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Perceptual and Conceptual Processes in Implicit and Explicit Tests with Picture Fragment and Word Fragment Cues

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In two experiments subjects studied mixed lists of pictures and words presented once (P, W), twice in the same form (PP, WW), or twice in different forms (PW, WP). The different-form condition repeated the concept but not the perceptual features of the stimulus. In Experiment 1, subjects received either an implicit word fragment completion (WFC) test, an implicit picture fragment identification (PFI) test, or a word-recognition test. On the WFC and PFI tests, neither repetition effects nor cross-form priming were obtained, indicating that performance was predominantly data-driven. However, repetition benefited recognition. In Experiment 2, subjects received explicit tests with either the word fragments or picture fragments as retrieval cues. Repetition effects and cross-form recall were now obtained on both tests, showing that conceptual processing contributed to performance. These dissociations are consistent with a transfer appropriate processing framework and suggest that explicit memory tests engage more conceptual processing than implicit tests, even with test cues held constant. The results meet the retrieval intentionality criterion and indicate that the implicit tests were not measurably contaminated by intentional recollection.

Investigators have been intrigued by differences between implicit and explicit memory tests for a number of years, and discoveries about the ways in which they differ continue to increase. Explicit tests are those that require intentional retrieval of a prior event and include free recall, cued recall, and recognition tests. Implicit tests are those on which subjects are instructed to respond to each test stimulus with the first suitable response that comes to mind, but typically are not told that the test items refer to previously studied items. Retention is reported as priming, a measure of facilitation or bias in responding to test stimuli that refer to studied relative to unstudied items. Examples of implicit tests include word completion (providing missing letters for partial words like *_ku_k, sku___*) and category production (providing exemplars of a category like *mammals*).

Implicit and explicit tests are dissociable; variables that have one pattern of effects on one type of test often have opposite or no effects on the other type. For example, amnesics exhibit preserved priming on most

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implicit tests but impaired performance on explicit tests (e.g., Graf & Schacter, 1985; Graf, Squire, & Mandler, 1984; Warrington & Weiskrantz, 1970). Also, semantic processing typically improves performance on explicit but not implicit word fragment and word stem completion tests (Graf & Mandler, 1984; Roediger, Weldon, Stadler, & Riegler, 1992; but see Challis & Brodbeck, 1992). A host of other variables that dissociate implicit and explicit tests are reviewed elsewhere (see Richardson-Klavehn & Bjork, 1988; Roediger & McDermott, 1993; Schacter, 1987).

These dissociations have been explained in a variety of ways. The approach that guided the present work is the *transfer appropriate processing* framework developed by Roediger and colleagues (e.g., Blaxton, 1989; Roediger, 1990; Roediger, Weldon, & Challis, 1989), which is based on key elements of earlier works (Jacoby, 1983; Kolers, 1979; Morris, Bransford, & Franks, 1977). Three important tenets of this approach are as follows. First, performance on a memory test will benefit to the extent that the operations required to perform the test recapitulate those engaged during prior learning (see Morris et al., 1977). Second, tests can be characterized by the extent to which different processes govern performance, such as whether primarily conceptual or perceptual processing constitutes the critical challenge to successful retrieval. Note that this is not a dichotomous variable; performance on a particular task is unlikely to engage exclusively one type of processing (Bassili, Smith, & MacLeod, 1989; Challis & Brodbeck, 1992; Dunn & Kirsner, 1989; Jacoby, 1991; Weldon, 1991, 1993; Weldon & Jackson-Barrett, 1993), and most tests engage mixtures of these processes as well as others, such as lexical processing (Basden, Bonilla-Meeks, & Basden, 1994; Weldon, 1991, 1993; Weldon & Jackson-Barrett, 1993). However, because successful performance on many tasks depends primarily on either perceptual or conceptual processing, this distinction provides a convenient way to illustrate how the principle of transfer appropriate processing can account for test dissociations.

Third, dissociations will occur when there is a differential match between the processes engaged in the encoding and retrieval tasks. For example, on a primarily conceptual test, performance will be improved by manipulations that engender meaningful processing, such as the elaboration of the concept or the formation of associations during a deep level-of-processing task. However, performance is relatively insensitive to changes in the perceptual features of the encoding and test stimuli. In contrast, performance on a predominantly perceptual (or data-driven) test is affected by the surface similarity between the study and test stimuli, because the physical features drive the type of retrieval processes that occur. For example, reading a word may engage orthographic processing and also lexical or word-unit processing (see Weldon, 1991), processes which are recapitulated while later trying to provide the information missing from a word fragment. Similarly, viewing a picture may engage structural processing, which is recruited while trying to resolve a picture fragment. However, data-driven tests are less sensitive to manipulations of meaning.

Many dissociations between implicit and explicit tests can be explained by noting that historically, most implicit tests have been perceptually based (e.g., word completion, perceptual identification) and most explicit tests conceptually based (e.g., recall, recognition; see Blaxton, 1989; Roediger et al., 1989; Roediger, 1990). Thus, because they engage different processes, they are readily dissociated. However, it is important to note that these types of processing are not necessary properties of implicit and explicit tests. For example, Blaxton (1989) devised a conceptual implicit test and a perceptual explicit test. She found that implicit and explicit conceptual tests behaved similarly, and were dissociable from implicit and explicit perceptual tests, which also behaved similarly to one another. Thus, dissociations between implicit and explicit tests cannot be properly characterized without considering the processing requirements of the tests.

