Dissociations Between Implicit Measures of Retention

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INTRODUCTION

Implicit (or indirect) measures of retention are usually contrasted with explicit (or direct) measures (Graf & Schacter, 1985; Segal, 1966). Explicit tests are those on which subjects are told to recollect recent events, whereas on implicit tests subjects are told to perform a task and retention is measured by transfer from prior experience. The typical strategy followed by researchers investigating the relation between these tests is to contrast performance on an explicit measure of retention (usually recall or recognition) with performance on an implicit measure (usually repetition priming in one of several tasks) as a function of independent variables under experimental control or as a function of subject characteristics. The general finding that has excited so much interest, and which is probably responsible for the production of this book, is that many variables produce dissociations between these two classes of measures. Often a variable will have large effects in an explicit memory test, but little or no effect in an implicit test (e.g., Jacoby & Dallas, 1981; Warrington & Weiskrantz, 1970). Sometimes a variable will have one effect on an explicit test and the opposite effect on an implicit test (e.g., Blaxton, 1989; Jacoby, 1983b; Weldon & Roediger, 1987). We now have a large body of evidence showing such dissociations between these classes of tests (see Richardson-Klavehn & Bjork, 1988; Schacter, 1987).

The dominant theoretical interpretation of the dissociations between implicit and explicit tests has been provided by the assumption that these measures tap different memory systems in the brain. For example, Squire (1986, 1987) has argued for a distinction between declarative memory (revealed by performance on explicit
tests) and procedural memory (revealed by implicit tests). Tulving (1983) developed his distinction between episodic and semantic memory to explain these dissociations, although more recently he has argued that semantic memory is a subsystem of procedural memory and episodic memory a subsystem of the semantic system (Tulving, 1984a, 1985).

It is not our purpose to review the evidence for the memory systems approach. Rather, we simply wish to note certain features of the argument. Most of the evidence interpreted in this light has come from experiments in which a single explicit (declarative, or episodic) test was contrasted with a single implicit (procedural, or semantic) test. Obviously, under such conditions any dissociation can be taken as supporting the separation of systems, although usually other interpretations cannot be ruled out (Neely, 1989). This is especially so when the systems approach is not specific enough to predict the form of the interaction, but only its existence (Roediger, 1984). Rarely have researchers contrasted performance on a variety of implicit memory tests under the same conditions to ask whether or not dissociations can be found within implicit memory tests.

One purpose of this chapter is to review the limited evidence now available showing dissociations between implicit memory tests. The logic of functional dissociation has been one of the primary criteria for distinguishing between memory systems (e.g., Tulving, 1983, Ch. 5). If dissociations are found between implicit tests that are thought to tap the same system (semantic memory, or procedural memory), then subsystems may be implicated. On the other hand, if dissociations between tasks believed to tap the same system are as easily obtained as dissociations between tasks tapping different systems, then the whole 'systems' approach to explaining test differences becomes less persuasive (Dunn & Kirsner, this volume). An alternative approach to explaining dissociations between memory measures may be required.

A PROCESSING APPROACH TO EXPLAINING DISSOCIATIONS

In several prior chapters we have developed an alternative method of explaining dissociations between explicit and implicit tests that we have referred to as a transfer appropriate procedures approach (see especially Roediger & Blaxton, 1987a; Roediger & Weldon, 1987; and Roediger, Weldon, & Challis, 1989a). In this section we will review the primary tenets of this approach, although we will not exhaustively review the evidence supporting these assumptions.

First, we assume that memory tests benefit to the extent that the operations required at test recapitulate or overlap the encoding operations during prior learning (Kolers & Roediger, 1984; Morris, Bransford, & Franks, 1977; Tulving & Thomson, 1973). This assumption seems relatively uncontroversial at this point.
Second, we assume that explicit and implicit memory tests typically require different retrieval operations (or access different forms of information) and consequently will benefit from different types of processing during learning.

The third assumption is that most explicit memory tests rely on the encoded meaning of concepts, or on semantic processing, elaborative coding, mental imagery and the like. Of course, much evidence supports this general proposition. Following Jacoby (1983b), we refer to tests benefiting from such elaborative manipulations as generating information (instead of reading it out of context) as conceptually-driven.

The fourth assumption is that most typical implicit memory tests rely heavily on the match of perceptual processing of events between the learning and testing episodes. As commonly used, many implicit tests (repetition priming in perceptual identification, lexical decision, word fragment or word stem completion, etc.) seem to tap the perceptual record of past experiences (Kirsner & Dunn, 1985). Therefore, we will refer to these tests as being largely data-driven (Jacoby, 1983b).

