Subjects studied words in two different sensory modalities (auditory and visual) and under two levels of processing (deep and shallow). Past research has demonstrated that changing sensory modality between study and test reduces performance on data-driven implicit tests of memory but does not affect conceptually driven explicit tests (Blaxton, 1989; Craik, Moscovitch, & McDowd, 1994; Jacoby & Dallas, 1981; Rajaram & Roediger, 1993; Roediger & Blaxton, 1987). Conversely, levels of processing have been shown to affect conceptually driven explicit tests of memory but to have only a small effect on data-driven implicit tests (Challis & Brodbeck, 1992; see Brown & Mitchell, 1994,

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for a review). Thus, sensory modality is our marker of incidental retrieval processes, whereas levels of processing will mark the contributions of intentional retrieval processes. The effects of study modality and levels of processing were examined on both visual and auditory word-fragment tests.

If a benefit of matching the sensory modality between the study and test phases were observed, this would indicate the presence of incidental retrieval processes; lack of such an advantage for the within-modality condition over the cross-modality condition would indicate that incidental retrieval processes did not strongly affect the memory task in question. Similarly, if deep processing produces better memory than shallow processing, then it would be likely that the memory task in question was being affected by intentional retrieval processes. A small difference between the deep and shallow conditions would indicate that intentional retrieval processes did not strongly affect task performance.

Method

Subjects. Forty University of Toronto students were paid for their participation in this experiment. Twenty subjects were tested under implicit test instructions; the remaining 20 were tested under explicit test instructions.

Design. The present experiment had a 3 (study condition: visual/auditory/nonstudied) by 2 (levels of processing: deep/shallow) by 2 (test modality: visual/auditory) by 2 (test instruction: implicit/explicit) mixed design. Study condition, levels of processing, and test modality were manipulated within subjects; test instructions were manipulated between subjects. The order of the four study conditions, A-D (auditory-deep), A-S (auditory-shallow), V-D (visual-deep), and V-S (visual-shallow), was randomized across subjects and presented in blocks. Similarly, during the test phase, the order of test modality (auditory and visual) was randomized across subjects and presented in blocks.

Materials. The stimulus pool for the present experiment consisted of 150 words and visual fragments taken from the Roediger, Weldon, Stadler, and Riegler (1992) pool of words. Most visual fragments had only one solution; however, several multiple-solution fragments did appear in the stimulus pool. Auditory fragments were created for each word by digitizing spoken words using an IBM PC with a Sound Blaster sound card. The digitized form of the spoken word was then edited with the Wave Studio program, removing parts of speech and replacing them with equivalent amounts of silence (see Habib, 1996). Auditory word fragments sound similar to stuttered versions of their corresponding words.

The stimulus pool was divided among 10 lists of 15 words. The lists were counterbalanced such that each appeared at least once in each of the experimental conditions (including the nonstudied condition). Fifty new words were used as filler items on the fragment completion and fragment cued recall tests.

There were four study conditions made by crossing study modality (auditory/visual) with levels of processing (physical/semantic). Thirty words were studied in each condition, for a total of 120 words from the pool of 150 words. The remaining 30 words served as nonstudied items. Each test list consisted of 100 words: 60 previously studied words (15 from each study condition), 15 new words, and 25 filler items which were not analyzed further.

Procedure. Depending on the study condition (A-S,A-D,V-S,V-D), subjects were instructed to either read or listen to a list of words and to rate the pleasantness of each item on a 5-point scale (V-D/A-D), to rate the loudness of each word (A-S) on a 5-point scale, or to count ascenders and descenders (V-S). In the visual condition, words were presented at the center of the computer screen in roman font. In the auditory condition, words were presented over headphones connected to the computer. The subjects were alerted to the upcoming presentation of the auditory and visual stimuli by a preceding + sign, presented for 500 msec. Thereafter, the subjects were provided with as much time as

necessary to type in their responses. The next stimulus was presented only after an appropriate response was recorded.

Immediately following the four study conditions, the test instructions were presented to the subjects on the computer screen. Depending on the test condition, the subjects were instructed to either read or listen to the word fragment, which was presented either on the screen or over the headphones. The visual fragment remained on the screen for up to 8 sec. The auditory fragment was presented twice in succession over the headphones, with a 6-sec delay starting after the second presentation. The subjects could enter their responses any time before the next stimulus presentation, which was initiated automatically either by a subject's response or by an elapsed presentation duration. Immediately after the first test was completed (auditory or visual), the second test began. Subjects in the implicit condition were instructed to respond to each word fragment with the first word that came to mind. Subjects in the explicit condition were instructed to use each word fragment as a cue for the retrieval of a word from the study phase and were discouraged from guessing.