We are interested in applying the transfer appropriate processing framework to explain why pictures and words are remembered on implicit and explicit tests and in particular how the relative contribution of perceptual and conceptual processing shifts on implicit and explicit tests. Past research has demonstrated that pictures are remembered better than words on tests like free recall and recognition (Madigan, 1983; Paivio, 1971; Paivio, Rogers, & Smythe, 1968; Shepard, 1967). Prior evidence also suggests that the meaning of pictures is encoded more readily (e.g., Nelson, Reed, & McEvoy, 1977) and richly than that of words (see discussion in Madigan, 1983). For example, pictures are categorized faster than words (Potter & Faulconer, 1975; Smith & Magee, 1980), and the picture superiority effect is reduced or eliminated when words are encoded meaningfully (Durso & Johnson, 1980). Such findings suggest that pictures more readily or regularly access semantic codes. From this, Weldon and Roediger (1987) suggested that pictures are remembered better than words on free recall because this test is predominantly concept-driven; elaborations and associations aid conscious recollection, so the meaningful processing that is more likely to accompany pictorial than word encoding will favor picture over word recall.

Applying the transfer appropriate processing logic, it follows that one should be able to reverse this effect and find better memory for words on an appropriate test. Weldon and Roediger (1987) suggested that the word fragment completion (WFC) test would be such a test. Because subjects must resolve perceptually degraded word stimuli, performance should depend on the similarity between the perceptual processes engaged at study and test. Therefore, relative to viewing a picture, the process involved in reading a word, such as the visual processing of orthographic and lexical information, should transfer better to resolving a fragmented word. This result was obtained. On an implicit WFC test words produced more priming than pictures. Weldon and Roediger (1987) further argued that it was not the implicit nature of the WFC test per se that was responsible for the reversal of the picture superiority effect, because when subjects were given a pictorial analogue in which they had to identify fragmented pictures, pictures then produced more priming than words.

But what might be the effect of changing an implicit perceptual test into a cued recall test? Arguably, explicit retrieval engages conceptual processing because subjects typically use meaning and associations to aid intentional retrieval. If subjects are told to use word fragments as retrieval cues, will pictures be remembered better than words due to the increased value of conceptual information? Two experiments have demonstrated otherwise. When word stems or fragments have been given as cues for intentional retrieval, the picture superiority effect has not been obtained (Roediger et al., 1992; Roediger & Weldon, 1987; Weldon, Roediger, & Challis, 1989), although the advantage of words over pictures is reduced relative to implicit test conditions. These findings suggest that even under explicit retrieval conditions perceptual processing played a major role in guiding retrieval. However, these findings do not rule out the possibility that explicit word completion tests also engage more conceptual processing than do the implicit versions of these tests. For example, Roediger et al. (1992) obtained a level-of-processing effect on explicit but not implicit word-fragment and word-stem completion tests. The following experiments were designed to investigate how the balance of perceptual and conceptual processing changes when word and picture fragments are used as implicit versus explicit test cues.

In both experiments, subjects received

study lists containing a mixture of once-presented words (W), once-presented pictures (P), twice-presented words (WW), twice-presented pictures (PP), word–picture repetitions (WP), and picture–word repetitions (PW). The average lag between repetitions was 12 items. Experiment 1 assessed performance on two implicit perceptual tests, word fragment completion (WFC) and picture fragment identification (PFI), and on one explicit conceptual test, word recognition. (Examples of the fragment test cues are presented in Fig. 1.) In Experiment 2, the study conditions and fragment test cues were the same, but the tests were administered as explicit tests by telling subjects to use the fragments to help them remember items from the study list.

The predicted effects of the manipulation of surface form (picture vs words) are relatively straightforward because they are documented in previous research. Because performance on the implicit tests is extensively data-driven, the studied items should produce large amounts of priming on the same-form tests (pictures on the PFI test, words on the WFC test) but little or no cross-form priming (Gabrieli, Keane, Stanger, Kjelgaard, Corkin, & Growdon, 1994; Hirshman, Snodgrass, Mindes, & Feenan, 1990; Roediger et al., 1992; Weldon, 1991, 1993; Weldon & Jackson-Barrett, 1993; Weldon & Roediger, 1987;

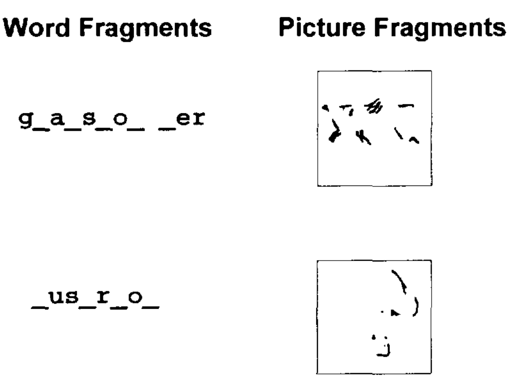

FIG. 1. Examples of word fragments and picture fragments used in the experiments reported here. Solutions are *grasshopper, mushroom.*

Weldon et al., 1989). However, if intentional retrieval is influenced by conceptual processes, then on the picture fragment and word fragment cued recall tests cross-form retrieval should be observed because the target concepts were encoded during the study phase, even though they were presented in different physical forms.

The more novel manipulation concerns the effects of item repetition. Prior research has demonstrated that repetition improves performance on explicit conceptual tests like recall and recognition. Repetitions can be either massed (lag = 0; the item is repeated immediately) or spaced (lag > 0; at least one item intervenes between the first and second presentations). On free recall both massed and spaced repetitions improve memory, with spaced repetitions typically improving memory more (Hintzman, 1974; Madigan, 1969; Melton, 1970). Several possible explanations have been proposed, including the possibility that (a) massed repetitions receive less rehearsal or processing than spaced repetitions (e.g. Greene, 1989); and (b) because the context changes when repetitions are spaced, encodings will be more elaborated and hence more retrievable (Melton, 1970). For the present research the important point is that repetitions seem to engage more meaningful or elaborative processing, especially if the repetitions are spaced (Challis & Sidhu, 1993; Roediger & Challis, 1992).