The general sort of evidence favoring this approach is the finding that, whereas manipulations of conceptual processing have large effects on conceptually-driven tests, they have little or no effect on data-driven implicit tests (e.g., Graf & Mandler, 1984; Jacoby & Dallas, 1981). On the other hand, manipulation of surface features between study and test have large effects on data-driven tests but little or no effect on many conceptually-driven tests (Jacoby & Dallas, 1981; Roediger & Blaxton, 1987a). Roediger et al. (1989a) review the literature supporting these assumptions.

An important point for purposes of this chapter is that there is no necessary correlation between explicit memory tests and conceptually-driven processing, or between implicit memory tests and data-driven processing. That is, one can develop implicit, conceptually-driven tests and explicit, data-driven tests (Blaxton, 1989). This realization leads naturally to the question of whether or not dissociations can be found between explicit tests, or between implicit tests, if two or more tests of each type are evaluated following some experimental manipulation. We know that the answer to the question with regard to explicit memory is affirmative. After all, the entire literature documenting encoding specificity (see for example, Tulving, 1983, Ch. 10) and transfer appropriate processing (Fisher & Craik, 1977; McDaniel, Friedman, & Bourne, 1978; Morris et al., 1977) employed explicit memory tests and showed dissociations between explicit measures.

The purpose of this chapter is to review the evidence showing comparable dissociations between implicit memory tests. The evidence is relatively sparse, as compared to that for explicit tests, for the good reason that few researchers have yet done experiments comparing performance on two or more implicit tests as a function of the same variables. However, several sharp dissociations between performance on implicit tests can be found in the literature. To presage our conclusion, the finding of dissociations on implicit tests shows that these tests are not tapping
a single system that operates the same way in all tests (see Dunn & Kirsner, this volume).

**DISSOCIATIONS BETWEEN IMPLICIT TESTS**

All of the experiments reviewed below have some features in common. Typically, the researchers manipulated an independent variable and measured performance on two or three implicit memory tests. The case of interest is when dissociations are revealed between tests, although in a later section we also point to cases where parallel effects are obtained. Within the transfer appropriate processing framework, dissociations between implicit tests can be expected under at least two conditions, which we review in turn.

**Dissociations Between Tests Requiring Different Modes of Processing**

If one implicit test is data-driven and a second is conceptually-driven, then dissociations should be expected following certain experimental manipulations and the form of the interaction should be predictable. (1) If the experimental manipulation affects appearance of the data during study, but not conceptual elaboration, then effects would be expected on data-driven but not on conceptually-driven implicit tests. Modality of presentation (visual or auditory) is one such variable. (2) On the other hand, a manipulation (such as in the typical levels of processing experiment) that affects conceptual elaboration but not the form of ‘data’ presentation should affect conceptually-driven but not data-driven tests. These predicted patterns (1 and 2) represent single dissociations, with a variable affecting one test but not the other. (3) Crossover dissociations (opposite effects on the two implicit tests) should be found when an experimental manipulation affects both perceptual processing and conceptual elaboration. An example is the contrast of reading words out of context (xxx–cold) or generating them from conceptual clues (hot–?). Jacoby, 1983b). Available data conform reasonably well to these three predictions, as reviewed in the following paragraphs.

The first attempt to show dissociations between two implicit (or semantic, or procedural) memory tests was reported in a series of experiments by Blaxton (1985; 1989). Her experiments were actually much more ambitious than the abbreviated versions summarized here, because she compared performance following various study conditions on five tests altogether (three explicit, two implicit) in each of three experiments. Of central interest here is performance on the two implicit tests, which were primed word fragment completion and answering general knowledge questions. Following a study phase in which material was presented under different conditions, subjects in one test condition received a series of word fragments (c__gn_, m_t__ol_s), some of which represented studied words and others of which did not. Another group of subjects answered general knowledge questions such as “What German city is famous for the scent
it produces?" and "In what fictional city did Clark Kent and Lois Lane live?". (Cologne and Metropolis correctly complete the fragments and answer the questions.) Primed fragment completion was considered to be a data-driven test, whereas answering general knowledge questions was judged to be conceptually-driven. Thus, perceptual similarity between the study and test experiences should matter in the case of primed fragment completion, whereas the degree of conceptual elaboration during study should affect the answering of general knowledge questions. Instructions to subjects prior to either test stressed that they should try to complete the word fragments or to answer the questions as well as possible in the time available.

