from that in which *black* had originally been studied. In contrast, in the cued-recall test context, subjects were given the original context (train) with which they had studied the word. Thus, if the contextual factors are sufficiently weighted in favor of recall, as they were in these experiments, recall can be superior to recognition. Tulving interprets these results as illustrating what he calls the **encoding-specificity principle:** The probability of recalling an item at test depends on the similarity of its encoding at test to its original encoding at study.

Subjects show better word memory if the words are tested in the context of the same words as they were studied.

Implicit versus Explicit Memory

So far this chapter has focused on memories that subjects have conscious access to. However, some of the most interesting research in the field of memory concerns memories that we are not conscious we have. Occasionally, we will become aware that we know things which we cannot describe. One example that some people can relate to is memory for the keyboard of a typewriter. Many accomplished typists cannot recall the arrangement of the keys except by imagining themselves typing. Clearly, their fingers know where the keys are, but they just have no conscious access to this knowledge. Such implicit memory demonstrations highlight the significance of retrieval conditions in assessing memory. If we asked the typists to tell us where the keys were, we would conclude they had no memory. If we tested their typing, we could conclude that they have perfect memory. In this section, we will be looking for such contrasts between explicit and implicit memory. Such contrasts are referred to as **dissociations.** That is, they involve showing that implicit and explicit memory behave differently. In the keyboard example above, explicit memory shows no knowledge while implicit memory shows total knowledge. **Explicit memories** is the term for things which we can consciously recall. **Implicit memories** is the term for things for which we show knowledge only by our improved performance on some task.

Implicit Memory Spared in Amnesics

Cases of such total dissociation of implicit and explicit knowledge are rare with normal humans. However, such cases are more common in patients who suffer from certain amnesias. An **amnesia** is a memory deficit due to neural damage. One group of such patients includes those who suffer from **Korsakoff syndrome.** This condition is associated with chronic alcoholism and is a result of malnourishment and consequent brain damage. These

patients seem unable to remember very much after the onset of Korsakoff syndrome. It is believed that such patients suffer extensive damage to neural structures both in the frontal lobes and the hippocampus. As we have described in these last two chapters, both areas are particularly important to memory. Consider the following description of a patient:

> *Only after long conversation with the patient, one may note that at times he utterly confuses events and that he remembers absolutely nothing of what goes on around him: he does not remember whether he had his dinner. On occasion the patient forgets what happened to him just an instant ago: you came in, conversed with him, and stepped out for one minute, then you come in again and the patient has absolutely no recollection that you had already been with him. Patients of this type read the same page over and over again, sometimes for hours, because they are absolutely unable to remember what they had read. (Oscar-Berman, 1980, p. 410)*

Research has indicated that amnesic patients have implicit memories of many experiences that they cannot consciously recall. For instance, Graf, Squire, and Mandler (1984) compared amnesic versus normal subjects with respect to their memory for a list of words. After studying these words, subjects were asked to recall the words. The results are shown in Figure 7.10. Amnesic subjects did much worse than normal subjects. Then subjects were given a word-completion task. They were shown the first three letters of a word they had studied and were asked to make an English word out of it. For instance, subjects might be asked to complete ban____. By chance, there is a less than 10 percent probability that subjects can guess the word they studied, but as shown in the figure, subjects in both groups were coming up with the studied word more than 50 percent of the time. Moreover, there was no difference between the amnesic and the normal subjects in the word-completion task. So, the amnesic subjects clearly did have memory for the word list. However, they could not gain conscious access to these memories in a free-recall task. Rather, they displayed implicit memory in the word-completion task.

One of the most studied amnesic patients is a patient known as H.M. Large parts of this man's temporal lobes had been removed in an operation to cure epilepsy. He has one of the most profound amnesias and for more than forty years has been almost totally unable to remember new events. His surgical operation involved complete removal of the hippocampus and surrounding structures, and this is considered to be the reason for his profound memory deficits (Squire, 1992). However, he has been shown capable of acquiring implicit memories. For example, he is able to improve on various perceptual-motor tasks across days, although each day he has no memory of the task from the previous day (Milner, 1962).