Research investigating repetition effects on implicit perceptual tests shows that such effects are weak or absent (e.g., see Roediger & McDermott, 1993, for a review). Investigators have consistently failed to find an increase in priming with massed repetitions relative to single presentations on the word identification and word completion tests (e.g. Challis & Sidhu, 1993; Greene, 1990; Jacoby & Dallas, 1981; Perruchet, 1989). However, the effects of spaced repetitions are somewhat inconsistent. On the word fragment completion test, Parkin, Reid, and Russo (1990) reported no advantage of spaced repetitions, Challis and

Brodbeck (1992) and Roediger and Challis (1992) found a small advantage of spaced repetitions in some experiments but not others, and Greene (1990) reported a significant advantage of spaced repetitions in one experiment. Overall, the data suggest that spacing effects are either small or nonexistent on implicit perceptual tests.[1] To our knowledge, there has been no work examining repetition effects on the PFI test, but since we consider it the pictorial analogue of the WFC test, we expect it to behave in a parallel fashion and exhibit little or no benefit of item repetition. However, when the PFI and WFC tests are administered as explicit tests, we predict they will engage more conceptual processing, and thus both should exhibit repetition effects. We chose to test only spaced repetitions in these experiments because spaced repetitions are thought to promote more elaborative processing, which provides a better test of our hypothesis.

In addition to testing our primary hypotheses, these experiments accomplish two other goals. First, they provide an opportunity to learn more about the nature of picture fragment identification, which has received considerably less attention than word completion (but see Gabrieli, et al., 1994; Hirshman et al., 1990; Srinivas, 1993; Weldon & Roediger, 1987). Second, these experiments apply the retrieval intentionality criterion to determine whether the implicit tests are contaminated by intentional retrieval. Some investigators have been concerned about the use of the WFC test as an incidental memory test. The test is difficult, and subjects are usually given a long period of time of solve each fragment (typically 10 to 15 s). Subjects might think back to the study list to help their performance and thus use intentional retrieval strategies, as argued by Graf and Mandler (1984) among others. Schacter, Bowers, and Booker (1989) have suggested that if the retrieval intentionality criterion is met in a comparison of implicit and explicit memory tests, then the implicit test is not measurably contaminated by intentional retrieval. This criterion requires that the only difference between the implicit and explicit tests be the test instructions; the study and test materials must be identical so that test strategies are not confounded with differences in materials or other task variables. (However, we will suggest that this is overly simplified because changing task instructions does affect the type of processing that occurs). Furthermore, an experimental manipulation must be incorporated that selectively affects performance on one test but not the other. If these conditions are met, then dissociations between the tests can be attributed to the effects of intentional versus incidental retrieval. The present design permits the application of this logic to evaluate whether WFC and PFI are in fact incidental tests under our conditions.

Experiment 1

Experiment 1 was conducted to assess the effects of within-form and cross-form repetitions on priming on the implicit WFC and PFI tasks. A word-recognition test was included as a manipulation check to ensure that repetition effects were obtained in the expected manner on an explicit conceptual test.

On the WFC and PFI tests, little or no cross-form priming should be obtained and little or no benefit of item repetition should be observed because fragment completion depends mainly on perceptual processes. However, on the recognition test, we expected to observe benefits of both same-form and different-form repetitions because performance will largely depend on engaging conceptual processes, regardless of the surface form of the study items. Such effects have been obtained on the free recall

[1] Little work has been conducted to examine repetition effects on implicit conceptual tests, but it appears that both implicit and explicit conceptual tests exhibit repetition effects (Challis & Sidhu, 1993), supporting our suggestion that repetition enhances elaborative processing.

test (Paivio, 1974; Paivio & Csapo, 1973), and we expected to replicate them here.

Method

Subjects and design. The subjects were 126 undergraduates at the University of California, Santa Cruz, who participated for credit in lower division psychology courses. All subjects were native English speakers and had normal or corrected vision.

Subjects participated in one of three different test conditions: implicit WFC, implicit PFI, or explicit recognition. The independent variable was encoding condition, which had seven levels manipulated within subjects: once-presented words (W), once-presented pictures (P), repeated words (WW), repeated pictures (PP), mixed repetitions (WP or PW), and nonstudied items (NS).

Materials. Fifty-six target items were selected from the Snodgrass and Vanderwart (1980) picture norms and from Weldon and Roediger's (1987) pool of items. Two slides were prepared for each item: a black-and-white line drawing and a word slide with the name of the item typed in black lowercase Courier font. Norms collected earlier on a different group of subjects indicated that naming consistency for the pictures averaged 97%, ranging from 88 to 100% for individual items.

The target items were randomly divided into seven sets of eight items. Seven lists were created by rotating the sets through the seven encoding conditions (including the nonstudied condition). Six subjects in each test group studied each list. Therefore, the items were completely counterbalanced across encoding and test conditions.

The length of each study list exceeded the capacity of a single slide tray, so all lists were divided into two sublists, each containing four items from each of the six study conditions (W, P, WW, PP, WP, PW). Each sublist was placed into a separate slide tray and arranged so that the average lag between repetitions was 12 items, ranging from 9 to 16 items. The average lag within each repetition condition did not differ significantly: WW = 11.75 items, PP = 12.25 items, WP = 12.25 items, and PW = 11.25 items. The different encoding conditions were distributed evenly through each of the two sublists. Three buffer items were placed at the beginning and end of each sublist; these were pictures and words that were similar to the targets but were not scored. Each sublist thus contained 46 slides; the subjects studied the sublists in immediate succession. Overall, the entire list presentation to each subject included 92 slides.