The results of three experiments performed by Blaxton are partially summarized in Table 5.1. On the far right-hand side of the table is baseline performance in each of the conditions, or the probability of successfully completing the fragment or answering the question without prior study of the target. The figures in the other columns represent priming, or the advantage in performance from prior presentation during the study phase relative to the nonstudied baseline. (Items were completely counterbalanced over conditions in the experiments.)

In Experiment 1, Blaxton manipulated whether, during the study phase, words were read without context (xxx—cologne), or read in context (perfume—cologne),

<table>
<thead>
<tr>
<th>TABLE 5.1</th>
<th>Priming Scores (Advantage of Studied Conditions over Non-studied Baseline) for two Implicit Memory Tests as a Function of Various Study Conditions (adapted from Blaxton, 1989)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment</strong></td>
<td><strong>Task</strong></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fragment Completion</td>
<td></td>
</tr>
<tr>
<td>General Knowledge Questions</td>
<td></td>
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<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Fragment Completion</td>
<td></td>
</tr>
<tr>
<td>General Knowledge Questions</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Fragment Completion</td>
<td></td>
</tr>
<tr>
<td>General Knowledge Questions</td>
<td></td>
</tr>
</tbody>
</table>
or were generated from associative clues (perume—c______). This manipulation had opposing effects on the two implicit memory tests. In answering general knowledge questions, the conceptually-driven test, the generate condition produced the most priming and reading the words out of context produced the least priming. On the other hand, primed fragment completion was greatest in the no context condition and poorest in the generate condition. (The context condition produced intermediate performance in both instances.) Because the manipulation of context produced opposite effects on the two tests, we may say that this pattern of results represents a crossover dissociation between the implicit memory tests of word fragment completion and answering general knowledge questions.

In a second experiment, Blaxton manipulated modality of presentation in the study phase and discovered another dissociation between the two measures. Manipulation of modality had no effect on the amount of priming in answering general knowledge questions, but visual presentation produced more priming in the fragment completion test than did auditory presentation. The prior reading of the word in the study phase transferred better to constructing the word from a visual fragment than did its prior auditory presentation. However, there is also substantial priming from auditory presentation on the fragment completion test. This raises the question of why, if word fragment completion is data-driven, such healthy priming occurs from a mode of presentation (auditory) that differs so much from the visual test format. We return to this puzzle near the end of the chapter (see also Kirsner, Dunn, & Standen, this volume).

In the third experiment, Blaxton manipulated study instructions accompanying the presentation of the same words to two groups. One group was instructed to form visual images of the referents of the words, whereas the other group was not given these instructions. Imagery is thought to be a conceptually-driven manipulation and, in line with this assumption, the imagery manipulation affected priming to answers of general knowledge questions, but did not affect primed fragment completion. (This neat summary does not describe other conditions of the experiment, where a more complex pattern of results occurred. However, this complication does not undermine the present points.)

In sum, these selected data from Blaxton’s (1989) three experiments indicate that dissociations between two implicit memory measures can be obtained, and illustrate all three predictions made on page 70. These data would be hard to explain by proposing a single system underlying implicit memory, such as a procedural or semantic system, but are readily understood from the transfer appropriate processing perspective. Briefly, study conditions that encourage attention to visual features of the items produced greater priming in word fragment completion, whereas those manipulations encouraging elaboration of the study material (imagining or generating) produced greater priming in answering general knowledge questions.

A similar pattern of results appears in a recent paper from the social cognition literature. Smith and Branscombe (1988) were interested in the phenomenon of priming in person perception (Srull & Wyer, 1980). In a typical paradigm, subjects
are exposed to some material during an initial phase in which (for example) many of the words have a hostile connotation. Later, during an apparently unrelated phase of the experiment, subjects are asked to rate hypothetical people in terms of their personality traits when various ambiguous behaviors are attributed to the people. The measure of interest is how much the prior study phase affects use of a category (e.g., hostility) in describing the behaviors, relative to ratings of subjects who are not exposed to the prior material implicating hostility. The general finding is large priming effects on measures of category accessibility that persist even over a week (Srull & Wyer, 1980).

