chapter 6

Brain and Consciousness II: Dissociations between Consciousness and Behavior

One of the main concerns of the psychology of consciousness is the distinction between conscious and nonconscious mental processes. In order to understand the nature of consciousness and its functions, we need to know when conscious awareness does, or does not, accompany mental processes. Endel Tulving (1989) noted that until recently the relationship between consciousness and the cognitive processes of memory and perception was largely ignored by cognitive psychologists. He attributed this neglect to an implicit assumption, which he termed the *doctrine of concordance* of cognition, behavior, and experience:

> It holds that there exists a close and general, even if not perfect, agreement between what people know, how they behave, and what they experience. Thus, conscious awareness is [assumed to be] required for, and therefore accompanies, the acquisition of knowledge, or its retrieval from the memory store; retrieved knowledge guides behavior, and when this happens, people are aware of the relation between the knowledge and the behaviour; future behaviour is planned and ongoing behaviour is executed under the watchful eye of consciousness (p. 8).

Because of the doctrine of concordance, researchers assumed that human performance necessarily involves conscious awareness of the relevant stimuli or information stored in memory, and they did not look for exceptions to the rule. When evidence against concordance was found, such as evidence for subliminal perception, it was either ignored, regarded as a curiosity but not taken seriously, or vehemently attacked.[1]

Conscious versus nonconscious processing. Nowadays, however, most cognitive psychologists agree that much—perhaps most—of our mental processing occurs nonconsciously (Kihlstrom, 1987). Here, I distinguish between conscious and nonconscious processing as follows: *Conscious processing* is processing that occurs with awareness of the contents being processed. Awareness of contents might occur either at the end of the process, at intermediate stages along the way, or both. For example, conscious processing occurs when you see a word ("apple") and you consciously recognize the word and its meaning (an edible fruit) or you have an image associated with the word (such as a visual mental image of an apple). *Nonconscious processing* is processing that occurs without awareness of the contents being processed, that is, there is no awareness of either the outcome of the process or of intermediate stages along the way. Nonconscious processing is important because its outcome may affect peoples' behavior, their emotional reactions, or other mental processes that produce conscious outcomes. The prototype example of nonconscious processing is subliminal perception, where peoples' behavior is influenced by stimuli that are too brief to be consciously recognized.

It is important to note that conscious processing, by the definition given above, does not mean that people are introspectively aware of the mental processes themselves; it means only that they are aware of the contents or outcomes of the processes. For example, when you read a word ("apple"), you are not aware of the processes that analyze the visual pattern and match it against the thousands of word shapes stored in long-term memory until the correct word and its meaning are located. You are only aware of the result or outcome of the process, in which a particular word ("apple") and its meaning are consciously recognized. As I explained in Chapter 1, basic cognitive and sensory-motor skills or procedures—such as pattern recognition, memory retrieval, and selective attention—are stored in procedural memory and they operate automatically or by habit; we have no introspective access to their operational details. Thus, the distinction between conscious and unconscious processes depends on whether we are aware of their contents or outcomes, not whether we are aware of the processes themselves.

The purpose of this chapter is to describe some of the evidence for nonconscious information processing. The occurrence of nonconscious processing is demanded by a number of cognitive psychological theories (Kihlstrom 1987) as well as by the absence of introspective access to certain cognitive processes, such as pattern recognition. However, it has taken extraordinary ingenuity for researchers to provide explicit experimental demonstrations of nonconscious processing. The criterion for experimentally demonstrating nonconscious processing is to show behavioral evidence of information processing in the absence of conscious awareness of that information. In other words, we need to demonstrate a *dissociation* or disconnection between task performance and consciousness. A stimulus input or information stored in memory must affect subjects' responses, without them being aware of the stimulus or stored information. Ordinarily, when subjects perform experimental tasks, such as perception and memory tasks, they are consciously aware of the input stimuli or remembered information that they use to perform the task. Thus, it has been necessary to develop special procedures to demonstrate nonconscious processing. This chapter will emphasize research on nonconscious processing in brain-damaged subjects. I will also describe some evidence for nonconscious processing in normal subjects (such as subliminal perception).