The WFC test consisted of 96 fragments in random order, 56 targets and 40 fillers; the ratio of studied to nonstudied items was 1:1 (8 targets were nonstudied). Each fragment had a unique solution. The PFI test contained 96 picture fragments like those illustrated in Fig. 1. Fifty-six of the items were fillers (but not all were the same fillers used on the WFC test), so that half the items were nonstudied. The recognition test contained intact words for the same 96 items from the WFC test; half the items were nonstudied. On all tests only the targets were scored.

Procedure. Subjects were tested in groups of two to four individuals, and were told they were helping prepare materials for a future research project. To ensure subjects' attention to each item during the encoding phase, they were instructed to rate the graphic quality of each slide on a scale from 1 (poor quality) to 5 (good quality). (The slides were not designed to vary on this dimension; subjects responded to natural variation in the reproductions). The slides were presented for 4.25 s each with a change time of .75 s. The slides were in two separate trays; about 10 s elapsed between the end of the first tray and the beginning of the second.

After viewing the slides, subjects performed two filler tasks. They completed the short form of the Need for Cognition questionnaire (Cacioppo, Petty, & Kao, 1984) for 4 min and solved mazes for 8 min.

Subjects were then administered one of the three tests; all subjects within a particular experimental session received the same test. On the WFC test, subjects were told they were playing a word game and were instructed to try to solve each fragment, one at a time. They were given a cover sheet to conceal upcoming fragments, and were told to work on each fragment for only 12 s and not to work ahead or go back to any fragments. The task was timed by a tape which said "next" every 12 s. They were given a short break halfway through the test.

The PFI test was administered like the WFC test, except that subjects were given a booklet with the picture fragments and wrote their answers on a separate piece of paper. Subjects were allowed 12 s to identify each picture fragment and used a cover sheet to conceal upcoming fragments.

Subjects who took the recognition test were instructed to circle the words that they thought were pictures or words they had seen on the slides. They were allowed 10 min to complete the test.

Results and Discussion

Table 1 presents the total proportions correct and priming scores for the WFC and PFI tests, and the total proportions of hits and false alarms for the recognition test. A one-way analysis of variance (ANOVA) was performed on the total proportions correct for each test separately. Results are reported at the $p < .05$ level of significance unless otherwise indicated.

Word fragment completion and picture fragment identification. Performance on the WFC test exhibited a significant effect of encoding condition, $F(6, 246) = 9.38$, $MS_e = .027$. A Newman–Keuls test revealed that the W, WW, WP, and PW conditions all produced significant priming, but were not significantly different from one another. Neither the P nor PP encoding conditions produced priming.

Encoding condition also produced a significant effect on the PFI test, $F(6, 246) =$

TABLE 1

TEST PERFORMANCE AS A FUNCTION OF ENCODING CONDITION IN EXPERIMENTS 1 AND 2

	Encoding condition						
Test condition	W	WW	P	PP	WP	PW	NS
Implicit tests							
Word fragment completion[a]							
Total proportion correct	.42	.37	.24	.26	.40	.43	.29
Priming	.13	.08	−.05	−.03	.11	.14	—
Picture fragment identification[a]							
Total proportion correct	.20	.18	.33	.35	.31	.32	.21
Priming	−.01	−.03	.12	.14	.10	.11	—
Explicit tests							
Word recognition[a]	.51	.61	.71	.81	.79	.78	(.11)
Word fragment cued recall[b]	.29	.37	.30	.36	.49	.47	(.10)
Picture fragment cued recall[b]	.13	.12	.38	.46	.40	.38	(.02)

Note. W, once-presented word; WW, repeated word; P, once-presented picture; PP, repeated picture; WP, word–picture repetition; PW, picture–word repetition; NS, nonstudied item. Repetition lag averaged 12 items. On the implicit tests, priming was computed by subtracting the nonstudied condition from the total proportion correct. On the explicit tests performance is reported as the total proportion correct, except for the numbers in parentheses which represent false alarms (see text).

[a] Experiment 1.

[b] Experiment 2.

8.81, MS_e = .025. A Newman–Keuls test revealed that the P, PP, WP, and PW conditions all produced significant priming, but were not reliably different from one another. Here, neither the W nor WW conditions produced priming.

The results are consistent with the idea that performance on these tests is primarily data-driven. First, cross-form priming was absent, and although small cross-form priming is sometimes obtained on the WFC and PFI tests, neither test exhibited such an effect here, even when items were presented twice. Indeed, there were no effects of item repetition on either test, either with the same form (WW or PP) or with different form (WP or PW) primes. The failure to find repetition effects can be attributed to the fact that repetitions increase elaborative processing, which is of little benefit on tests that depend primarily on perceptual processing and are relatively insensitive to conceptual processing (Challis & Sidhu, 1993).

One might expect that same-form repetitions (WW and PP) would engage additional perceptual processing and so should increase perceptual priming. However, benefits of increased perceptual processing have not been reported in the literature on these types of tasks, even with up to 16 repetitions (Challis & Sidhu, 1993). Some investigators have suggested that perceptual processing of familiar words is so fluent that little additional benefit accrues from repeated perceptual processing. Alternatively, bias toward the target response may not readily be incremented after the first presentation (see Ratcliff, McKoon, & Verwoerd, 1989, for a bias interpretation of perceptual priming). At any rate, the results obtained here are compatible with earlier studies that have obtained little or no benefit of spaced repetitions on perceptual tests. It appears that even if perceptual processing or bias is augmented by item repetition, it has minimal benefit in priming as measured by these tests.