Smith and Branscombe (1988) had subjects either read priming words in the first phase of such an experiment, or generate them from conceptual clues. One group of subjects later took the category accessibility test, in which they were given a description of behaviors that were ambiguous and asked to provide a one word trait adjective to describe the person. Another group of subjects was given the same materials during the study phase, but was then given a word fragment completion test. (One set of traits was not presented during the study phase to assess priming

![Graphs showing Word Fragment Completion and Category Accessibility](image)

FIGURE 5.1. Results adapted from Smith and Branscombe (1988). Priming in the word fragment completion test benefited more from reading a word out of context than from generating it, whereas the converse was true for the category accessibility test. Baseline rates were .41 for the fragment completion test and .34 for the category accessibility test.
on the category accessibility and word fragment completion tests, with materials rotated through conditions across subjects.)

Smith and Branscombe’s (1988) results are shown in Figure 5.1. The measure of interest is priming, or the advantage of performance in the studied conditions beyond the nonstudied baseline. The word fragment completion results replicate Blaxton’s (1989), with much more priming from prior reading of a word than from generating it. However, the opposite pattern was obtained on the category accessibility test, where prior generation produced much better performance than did prior reading. Once again, the overall pattern represents a crossover dissociation between two implicit memory tests that can be explained by reference to the transfer appropriate processing viewpoint.

Another experiment constitutes part of a Master’s thesis by Srinivas (1988, Experiment 1) and is, as far as we know, the first experiment to compare three implicit memory tests under the same conditions. Srinivas’ study manipulations were like those of Jacoby (1983b) and Blaxton (1989), in that she had subjects read words out of context (donkey), read words in a sentence context (“A mule is similar to a donkey”), or to generate a word from the sentence, but with only the first letter of the word presented (“A mule is similar to a d_____”). Following production of the word in the no context, context, or generate conditions, subjects took one of three implicit memory tests. One was the familiar word fragment completion test. A second involved free association to a category name. Subjects were given Animals and told to generate as many as they could for 30 seconds. (The target items were selected to be relatively low frequency in category production norms.) The third test involved solving anagrams. Subjects were given strings of letters such as endoyk and told to unscramble these to make a word. In the case of all three tests, subjects were told to complete the task as well as possible, and no reference was made to the prior study phase. In addition, one group of items was not studied to serve as the baseline against which to assess priming. (Items were

<table>
<thead>
<tr>
<th>Task</th>
<th>No Context</th>
<th>Context</th>
<th>Generate</th>
<th>Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fragment Completion</td>
<td>.24</td>
<td>.20</td>
<td>.14</td>
<td>(.21)</td>
</tr>
<tr>
<td>Anagram Solution</td>
<td>.13</td>
<td>.09</td>
<td>.08</td>
<td>(.49)</td>
</tr>
<tr>
<td>Category Association</td>
<td>.07</td>
<td>.09</td>
<td>.17</td>
<td>(.16)</td>
</tr>
</tbody>
</table>

TABLE 5.2
Priming Scores (Advantage of Studied Conditions over Non-studied Baseline) for three Implicit Memory Tests as a Function of Study Conditions (adapted from Srinivas, 1988)
completely counterbalanced across the three studied conditions and the nonstudied condition.)

Srinivas' (1988) results are presented in Table 5.2. On the far right-hand side are the base rates for the three tasks, or the probability of completing fragments, solving anagrams, and associating targets from the category names when the targets were not studied. In the other three columns are priming scores, or the advantage produced from having studied the words relative to the baselines. As expected, the no context condition produced the greatest priming in the word fragment completion test and the generate condition produced the least priming, the usual pattern for a data-driven test. The category association test, thought to be conceptually-driven, reflected the opposite pattern of results. That is, priming was greater for words in the generate condition at study than for those in the no context condition. Comparison of performance between the word fragment completion and the category association test reveals a crossover dissociation between two implicit memory tests.

Results from the anagram solution test were not as clear-cut. Srinivas had expected the anagram test to reflect a data-driven pattern of performance, that is, the no context condition to produce more priming than the generate condition. Although a trend in this direction exists in the data, it was not statistically significant, even with 440 observations per condition (44 subjects and 10 items per condition).