Neuropsychological syndromes. Neuropsychologists have discovered several syndromes in which brain-damaged patients show a dissociation or disconnection between consciousness and performance on certain types of tasks (Schacter, McAndrews & Moscovitch 1988; Weiskrantz 1988a). That is, the brain-damaged patients/subjects can perform the tasks without being consciously aware of the external stimuli or memory information that affects their responses—though the test procedure is one in which normal people would be aware of the relevant stimuli or memory information. The last chapter discussed research on split-brain patients, a dissociation syndrome in which the mute right hemisphere can perform a variety of cognitive tasks without the speaking left hemisphere knowing what the right hemisphere is seeing, thinking, or doing. This chapter considers dissociations in patients that have suffered injuries to specific parts of the brain, resulting in impairment or loss of certain cognitive functions; for example, patients with cortical blindness or amnesia. In "blindsight," cortically blind patients are able to respond to visual stimuli that they do not consciously see. And amnesic patients can use information stored in memory, without consciously recalling that information or the occasion when they learned it. Such cases can help us understand what sorts of cognitive processing can occur without awareness, and it gives important clues about the relationships between brain processes and consciousness.

Schacter et al. (1988) described dissociations between awareness and performance as dissociations between explicit and implicit knowledge. *Explicit knowledge* is knowledge that subjects can use to perform a task while also being consciously aware that they possess the knowledge. *Implicit knowledge* is knowledge that is used to perform a task without subjects being consciously aware that they possess it. Implicit knowledge is nonconscious; it does not have access to consciousness.

BLINDSIGHT

In normal visual perception you are consciously aware of objects. You can point to them, identify them, and verbally describe them. You respond to objects with a high degree of confidence in your perception: you know *that* you are seeing and you know *what* you are seeing. Under special circumstances, however, people can respond to objects without knowing what they are seeing, or even knowing that they are seeing. In *blindsight,* patients with damage to the brain's primary visual area can respond discriminatively to different stimuli, even though they deny seeing the stimuli.

Visual stimuli are analyzed primarily in the *occipital lobe* of the cerebral cortex. The first stage of visual analysis for object recognition occurs in the *striate cortex* (also known as the primary visual area), which is located at the very back of the occipital lobes (see Figure 5.2, Chapter 5). When someone has a lesion (wound) in the striate cortex, some degree of cortical blindness will occur. The person will be totally blind if the striate cortex is totally destroyed, even though the eyes and optic nerves are undamaged. More commonly, however, only part of the striate cortex is destroyed, and the person is blind in only part of their visual field. The visual field is mapped precisely on the occipital cortex, so that damage in a particular part of the cortex will cause blindness in a particular part of the visual field. The visual fields are mapped on the occipital cortex *contralaterally*, such that the right visual field (RVF, the part to the right of the visual fixation point) is mapped on the left striate cortex, whereas the left visual field (LVF) is mapped on the right striate cortex (Figure 5.3). A blind spot in part of the visual field, caused by a striate lesion, is called a *scotoma*. Thus, a lesion in part of the left striate area would cause a scotoma in the RVF. Complete, or nearly complete, loss of vision in one visual field caused by extensive damage to the contralateral striate area is termed *hemianopia*.

A puzzling difference between the performance of monkeys and humans with striate damage has been known for over one hundred years (Weiskrantz, 1980). Like humans with accidental striate lesions, monkeys with extensive experimental striate lesions appear to be blind, according to observations of their behavior under ordinary conditions. But with special training, cortically blind monkeys were able to learn to perform conditioned responses to visual stimuli, and to discriminate the location and orientation of visual stimuli. Yet, when humans with similar (accidental) lesions were asked to make the same visual discriminations, they said that they couldn't see anything. Two questions arise: First, how could cortically blind monkeys perform visual discriminations? Second, why couldn't cortically blind humans do this?