The finding that mixed repetitions did not improve performance relative to a single presentation is consistent with prior work by Roediger and Challis (1992). They found no increase in word fragment completion priming when both the target and its synonym (e.g., *fireplace, hearth*) were presented in a study list as compared to the target only (e.g., *fireplace*). The mixed repetition conditions employed here (WP, PW) provide a conceptual replication of Roediger and Challis' work since these conditions repeated the concept but not the physical form of the target. Conceptual repetitions produced no additional priming beyond that produced by the single presentation of the item in its test-appropriate form (W on the WFC test, P on the PFI test; also see Durgunoğlu & Roediger, 1987, for a related finding with cross-language repetitions).

This experiment extends earlier work with word completion tests by demonstrating that the PFI test behaves in an analogous manner in three ways. On the PFI test, (a) no cross-form priming occurred, (b) two presentations of intact pictures did not increase picture priming relative to a single presentation, and (c) mixed repetitions (WP, PW) did not increase priming relative to a single presentation of a picture. However, the WFC and PFI tests did dissociate as a function of the match between the encoding and retrieval stimuli, since words produced more priming than pictures on the WFC test, and pictures produced more priming than words on the PFI test (also see Weldon & Roediger, 1987, Experiment 4). This pattern of findings is consistent with the notion that performance on these tests is primarily data-driven.

Word recognition. The word-recognition test showed a very different pattern of effects. A one-way ANOVA omitting the nonstudied condition revealed a significant effect of encoding conditions, $F(5, 205)$ = 23.74, MS_e = .026. A Newman–Keuls test indicated that pictures were remembered significantly better than words, revealing the expected picture superiority effect.

There were significant repetition effects for both pictures and words (WW > W, PP > P). Also, mixed repetitions were as effective as repeated picture presentations (WP = PW = PP), and these three conditions were significantly better than repeated word presentations (WW). These results are generally consistent with those obtained by Paivio (1974) and Paivio and Csapo (1973) with a free recall test.

The important point is that the recognition test dissociates from the WFC and PFI tests in showing greater sensitivity to conceptual processing in three ways. First, recognition benefited from item repetition, which presumably enhances elaborative encoding and facilitates intentional recollection (Challis & Sidhu, 1993). Second, the recognition test exhibited a clear picture superiority effect as one would expect on a conceptual test (Weldon & Roediger, 1987). Third, mixed form repetitions (WP, PW) produced recognition accuracy as good as repeated pictures (PP). Although transfer appropriate processing does not specifically predict this outcome, Paivio and Csapo (1973) suggested a reason why this might happen on free recall, which may apply here. An event represented with two different codes (imaginal and verbal) is more retrievable than an event represented with a single code, and pictures are more likely than words to be encoded both imaginally and verbally. Thus, both mixed repetitions (WP, PW) and picture repetitions (PP) involve dual coding and can produce equivalent performance. In sum, the patterns of outcomes obtained here point to the importance of conceptual processing in recognition memory.

It is worth mentioning that these results clearly show that it is not the physical similarity between the encoding and test stimuli per se that determines the type of processing that occurs. That is, just because the words presented during encoding physically match those presented on the recognition test, it does not mean that the test is predominantly data-driven. If it were, then words should have been recognized better than pictures, but instead pictures were recognized better. These results emphasize the importance of task requirements, not just the physical stimuli themselves, in characterizing the similarity between encoding and retrieval tests. Although recognition may have a perceptual component (e.g., Geiselman & Bjork, 1980; Jacoby & Dallas, 1981; Johnston, Dark, & Jacoby, 1985; Mandler, 1980), the conceptual operations engendered by the requirement for conscious recollection are more important in determining whether information is accurately recognized.

Finally, note that the results of the recognition test also rule out the possibility that the patterns of findings on the WFC and PFI tests were due to idiosyncracies in the materials, such as an insensitivity to repetition effects. The standard effects of repetition were obtained on the recognition test.

Experiment 2

One way in which implicit and explicit memory tests may differ is in the role of conceptual processing during retrieval. That is, meaningful processing may be much more important to intentional retrieval than to spontaneous or incidental retrieval. If so, then if subjects are instructed to use word fragments or picture fragments as retrieval cues, performance should reflect influences of conceptual encoding.

Some research has supported this claim. For example, level-of-processing effects are obtained on explicit but not implicit versions of word completion and identification tests (Craik, Moscovitch, & McDowd, 1994; Graf & Mandler, 1984; Hashtroudi, Ferguson, Rappold, & Chrosniak, 1988; Nelson, Schrieber, & Holley, 1992; Roediger et al., 1992). Little work has been conducted to examine repetition effects on explicit versions of these tests but Challis and Sidhu (1993) obtained benefits of massed repetition on explicit WFC, and Greene (1990) obtained benefits of spaced repetition on explicit WFC, findings that are consistent with our hypothesis.

Experiment 2 was designed to investigate whether explicit retrieval tests are more concept-driven than implicit tests, even with the standard perceptually degraded test cues. Subjects studied the same lists that were presented in Experiment 1 and then were given either word fragments or picture fragments to use as cues to help them remember the pictures and words. If performance becomes conceptually driven with an explicit retrieval orientation, then repetition effects and cross-form retrieval should be observed, and mixed repetitions should improve memory over single presentations. Despite the increased role of conceptual processes, however, performance should still be constrained by the perceptual requirement of resolving the fragments on the tests.