There are at least three possible reasons for this state of affairs. First, note that the nonstudied base rate was much higher for the anagram solution test than for the other two. Perhaps the ease of the task helped mask any differences due to scaling problems. However, this possibility seems unlikely because, even with the higher base rate, no danger of a ceiling effect existed even in the no context condition that produced the best performance (62% completions). A second possible reason that the anagram solution test did not appear more data-driven is that the letters provided in the anagram were random rearrangements from the original word. It may be that the perceptual processes used in decoding the word donkey and the anagram endoyk are simply not very similar, and consequently the test may not recapitulate the processes engendered by the reading task, at least with these materials. Further experiments are required to test this idea. Third, it may simply be that the null effect is real. If the manipulation of context had no differential effect on solving anagrams, then the results would represent an interesting first: manipulation of a variable would have three different patterns of effect on three implicit memory tests, within the same experiment. These curious results may indicate that both data-driven and conceptually-driven components exist and further experiments, now under way, are aimed at this issue.

The dissociations between implicit memory tests described above can all be interpreted within the transfer appropriate procedures framework. Experimental manipulations that produce elaboration of encoding (e.g., generating or imaging) benefit conceptually-driven tests such as answering general knowledge questions, free associating to a category name, or producing a trait adjective when given an
FIGURE 5.2. Results from Weldon and Roediger (1987, Experiment 4). Priming on the word fragment completion test was greater from prior study of words than of pictures, whereas the reverse pattern appeared on the picture fragment identification test. Baseline rates were .47 for the word fragment completion test and .22 for the picture fragment identification test.

ambiguous behavior. However, these manipulations have either little or no effect on data-driven tests, or even an opposite effect (reading out of context relative to generating). On the other hand, manipulations of surface features had little effect on these conceptually-driven implicit tests, but sizable effects on word fragment completion, which is thought to be largely data-driven. At a minimum, these dissociations show that all implicit memory tests do not behave the same way as a function of independent variables.

Dissociations Between Data-Driven Tests

The dissociations between implicit memory tests described in the previous section showed differential effects of independent variables on data-driven and on conceptually-driven tests. According to the transfer appropriate processing
framework, it should also be possible to show dissociations between two data-driven tests, if they benefit from different sorts of ‘data’.

Weldon and Roediger (1987, Experiment 4) reported such a dissociation between two implicit, data-driven tests. Subjects studied a long series of pictures and words and then performed either a word fragment completion test or a picture fragment naming test. In the latter, subjects saw severely degraded pictures and tried to provide one-word names for them. On both tests, one third of the test items referred to previously studied words, one third to pictures, and one third had not been studied. (Items were completely counterbalanced over study conditions across subjects). The results are presented in Figure 5.2, where a crossover dissociation is apparent. Words produced more priming than pictures on the word fragment completion test, whereas pictures produced greater priming than words on the picture fragment identification test.

This pattern can be easily accommodated within the transfer appropriate processing account. The match between perceptual processes engaged at study and test is greater for words and word fragments, and pictures and picture fragments, than for the converse cases. Dissociations can be created by such mismatches between data presented at study and those required at test.

Interestingly, other researchers have discovered independence between data-driven implicit memory tests when independence is assessed in different ways. For example, Perruchet and Baveaux (1989) found low correlations across subjects on priming in tests of word fragment completion and tachistoscopic identification, among others. Witherspoon and Moscovitch (1989) reported stochastic independence between priming in word fragment completion and perceptual identification tests. And Hayman and Tulving (1989b) even showed independence between two fragment completion tests when the fragments consisted of nonoverlapping letter sets from the targets presented earlier (e.g., $a\_a\_in$ on the first test and $ss ss$ on the second). Apparently, different component processes may even underlie data-driven implicit memory tests.

Other Dissociations?

We have reported dissociations between two data-driven tests and between data-driven and conceptually-driven tests. Experiments revealing the latter pattern were all constructed to contrast the transfer appropriate processing notions with theories specifying memory systems. Thus, the range of variables used in this line of research has been quite limited, so far. Each of the reported experiments either manipulated reading a word or generating it, seeing it or hearing it, or performing (or not) some elaborative operations such as imagining the referents of words.

We may well wonder whether or not other manipulations besides these (or similar ones, such as levels of processing) will also produce dissociations between two implicit tests, for example between two conceptually-driven tests. We suspect that the answer is yes, but the research is not yet at hand to prove the point.
However, one example comes from an experiment by Balota and Chumbley (1984), which examined the effects of several variables on three tasks that could plausibly be said to reflect semantic memory: category verification, lexical decision, and word naming. They found that word frequency had a minimal effect on reaction time in the category verification task, but a significantly greater effect on naming; the word frequency effect was even greater on the lexical decision task than on naming. Technically, this result represents a dissociation between tasks tapping semantic memory, or perhaps procedural memory. However, these tasks were not implicit memory tests, because there was no prior study of the words and therefore no measure of transfer or repetition priming. Thus, the relation of this experiment to the studies reviewed in this section is unclear. Although other manipulations besides those reviewed here will probably create dissociations on implicit memory tests, this speculation must await future testing.