Results and Discussion

Priming scores (studied minus nonstudied completion scores) and recall scores corrected for guessing¹ (studied minus nonstudied recall scores) on the visual and auditory word-fragment completion and word-fragment cued recall tasks are presented in Table 1. On both the visual and auditory word-fragment completion tasks, priming was observed in all conditions. One-tailed paired-sample *t* tests showed that the levels of priming were statistically significant in all conditions ($p < .05$), with the exception of the A-S study condition on the visual word-fragment completion task, in which case the priming effect was marginally significant ($p < .10$).

A four-way ($2 \times 2 \times 2 \times 2$) analysis of variance (ANOVA) was carried out on the corrected completion scores. Study modality, test modality, and levels of processing represented within-subjects factors, and test instructions represented the between-subjects factor.

The analysis revealed significant ($p < .001$) main effects of test instruction [$F(1,38) = 15.04, MS_e = 0.07$] and levels of processing [$F(1,38) = 109.63, MS_e = 0.02$]. Two two-way interactions reached significance. The first was between study modality and test modality [$F(1,38) = 54.85, MS_e = 0.02$], reflecting greater performance in the within-modality condition than in the cross-modality condition. The second interaction was observed between levels of processing and test instruction [$F(1,38) = 44.69, MS_e = 0.02$], reflecting a significant benefit of deep over shallow processing on only the explicit memory test. Nei-

Table 1
Priming and Corrected Recall Scores on the Implicit and Explicit Fragment Tests

Retrieval Instructions	Test Modality	Study Conditions			
		Visual		Auditory	
		Shallow	Deep	Shallow	Deep
Implicit	visual	.19	.24	.04	.10
	auditory	.09	.12	.16	.21
Explicit	visual	.19	.46	.18	.35
	auditory	.04	.34	.12	.43

Note—Baseline completion rate in visual word-fragment completion = .33 and in auditory word-fragment completion = .40. Guessing rate in visual word-fragment cued recall = .09 and auditory word-fragment cued recall = .12.

ther the remaining two-way and three-way interactions nor the four-way interaction reached significance.

The most important finding was that sensory modality, our marker of incidental retrieval processes, affected both explicit and implicit test performance, whereas levels of processing, our marker of intentional retrieval processes, affected only explicit test performance. In 15 of 16 relevant comparisons (across-study modality, test modality, and test instructions), performance was greater in the within-modality condition than in the cross-modality condition (the only exception was due to an unexpectedly high performance in the A-S condition on the visual explicit test). Similarly, in all conditions, the difference in performance following deep and shallow encoding was larger on the explicit test than on the implicit test. This finding may reflect the fact that when data-limited retrieval cues are used, both intentional and incidental retrieval processes affect explicit tests of memory, whereas intentional retrieval processes do not seem to affect implicit test performance to the same extent (see Jacoby et al., 1993; Roediger & McDermott, 1993). The purpose of Experiment 2 was to test this idea further.

EXPERIMENT 2

In Experiment 2, we crossed study and test modalities and examined memory performance on two explicit memory tests: word-fragment cued recall and recognition. On the basis of the results of Experiment 1, we predicted that incidental retrieval processes would influence performance to a greater extent on a data-limited test than on a test with complete cues. We thus expected to find a larger modality effect on the fragment cued recall test than on the recognition test.

Method

Subjects. A total of 24 participants were tested in the experiment, either as volunteers or for pay. Half of the subjects participated in the recognition test, and the other half participated in the word-fragment cued recall test.

Design. Study modality (auditory/visual) and test modality (auditory/visual) were manipulated within subjects, and test type (word-fragment cued recall/recognition) was a between-subjects factor. All three factors were fully crossed. A nonstudied condition was also present on each test list. Study and test modality orders were selected randomly for each subject.

Materials. A total of 240 words were selected from the same pool of words as in Experiment 1. Visual and auditory word fragments were created in a similar manner. The pool of words was divided among eight lists of 30 words. Six of these lists served as target and distractor lists, while the remaining two lists were used as filler items to equate the number of target and distractor items on each test. The lists of target and distractor items were counterbalanced, while the filler lists were not (and hence, were not scored).

Each study list consisted of 60 items, 30 to be tested in each test modality. Each test list consisted of 120 items, 60 of which had been studied previously (30 in the congruent modality, 30 in the incongruent modality), 30 new items, and 30 filler items. A unique set of target, new, and filler items were presented on each test.