Neuroanatomical research has shown that monkeys have not one, but ten different visual pathways from the optic nerves to various parts of the cortex (Weiskrantz, 1990). The primary visual pathway, with a large majority of the one million neurons in each optic nerve, goes through the dorsal-lateral geniculate nucleus in the thalamus (a sensory relay station in the central core) to the striate cortex in the occipital lobes. But some 150,000 of the neurons go via other relay stations to secondary visual areas in other parts of the occipital lobes and temporal lobes. Thus, when the monkey's primary (striate) visual area is destroyed, some degree of visual capacity remains due to the secondary visual areas. But since visual-system neuroanatomy is quite similar for humans and monkeys, it was puzzling that secondary visual areas did not seem to be able to support simple visual discriminations in humans as they do in monkeys. The solution to this puzzle came when neuropsychologists developed special testing procedures for cortically blind humans, to demonstrate their residual visual capacities.

Lawrence Weiskrantz and his colleagues (Weiskrantz, Warrington, et al. 1974; Weiskrantz 1980, 1986) tested a man who had had a tumor removed from his right visual cortex. The result was that the patient—known as D.B.—had a left hemianopia, in which he was blind in the lower half of the left visual field, as well as most of the upper half. D.B. could not name or describe objects presented in his blind field, and he reported no awareness of them. Weiskrantz et al. devised ways of testing D.B.'s visual sensitivity, using forced-choice procedures. In *forced-choice procedures*, subjects are required to choose among a limited number of alternative responses (such as "yes" or "no"), even if it is just a guess; they are not allowed to say "I don't know." In the first test, the patient focused on a fixation point in the middle of a projection screen, then a small spot of light was flashed very briefly in the blind LVF area. The spot was flashed in different positions to the left of the fixation point on different trials. D.B. was required to point to the position where he thought the spot was flashed. It took some coaxing to get him to respond at first, since he said he did not see anything, and he felt silly trying to point to something that he didn't see. Yet, his pointing performance was remarkably accurate (see Figure 6.1). Thus, D.B. showed a dissociation between conscious visual experience and pointing performance on the spot-location task. In Schacter et al.'s (1988) terms, D.B. had implicit knowledge of the spot's location.

D.B. has also shown dissociations between conscious visual experience and performance on several other visual tasks. For example, he can distinguish between vertical, horizontal, and diagonal lines, and also between simple patterns (X versus O; straight-sided versus curved-sided triangles), provided that the stimuli are larger than a critical size. D.B.'s visual acuity was measured by asking him to discriminate the presence versus absence of gratings (patterns of crossed vertical and horizontal lines). In a random sequence, sometimes the stimulus was a grating, and sometimes it was a blank white screen of equal brightness. Visual acuity was measured by varying the grating's spatial frequency (number of lines per centimeter), where gratings of higher spatial frequency required finer visual acuity to distinguish them from the blank screen. In some regions of the "blind" field, acuity was actually higher than in some off-center regions of the sighted visual field.

In all of these visual tasks, successful performance depended on using a forced-choice response, such as requiring D.B. to say "yes" or "no," or point, or choose from a limited set of alternatives. In all cases in which stimuli were presented in the blind field, he insisted that he did not see anything. Performance on particular tasks tended to improve with practice, even though D.B. was not given any feedback on the correctness of his responses. In some cases, after extensive practice, D.B. reported a vague awareness that "something was there" (referring to a stimulus), but the subjective experience was not a visual experience. The distinction between visual experience and its absence was shown in some tests in which stimuli were presented in a small *amblyopic* area (area of spared vision) in the damaged LVF. D.B. reported that he could "see" patterns in the amblyopic area; he had a subjective visual experience, even though his vision was fuzzy in that area. In contrast, he said he could not see anything when the pattern was presented in a nearby scotomic (blind) area. Yet the grating test showed that visual acuity was actually better in some parts of the scotomic area than in the amblyopic area.