Theoretical Implications

Theories of dissociations between tests of explicit and implicit retention have usually been cast in terms of different systems, or types of information, underlying the two types of test. Explicit tests may tap episodic memory and implicit tests semantic memory (Kinsbourne & Wood, 1982); explicit tests might tap declarative memory and implicit tests procedural memory (Squire, 1986, 1987); or explicit tests might draw mostly on elaboration of information in memory, while implicit tests reflect activation or integration of units in memory (Graf, Squire, & Mandler, 1984; Mandler, 1980). All three approaches have taken functional dissociations as their primary supporting evidence.

These theories generally consider, at least by omission, all explicit tests as alike and all implicit tests as alike. Thus they are ill-equipped to deal with the finding of dissociations between tests as documented in the prior section. Within the memory systems framework, the most natural extension to explain such dissociations would be to postulate subsystems. For example, in Squire’s (1987) theory, several subcategories such as priming, classical conditioning, and motor learning are nested under procedural memory. Thus dissociations might be expected among tasks tapping these different forms of procedural knowledge. Indeed, some researchers have even suggested that priming might reflect an entirely separate memory system (e.g., Shimamura, 1986; Tulving, Schacter, & Stark, 1982).

But none of these ideas help to account for the dissociations just reviewed, because the dissociations occurred within measures of priming. For example, one would need to invent separate ‘priming’ memory systems for verbal and pictorial information to account for Weldon and Roediger’s (1987) data in Figure 5.2. This step might be plausible enough in light of dual code theory (e.g., Paivio, 1986), but one would also need to create separate systems for information read and heard, and for that read and generated, etc., to account for other dissociations. The number of memory systems would quickly grow large. The transfer appropriate
processing approach is more straightforward and parsimonious, albeit at a general level of explanation.

It is also unclear how such results can be accommodated by theories distinguishing between activation and elaboration (e.g., Graf & Mandler, 1984; Mandler, Graf, & Kraft, 1986). On this view, priming effects in implicit memory tests are due to activation of a pre-existing mental representation. Activation "strengthens the relations among ... components [of the representation] and increases its accessibility" (Graf & Mandler, 1984, p. 553). This theory can account for the fact that variations in elaborative processing do not affect priming on implicit memory tests that are data-driven. For example, the typical levels of processing manipulation is considered elaborative and has large effects on explicit tests. But word nodes are presumably activated under all 'levels' conditions, so no difference in priming occurs on implicit tests (Graf & Mandler, 1984; Jacoby & Dallas, 1981). However, because elaborative manipulations do affect priming on conceptually-driven implicit memory tests (e.g., Blaxton, 1989), then simple activation cannot serve as a general explanation for priming on all implicit memory tests. More generally, because of strong dissociations shown between implicit memory tests, it seems likely that more than one factor will be needed to account for these phenomena (but see Dunn & Kirsner, 1988).

The transfer appropriate processing ideas were used to predict the dissociations between implicit tests reviewed here, and so obviously can account for them and for other phenomena (see Roediger & Blaxton, 1987a; Roediger et al., 1989a). This is not to say that the theory perfectly accounts for all data in this realm. Not only do some data from the reviewed experiments not fall into line perfectly (e.g., Blaxton, 1989, Experiment 3), but the framework does not provide as natural an account for the data from amnesics as do the various theories postulating memory systems (see Roediger et al., 1989a). Because tasks showing preserved priming in amnesics are implicit in nature (Shimamura, 1986), the distinction between implicit and explicit tests seem worth preserving. The data from amnesics may even indicate the need to postulate separate memory systems, although the case is not yet convincing, in our opinion. Some rapprochement between the 'systems' view and transfer appropriate processing ideas may be advisable (Hayman & Tulving, 1989b), but for now we prefer to pursue the processing approach to see how far it will take us. We turn now to some further predictions.