Procedure. At study, subjects intentionally encoded two lists of words, one visually and one auditorily. The words either were presented at the center of the computer screen or were spoken in a female voice over speakers attached to the computer at a rate of one word every 2 sec. Fol-

lowing the second study list, the subjects were presented either with instructions for the auditory or the visual recognition test or with instructions for the auditory or visual word-fragment cued recall test, depending on the test modality order (auditory/visual) and test condition (recognition/cued recall). In the recognition test, the subjects were instructed to press either a button marked "YES" or a button marked "NO," depending on whether or not they recognized the word. In the word-fragment cued recall test, subjects were instructed to type a solution to the word fragment that was presented during the study phase; they were explicitly instructed not to enter a response that had not been studied. Similar to the study phase, words or fragments were presented at the center of the screen or spoken in a female voice over speakers connected to the computer. In the visual condition, the subjects were given 8 sec to make a response; in the auditory condition, they heard the cue twice in succession and were given 6 sec in which to provide a response. Following the first test, instructions were presented for the remaining modality. This was followed immediately by the actual test.

Results and Discussion

Corrected recognition (hits minus false alarms) and recall scores (studied minus nonstudied recall scores) on the visual and auditory explicit memory tasks are presented in Table 2.

A three-way ANOVA ($2 \times 2 \times 2$) was carried out on corrected recognition (hits - false alarms) and corrected recall (studied - nonstudied) scores. Study modality and test modality were within-subjects variables, and test type was a between-subjects variable. The ANOVA revealed four significant effects ($p < .005$): the main effect of test type [$F(1,22) = 97.76$, $MS_e = 0.06$], an interaction between test type and test modality [$F(1,22) = 10.37$, $MS_e = 0.01$], an interaction between study modality and test modality [$F(1,22) = 18.97$, $MS_e = 0.00$], and a three-way interaction between study modality, test modality, and test type [$F(1,22) = 11.38$, $MS_e = 0.00$]. The critical effect was the last interaction, showing a benefit of the within-modality condition over the cross-modality condition on word-fragment cued recall but not on recognition.

The results of Experiment 2 replicated and extended those of Experiment 1 by showing that when the cues are data limited, incidental retrieval processes will influence test performance, as evidenced by a modality effect on word-fragment cued recall but not on recognition. When the cues were complete, our index of incidental retrieval processes did not affect test performance. This is likely due to the fact that subjects have to complete the cues in the word-fragment cued recall test before making a recognition decision, and this completion process draws upon incidental retrieval processes.

Table 2
Corrected Recognition and Cued Recall Scores

Test Type	Test Modality	Study Modality	
		Visual	Auditory
Recognition	visual	.64	.71
	auditory	.58	.68
Cued recall	visual	.28	.13
	auditory	.12	.17

Note—False-alarm rate in visual recognition = .07 and in auditory recognition = .10. Guessing rate in visual word-fragment cued recall = .14 and in auditory word-fragment cued recall = .07.

GENERAL DISCUSSION

The purpose of the present study was to test Roediger and McDermott's (1993) suggestion that incidental retrieval processes might affect explicit test performance when data-limited retrieval cues are used. We found that explicit word-fragment cued recall was affected by study-test modality changes (Blaxton, 1989; Roediger et al., 1987), whereas recognition performance was not. Under the assumption that test performance generally represents a blend of intentional and incidental retrieval processes, and given that the size of the modality effect can be used as a marker for the relative contribution of incidental processes, our findings support Roediger and McDermott's suggestion that incidental processes can influence explicit test performance when the retrieval cues are data limited. They are also in line with previous findings by Jacoby et al. (1993), suggesting that explicit tests of memory can be influenced by incidental retrieval processes.

Our results also suggested that intentional retrieval processes, as indexed by the magnitude of the levels-of-processing effect (Experiment 1), did not substantially affect implicit test performance. This finding, too, is in agreement with Roediger and McDermott's (1993) hypothesis that subjects are unlikely to attempt intentional retrieval with data-limited retrieval cues and implicit test instructions (see also Roediger & McDermott, 1996). While this does not mean that subjects do not become consciously aware of the relationship between the target item and the previous study phase, this awareness comes about as a product of incidental completion of the fragments (Richardson-Klavehn, Gardiner, & Java, 1994).

More generally, our results indicate that intentional retrieval processes should not be seen as the preferred "mode of operation." Rather, what determines which type of retrieval processes (intentional or incidental) will dominate is jointly determined by test instructions and the nature of the retrieval cues.

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NOTE

1. In Experiments 1 and 2, we subtracted the completion rate for new items from the completion rate for old items on the explicit word-fragment cued recall tasks. Jacoby et al. (1993) point out that this correction is based on the assumption that the probabilities of recollecting that an old item had been presented previously and a new item had not been presented previously are equivalent, an assumption which often is not met. For our results, applying this correction does not change the outcome of the analyses, because we are interested in differences between various encoding conditions within a particular test modality, and for each test modality there is only one guessing rate (new condition). Thus, applying the guessing correction only serves to subtract a constant value from all the encoding conditions within a particular test modality.

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