On the word fragment cued recall test, recall should be best with the mixed presentations (WP, PW) because these conditions engender both the perceptual and conceptual processing relevant to the test demands. That is, the cross-form repetitions involve both test-appropriate perceptual processing (reading the words, which will benefit fragment completion) and enhanced conceptual processing (viewing the pictures, which will benefit intentional retrieval). Additionally, due to the perceptual requirements of the test, repeated words should be recalled at least as well as repeated pictures, and once-presented words should be recalled at least as well as once-presented pictures.

For the picture fragment cued recall test, pictorial encoding provides the best match in both perceptual and conceptual processing, so repeated pictures should produce very good recall, and pictures should be recalled better than words. Furthermore, as noted earlier, mixed presentations should also produce good performance because repetitions increase elaborative processing.

In summary, the explicit tests should exhibit influences of both perceptual and conceptual processing. Both repetition effects and cross-form retrieval should be obtained, but the precise patterns of effects will also depend on the perceptual requirements of the picture fragment and word fragment tests.

Method

Subjects and design. The subjects were 84 undergraduates from the University of California, Santa Cruz, who participated for course credit. None had participated in Experiment 1, and all were native English speakers who were free of reading disabilities and had normal or corrected vision.

There were seven encoding conditions: W, P, WW, PP, WP, PW, and nonstudied items. Forty-two subjects received a word fragment cued recall test and 42 received a picture fragment cued recall test.

Materials and procedure. The materials and procedures were identical to those used in Experiment 1 except that immediately before the test subjects were told they were receiving a memory test for the pictures and words they had rated. They were instructed to use the word or picture fragments as cues to help them remember the items. They were also told that not all the fragments referred to words and pictures from the slides, and they were to solve a fragment only if they could remember it as an item from the list.

Results and Discussion

The total proportion of items correctly recalled in each condition are presented in Table 1. Responses to the nonstudied items represent intrusions or false alarms because subjects were instructed not to complete items that were not in the study list. These items are included in the analyses reported below, but analyses that were conducted excluding them did not change the pattern of results. Results are reported as significant if $p < .05$.

The patterns of repetition and cross-form retrieval effects are clearly different from those observed on the implicit tests in Experiment 1. On the word fragment cued recall test, there was a significant effect of encoding condition, $F(6, 246) = 29.89$, $MS_e = .024$. Planned contrasts revealed a significant repetition effect for words, $F(1, 41) = 6.22$, $MS_e = .019$, and a marginally significant repetition effect for pictures, $F(1, 41) = 3.47$, $.05 < p < .10$. Newman–Keuls tests showed that pictures were recalled significantly above baseline (nonstudied) levels in both the P and PP conditions, indicating that recall occurred when items were studied in one form and tested with cues of a different form. The Newman–Keuls test also revealed that the mixed encoding conditions (WP, PW) produced significantly better recall than any of the other conditions. This outcome is consistent with Roediger and Weldon's (1987) transfer appropriate processing view of picture–word effects. The mixed conditions combined appropriate perceptual processing of words with elaborative processing from pictures, and because the test engaged both perceptual and conceptual processing, performance was best in these mixed encoding conditions.

An ANOVA on the picture fragment cued recall test revealed a significant effect of encoding condition, $F(6, 246) = 64.63$, $MS_e = .020$. Planned comparisons revealed a significant effect of picture repetition, $F(1, 41) = 7.18$, $MS_e = .018$, but no effect of word repetition, $F < 1$. A Newman–Keuls test showed that words were recalled significantly above baseline (nonstudied) levels in both the W and WW conditions, thus revealing cross-form recall. The Newman–Keuls test also revealed that the same-form (PP) repetition condition was significantly better than the mixed conditions, and that all conditions involving a picture presentation (P, PP, WP, PW) were better than word-only presentations (W, WW).

The fact that cross-form retrieval and repetition effects were obtained on both tests supports the idea that conceptual processing is more important in deliberate recollection than in incidental retrieval (priming) on the WFC and PFI tests. Nevertheless, performance on the explicit tests was still constrained by the perceptual demands of the tests because cross-form retrieval was never superior to within-form retrieval. Most notably, pictures were not remembered better than words on the explicit WFC test; one would have expected a picture advantage if performance were predominantly conceptual as in free recall and recognition tests, and if there had been no requirement to provide missing orthographic information.

The finding that mixed presentations (WP, PW) produced the best performance on the word fragment cued recall test, but same-form repetitions (PP) produced the best performance on the picture fragment cued recall test, can be interpreted within the transfer appropriate processing approach. We have emphasized the importance of the match between encoding and retrieval processes, and have also argued that pictures engage more conceptual processing than words. Both of these ideas are important in interpreting our results. For the picture fragment cued recall test, repeated pictures (PP) were recalled better than mixed repetitions (WP, PW). It appears that repeating the pictures provided appropriate perceptual and conceptual processing, whereas adding a word to a picture (WP and PW) added a little along either of these dimensions. However on the word fragment cued recall test, although encoding the words provided appropriate perceptual processing, words are not as memorable as pictures, partly because they do not engage as much processing of the concept. Thus, adding the picture to the words (WP, PW) enhanced the retrievability of the items because of the pictures' mnemonic advantages in intentional retrieval. In other words, for the word fragment cued recall test the mixed repetitions (WP, PW) provided the best combination of perceptual and elaborative processing, but for the picture fragment cued recall test same-form repetitions (PP) provided the best combination of processes.