PARALLEL EFFECTS ON IMPLICIT MEMORY TESTS

A foregoing section reviewed the relatively scanty evidence showing dissociations between implicit memory tests. Of course, such outcomes are not always found. Indeed, the transfer appropriate processing approach predicts parallel outcomes (under some conditions) when two similar data-driven implicit tasks are compared with each other, or when two similar conceptually-driven implicit tasks are com-
TABLE 5.3  
Priming Scores (advantage of Studied Conditions over Non-studied Baseline) for Implicit Tests and Probability of Correct Recall (and Intrusions) for the Explicit Tests (results from Roediger, Weldon, Stadler, & Riegler, 1989)

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Graphemic</th>
<th>Semantic</th>
<th>Baseline/Intrusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implicit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stem Completion</td>
<td>.15</td>
<td>.16</td>
<td>(.16)</td>
</tr>
<tr>
<td>Fragment Completion</td>
<td>.24</td>
<td>.21</td>
<td>(.28)</td>
</tr>
<tr>
<td>Explicit</td>
<td></td>
<td></td>
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<tr>
<td>Stem Cues</td>
<td>.19</td>
<td>.58</td>
<td>(.04)</td>
</tr>
<tr>
<td>Fragment Cues</td>
<td>.29</td>
<td>.50</td>
<td>(.06)</td>
</tr>
</tbody>
</table>

pared. Because there have been so few experiments comparing implicit memory tests under the same conditions, the evidence on this point is relatively sparse, too.

We will describe part of one experiment conducted in our laboratory. Roediger, Weldon, Stadler, and Riegler (1989b) provided a direct comparison between word fragment completion and word stem completion as both implicit and explicit memory tests. In some conditions, subjects studied words under either a shallow level of processing (they were instructed to count the ascenders and descendents among the letters of the words, with t representing an ascender and g a descender) or a deep level of processing (they were instructed to provide ratings of how much they liked the word). All of the words were chosen so that a word fragment could be constructed that had only one or two solutions, and its word stem (the first three letters) would have at least ten completions, on average.

Four groups of subjects were treated identically up to the test phase of the experiment. At that point, two groups received word fragments and two groups word stems, with instructions manipulated between groups to make the test either implicit or explicit. One group of subjects that received either fragments or stems was simply told to respond with the first word to come to mind that would complete the fragment or stem; the other two groups were told to use the fragments or stems as recall cues for the words in the studied list. The specific stems or fragments were exactly the same in both the implicit and explicit forms of the test, with some representing studied words and others representing nonstudied words. Thus subjects given the explicit test were provided with many fragments or stems that did not correspond to list items. They were warned that this would occur, and were cautioned not to guess but to write down a word only if they were reasonably confident that it had occurred in the study list.
5. IMPLICIT MEASURES

The results are shown in Table 5.3 and can be described quite simply. On the implicit memory tests, the levels of processing manipulation had no effect whatsoever. The same amount of priming occurred for the shallow and deep levels of processing in both the word fragment and word stem completion tests. (The magnitude of priming was greater in the word fragment test than in the word stem test, but no attempt was made to equate the base rates prior to the experiment.) On the other hand, in the explicit memory tests, the levels of processing manipulation had a large effect with both types of cues. Items to which subjects had previously provided likeability ratings were recalled better than those to which they had provided a judgment about the number of ascending and descending letters. Again, the same pattern occurred whether or not the tests involved word fragments or word stems. (The word stem results in this experiment replicate those of Graf & Mandler, 1984, Experiment 3.)

The obvious interpretation of these results is that, at least within the range of the variables manipulated, word fragments and word stems produce similar patterns of performance whether the test is implicit or explicit (see Weldon, Roediger, & Challis, 1989, who reached a similar conclusion). Some researchers have worried that, relative to word stem completion, word fragment completion is not truly an implicit test. Because word fragment completion is a slow, laborious process relative to the completion of word stems, explicit strategies may be called into play, even when subjects are given implicit test instructions (e.g., Graf & Mandler, 1984; Shimamura, Squire, & Graf, 1987). However, the present results lead us to dismiss this possibility. If implicit word fragment completion were contaminated by explicit cued recall, then one should see a levels of processing effect for word fragments under implicit instructions, just as occurs under explicit instructions. As can be seen in Table 5.3, this pattern did not occur (see also Schacter, Bowers, & Booker, this volume).

The more general point is that we observe parallel effects between word fragment and word stem completion, both of which may be classified as data-driven implicit memory tests. Of course, it is unclear as to whether other data-driven implicit memory tests will conform to this pattern of results, but repetition priming in perceptual identification also shows no levels of processing effect (Jacoby & Dallas, 1981). We turn now to consider mechanisms of data-driven tests.