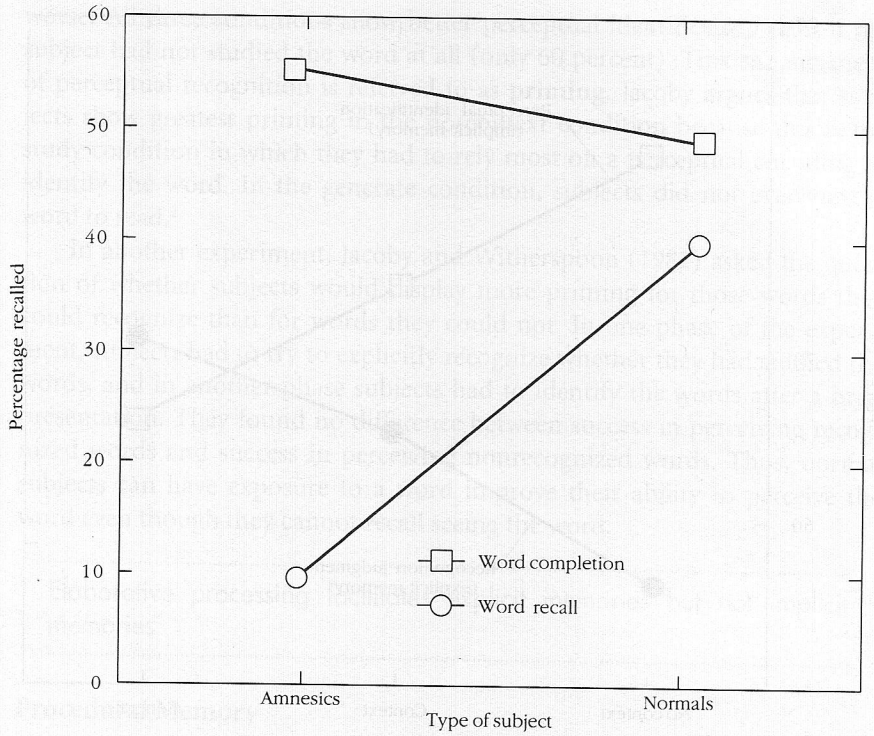

FIGURE 7.10: Ability of amnesic patients and normal subjects to recall words studied versus complete fragments of words studied. (From Graf, Squire, & Mandler, 1984.)

Amnesic patients with hippocampal damage are often unable to consciously recall some event but will show in implicit ways that they have some sort of memory for the event.

Implicit versus Explicit Memory in Normal Subjects

A great deal of recent research (for reviews, read Schacter, 1987; Richardson-Klavehn & Bjork, 1988) has looked at the dissociation between implicit and explicit memory in normal subjects. With this population it is often not possible to obtain the dramatic dissociations we see in amnesic subjects, where there is no conscious memory in the presence of considerable implicit memory. However, it has been possible to demonstrate that certain variables have different effects on tests of explicit memory than on tests of implicit memory. For instance, Jacoby (1983) had subjects either just study a word such as *woman* alone (the no-context condition) or study it in the presence of