A second difference between the two tests is the effect of cross-form repetitions; word repetition did not improve recall on the picture fragment cued recall test (W = WW), whereas picture repetition did improve recall on the word fragment cued recall test (P < PP). We did not predict this pattern of results, and the explanation is unclear at this time. An ad hoc interpretation can be offered. Words might provide little useful processing for the picture fragment cued recall test because they are perceptually inappropriate and provide little additional conceptual processing as compared to pictures; therefore, repeating the words (WW) did little to help retrieval on this test, which is sensitive to both the conceptual and perceptual appropriateness of the study item. However, according to our hypothesis, repeating a word should engage more conceptual processing than presenting it once, so a better understanding of this outcome awaits further investigation.

In summary, the patterns of cross-form retrieval and repetition effects on the explicit word fragment and picture fragment tests are consistent with the hypotheses that (a) explicit tests are more concept-driven than are implicit tests, (b) retrieval is still constrained by the perceptual requirement of the tests, and (c) the ideas of both transfer appropriate processing, and that pictures more readily access meaning codes than do words, are useful in understanding the results.

General Discussion

Two experiments examined the effects of same-form and cross-form repetition on implicit and explicit versions of the word fragment completion and picture fragment identification tests, as well as a word-recognition test. On the implicit tests, there were no cross-form priming effects (words did not prime PFI, and pictures did not prime WFC) and no repetition effects, findings consistent with the view that performance on these tests is primarily data-driven. However, when subjects were instructed to use the word or picture fragments to help them remember the study list, both repetition effects and cross-form recall were observed. Although performance was still constrained by the perceptual requirements of the tests, conceptual processing played a larger role on the explicit tests. Thus, the relative importance of conceptual and perceptual processes in retrieval is partly determined by whether the memory test is implicit or explicit.

The results are consistent with our transfer appropriate processing framework (Blaxton, 1989; Roediger, 1990; Roediger et al., 1989) which stresses the importance of the match between encoding and retrieval processes in determing performance on explicit and implicit tests. In past work, we have emphasized that a variety of memory dissociations can be explained by distinguishing between the relative predominance of perceptual and conceptual processing in a particular encoding or retrieval task. This framework does not suggest that these dimensions represent task dichotomies; performance on a particular task is unlikely to engage exclusively one or the other type of processing (Dunn & Kirsner, 1989; Jacoby, 1991; Weldon, 1991, 1993). The important point is that memory will be a function of the extent to which encoding and retrieval processes overlap.

In Experiment 1, performance on the implicit WFC and PFI tests was driven by perceptual requirements. On these tests the subject's task was to resolve missing perceptual information, and so performance was governed by the extent to which the encoding phase provided an opportunity to process relevant perceptual information. This constituted reading words for the WFC test, and viewing pictures for the PFI test, both of which involve the processing of the structural features of the stimuli. The tests did not require intentional recollection. Therefore, the conceptual or elaborative processing that occurred when the items were repeated or presented in different physical forms was not beneficial on the implicit tests. However, recognition did benefit from elaborative processing because it required conscious recollection, which is facilitated when more target-relevant conceptual information is available. Recognition is not dominated by perceptual processing because the subject is presented with an intact item and so perceiving it is relatively undemanding.

It is unclear why in other research repetition effects have sometimes been obtained on implicit perceptual tasks. However, even when they are obtained they are relatively small. Perhaps subjects have engaged in explicit retrieval in some situations. For example, Greene (1990) conducted the only other experiment directly comparing implicit and explicit tests with word fragment cues following spaced repetitions; he obtained repetition effects on both the implicit and explicit tests. Although he took precautions to ensure that the test was implicit, subjects were told ahead of time that they would receive a memory test which may have led to some intentional retrieval on the WFC test. A second possible explanation is that perceptual tests occasionally exhibit small influences of conceptual processing (e.g., Bassili et al., 1989; Challis & Brodbeck, 1992; Smith, 1991; Weldon, 1993), and perhaps some situational variables that are not yet well understood lend themselves to revealing conceptual influences.

Experiment 2 was consistent with the hypothesis that when subjects are given explicit test instructions with a word or picture fragment as a cue for the studied items, conceptual processing will play an important role in performance. Cued recall was affected by both the perceptual and conceptual requirements of the test. Subjects had to resolve perceptually degraded stimuli, a task heavily dependent on perceptual operations. However, conceptual processing also benefited performance in at least two ways. First, it may have helped subjects retrieve items from the list (recall), and second, it may have helped them decide whether candidate solutions they had generated referred to previously studied items (recognition). Perceptual and conceptual processes may interact in complex ways during retrieval, perhaps providing mutual activation (Weldon, 1993); other research suggests that perceptual and conceptual sources of information combine in a multiplicative fashion (Massaro, Weldon, & Kitzis, 1991). Craik et al. (1994) have suggested that conceptual information can be used in a consciously controlled manner, whereas perceptual information may be used more automatically. While the details of the mutual contributions remain to be worked out, these studies provide clear demonstrations of how the balance of conceptual and perceptual processing is affected by implicit or explicit retrieval instructions.

Our results also can be explained by Graf and Ryan's (1990) transfer appropriate processing framework, at least in part. Their framework draws on the distinction between integrative and elaborative processing (e.g., Graf & Mandler, 1984; Mandler, 1980). Integration bonds target features into a coherent or unitized representation, whereas elaboration associates the target with other information in the encoding context. Graf and Ryan posit that implicit tests tap into integrative processes, whereas explicit tests tap into elaborative processes. Successful performance on our implicit tests required subjects to resolve a fragmented word or object, a task that would be facilitated by prior integrative processing of that object. However, since implicit tests do not tap into elaborative processes, repetitions of the concepts are not useful. In contrast, explicit tests do tap into elaborative processing. Repeated presentations of the target presumably increased its associations with the study context and other items, and so cued recall improved. However, it is somewhat unclear how the framework would account for cross-form retrieval on the explicit tests, since in our experiments items were encoded in a relatively shallow fashion, which is typically characterized as primarily integrative. In this case, cross-form retrieval should not occur because integrative processing does not establish connections with other mental contents, such as the imaginal referent of a word. Cross-form recall should occur only if the item is processed elaboratively, but it is difficult to imagine that shallow encoding could be characterized as elaborative. Thus, in this framework it is not obvious how pictures are recalled on the word fragment cued recall test, for example.