Mechanisms of Data-Driven Retrieval

Most implicit memory tests in common use are data-driven. The hallmarks of data-driven processing are (1) that prior reading of a word out of context provides more priming than does generating it from a conceptual clue (Jacoby, 1983b), (2) that modality effects occur such that visual presentation of study items produces greater priming than does auditory presentation on tests employing visually degraded words, and (3) elaborative manipulations such as levels of processing have little or no effect on these tests (Roediger et al., 1989a). In this final section of the chap-
was instructed to think of the word that would result from interchanging the vowels in the nonsense words (e.g., tropics for tripocs). This group never saw or spoke the target word, but only thought of it after reading the nonword aloud. Later, subjects performed a word fragment completion test in which they were asked to complete fragments for target words such as tropics and golden, as well as for nonstudied words. The overt visual similarity between study and test events for nonwords was exactly the same for both groups of subjects (e.g., tripocs during study, _r_p_cs during test), but one group had been required to think of lexical items during study and the other group had not.

The results are shown in Table 5.4, where it is apparent that anagrams that had been mentally translated into words by the subjects produced as much priming on the word fragment completion task as did prior reading of the word itself. On the other hand, prior study of the anagrams in the nontranslation condition produced no priming, despite the visual similarity of the study and test events. The general pattern of results was replicated on a perceptual identification test, too: no priming occurred for the nontranslation group and sizable priming occurred for the translation group (although not as great as for prior study of words, in this case).

The general conclusion to emerge from Weldon’s (1988) research is that lexical processing is critical for priming in the word fragment completion and perceptual identification implicit memory tests. However, once lexical processing is achieved, the match in surface features between study and test events enhances the basic priming effect. Thus, what we have called ‘data-driven processing’ has a component of lexical processing and a further component of perceptual processing. Presumably, the lexical component is responsible for the cross-modal priming effects that are frequently observed in word fragment completion and in other implicit tests. Kirner et al. (this volume) reach a similar conclusion. This conclusion about lexicality also dovetails with D. Nelson’s (1989; Nelson, Canas, Bajo, & Keelean, 1987) results showing that a lexical search underlies performance on word fragment completion tests. However, the lexicality hypothesis has difficulty in at least one realm, explaining priming from pictures: Weldon and Roediger (1987, Experiments 2 and 3) manipulated subjects’ probability of labeling studied pictures, but with no differential effect on the amount of priming observed. This discrepancy from an otherwise consistent pattern deserves further attention.

SUMMARY AND CONCLUSIONS

We have tried to make several points in this chapter. First, the attempt to determine what causes dissociations between explicit and implicit memory tests may be asking too broad a question. (The same is true of contrast between episodic and semantic memory tests or declarative and procedural tests.) The reason is that typically these contrasts confound several different factors with the one of critical in-
terest in the comparison (Roediger, 1984; Neely, 1989). If general differences are sought between implicit and explicit tests (or episodic and semantic tests, or declarative and procedural tests), then one should show that independent variables affect many tests of the same class in the same way, and differently from tests of the other class. Instead, the typical research strategy is to select just one implicit and one explicit test for comparison.

The value of the present analysis, in our opinion, is to show that implicit memory tests themselves can be dissociated. We reviewed cases in which a variable was manipulated and shown to have effects on one implicit test but not on another, or even to have opposite effects on two implicit memory tests. The fact of such dissociations would seem to require, from the memory systems perspective, postulation of subsystems. However, we have argued that a processing account may be more natural in many cases (see Roediger et al., 1989a). The dissociations within implicit memory tests discovered so far can be accounted for by postulating a continuum of tests from those requiring more perceptual information (data-driven tests) to those requiring knowledge of meaning (conceptually-driven tests). It seems likely that the data-driven/conceptually-driven distinction is not the only one that cuts across the implicit/explicit dimension, and that dissociations can be found by manipulation of other variables. However, at present this claim remains speculation.

Finally, in the last part of the chapter we tried to specify the mechanism of data-driven processing, which we have not previously considered. The very term implies that a relatively low-level sensory analysis may be important, but Weldon's (1988) research shows that encoding of some form of lexical information during study is critical in producing priming on verbal tests. Data-driven processing certainly has a perceptual basis (for example, same mode presentation between study and test always yields greater priming than does cross-mode presentation), but more abstract lexical information also seems critical in the most commonly used data-driven tests such as word fragment completion and perceptual identification.

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