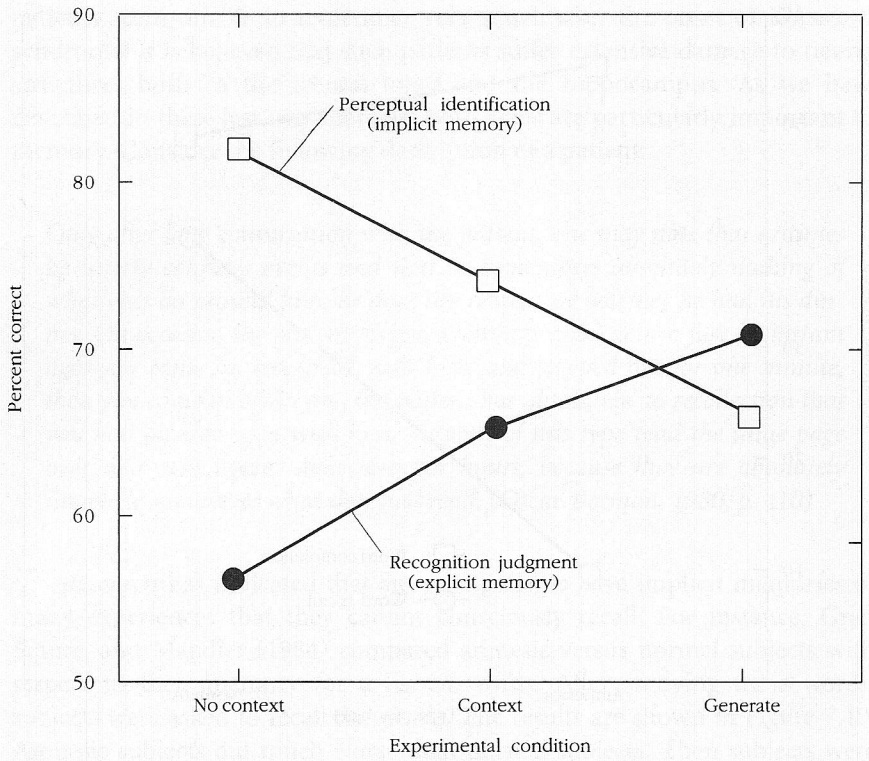

FIGURE 7.11: Ability to recognize a word in a memory test versus ability to identify it in a perceptual test as a function of how the word was originally studied. (From Jacoby, 1983.)

an antonym *man-woman* (the context condition) or generate the word as an antonym. In this last condition subjects would see *man-* and have to say *woman.*

Jacoby tested the subjects in two ways which were designed to tap explicit memory and implicit memory. The explicit memory test involved presenting subjects with a list of words, some studied and some not, and asking them to recognize the old words. The implicit memory test involved presenting the word to subjects for a brief period (40 milliseconds) and asking them to identify the word. Figure 7.11 shows the results from these two tests as a function of study condition. As can be seen, performance on the explicit memory test is best in the condition that involves more semantic and generative processing—in line with earlier research we reviewed on elaborative processing. In contrast, performance on the implicit perceptual identification test gets

worse. All three conditions show better perceptual identification than if the subject had not studied the word at all (only 60 percent). This enhancement of perceptual recognition is referred to as **priming.** Jacoby argues that subjects show greatest priming in the no-context condition because this is the study condition in which they had to rely most on a perceptual encoding to identify the word. In the generate condition, subjects did not even have a word to read.[2]

In another experiment, Jacoby and Witherspoon (1982) asked the question of whether subjects would display more priming for those words they could recognize than for words they could not. In one phase of the experiment, subjects had to try to explicitly recognize whether they had studied the words, and in another phase subjects had to identify the words after a brief presentation. They found no difference between success in perceiving recognized words and success in perceiving nonrecognized words. Thus, normal subjects can have exposure to a word improve their ability to perceive the word even though they cannot recall seeing the word.

Elaborative processing facilitates explicit memories but not implicit memories.

Procedural Memory

Implicit memory is defined as memory without conscious awareness. By this definition, rather different things can be considered implicit memories. Sometimes implicit memories involve things like the spelling of words or perceptual information relevant to recognizing the words. These memories result in the priming effects we saw in experiments such as Jacoby's. In other cases implicit memories involve knowledge about how to perform tasks. A classic example of such an implicit memory is riding a bike. Most of us have learned to ride a bike with no conscious ability to say what it is we have learned. Amnesic subjects show spared memory for procedural information as well as for the sort of information that underlies priming effects.

An experiment by Berry and Broadbent (1984) involved a procedural learning task that has a more cognitive character than riding a bike. They asked subjects to try to control the output of a hypothetical sugar factory (which was simulated by a computer program) by manipulating the size of the workforce. Subjects would see the month's output of the sugar factory in thousands of tons (e.g., 6,000 tons) and then have to choose the next month's

[2]Not all research has found poorer implicit memory in the no-context condition. However, all research finds an interaction between study condition and type of memory test. See Masson & MacCleod (1992) for further discussion.