Our interpretation of these data is not intended to imply that transfer appropriate processing alone accounts for all memory dissociations. A variety of neuropsyhcological data concerning dissociations lend themselves to an account that proposes the existence of neuroanatomically distinct memory subsystems (e.g., Gabrieli et al., 1994; Heindel, Salmon, Shults, Walicke, & Butters, 1989; Schacter, 1992; Shimamura, Janowsky, & Squire, 1990; Squire, 1992; Tulving & Schacter, 1990). For example, Tulving and Schacter (1990) have proposed the existence of a perceptual representation system (PRS) which contains subsystems that represent physical and structural information for words or objects. Such a framework could explain the data from our first experiment which showed that priming occurred only when an item had been studied in the same form in which it was to be tested. Presumably, this would happen because the test fragments cue perceptual representations in the appropriate perceptual subsystems. Furthermore, because the PRS operates at a presemantic level, priming would not show effects of the increased semantic processing that accompanies item repetitions. However, it is not obvious how this model would account for the data in Experiment 2, where the explicit tests showed effects of both conceptual and perceptual processes. Schacter and Church (1992) do suggest that subjects tend to rely on conceptual processes and strategies when performing explicit tests, so this could account for the conceptual effects. However, it is less clear what the source of the perceptual effects on the explicit test would be. Are the perceptual effects due to unconscious or automatic access to the PRS, or, because this is now an explicit test, is a perceptual representation accessed in an episodic system? Likewise, do different conceptual representations underlie performance on implicit and explicit tests, such that on an implicit test the conceptual representation in one semantic system is accessed, but on an explicit test a different conceptual representation in the episodic system is accessed? Presumably conceptual and perceptual systems interact, but the details of their interactions and whether different perceptual and conceptual systems exist for implicit and explicit retrieval have not been specified in this framework as of yet. Without knowing such details, it is difficult to speculate on how the model would account for the role of both conceptual and perceptual information on the explicit tests, and for the change in the relative importance of conceptual and perceptual information when subjects use identical cues under implicit versus explicit test instructions.

As this area of research develops it becomes increasingly clear that both mental processes and the neuroanatomy that underlies them are important considerations in understanding the basis of memory dissociations, and modern theories are moving in the direction of incorporating both perspectives (Roediger & McDermott, 1993; Schacter, 1992). However, if one considers a system as an anatomical unit that performs certain processes, the distinction between subsystems and processes becomes less clear. The results reported here illustrate the difficulty of separating systems and processes, because explicit tests, which allegedly tap some special system, also engage more conceptual processing. In amnesics, impaired intentional retrieval may be the result of impaired conceptual or elaborative processing (e.g., see Blaxton, 1992; Butters & Cermak, 1980; Graf & Mandler, 1984), which may comprise the function of a system that is damaged. Is conceptual processing an integral property of the system that governs intentional retrieval? If so, then what does the distinction between systems and processes mean? Regardless of the ultimate implications for conceptualizing the architecture and processes of memory, we do emphasize that a discussion of memory dissociations must include an analysis of the processing demands of the encoding and retrieval tasks.

One of the goals of this research was to apply Schacter et al.'s (1989) retrieval intentionality criterion to investigate the suitability of WFC and PFI as incidental memory tests. Some investigators have been concerned that these tasks are likely to encourage deliberate retrieval strategies because they are difficult and allow relatively long response times. In these experiments, identical materials and procedures were used on the implicit and explicit tests, which then differed only in the test instructions. Two different dissociations were obtained such that both cross-form retrieval and repetition effects were obtained on the explicit tests but not on the implicit tests. These results clearly demonstrate that the implicit and explicit tests engage at least some different retrieval processes, and that the WFC and PFI tests are suitable measures of incidental retrieval. If subjects receiving the implicit tests had employed intentional recollection throughout the test phase, we would have observed repetition effects and cross-form priming, as in the explicit tests.

We would like to add two comments about these issues. First, whereas some retrieval processes clearly differed on the implicit and explicit tests, we also assume that some processes are the same or highly similar on implicit and explicit versions of a particular test. For example, perceptual processing is important in both the implicit and explicit tests that use perceptually degraded cues, but it becomes less prominent in the explicit tests because of the increased importance of conceptual processes. However, at this time there is no reason to believe that perceptual processing is fundamentally different in kind on the implicit and explicit tests.

Second, to claim that implicit and explicit tests differ only in whether they engage intentional retrieval processes is to beg the question of how they differ. What comprises intentional retrieval? Here, we suggest it is at least partly an increased role of conceptual processing. More analytical paradigms are needed to understand the interplay between retrieval instructions and underlying processes, and may be provided by the time-course analysis developed by Weldon (1993; Weldon & Jackson-Barrett, 1993) and the use of neuroimaging techniques.

In conclusion, these experiments suggest that the balance of perceptual and conceptual processing is affected by test instructions, with more conceptual processing coming into play on explicit tests. In addition, the implicit PFI test behaves as a pictorial analogue to the implicit WFC test; as cued recall tests, they exhibit some analogous and some different patterns of effects. Finally, both the WFC and PFI tests are suitable measures of incidental retrieval.

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