Blindsight is not found in all patients with cortical blindness. But by using forced-choice procedures various investigators have shown that some patients can discriminate one or more of the following visual stimulus dimensions: presence, position, orientation, flicker, wavelength (color), movement, and simple forms (results are somewhat ambiguous for forms; Weiskrantz 1986, 1990). The different patterns of residual visual abilities are

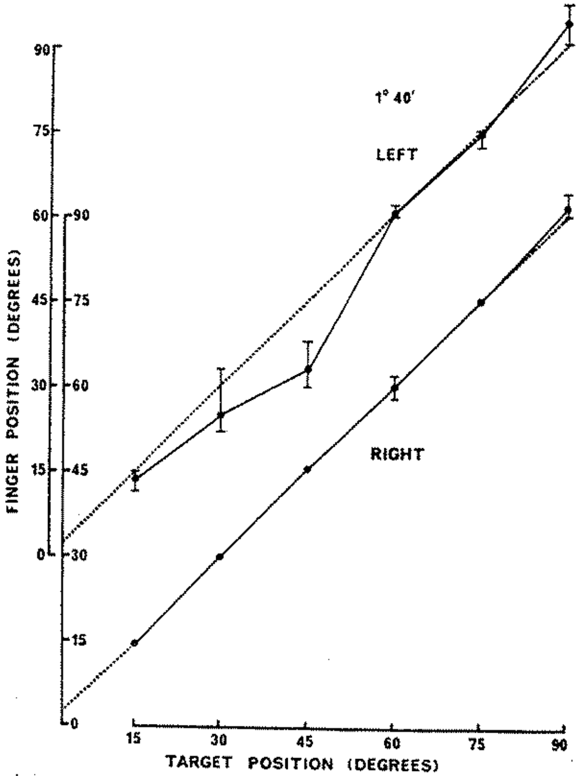

FIGURE 6.1. Average finger-reaching responses for blindsight subject, for targets in the left (blind) and right (normal) visual fields. The horizontal axis shows the position where the target (a spot of light, 1°40′ in diameter) was flashed, in degrees to the left or right of the central fixation point. The vertical axis shows the average position of the subject's reaching (pointing) response; vertical bars show the ranges. Perfect performance is indicated by the dotted line. The graph for the right visual field is displaced downward by 30 degrees. [From Weiskrantz, L., Warrington, E. K., Sanders, M. D., & Marshall, J. (1974). Visual capacity in the hemianopic field following a restricted occipital ablation. *Brain*, *97*, 709–28. By permission of Oxford University Press.]

bly related to the different location and extent of the lesions in different patients. What the patients have in common is that with forced-choice procedures they can successfully perform certain visual tasks even though they insist that they cannot see the stimuli. But they cannot perform tasks requiring explicit, conscious recognition, such as naming different objects shown in their blind field.

A problem in using forced-choice procedures is getting the subjects' cooperation: "Sometimes the subjects are so adamant that they cannot see that the forced-choice guessing requirement is dismissed as nonsense. Some stubbornly refuse to play such a game, and even accuse the experimenter of forcing them to lie" (Weiskrantz 1990, p. 257). After D.B. had had several years of practice on forced-choice tasks, during which his performance improved, Weiskrantz asked him whether he could see the stimuli any better than before. D.B. replied "No, but I now feel free to make this kind of [forced-choice] judgment. I have confidence. At first I was always afraid that I was somehow cheating or doing something silly" (p. 257).

Forced-choice procedures may be called *direct methods*, in that they require subjects to respond directly to a test stimulus in their blind field (as in pointing to it). In order to bypass the difficulties of direct methods, researchers have developed *indirect methods* of testing that do not require subjects to respond to stimuli that they deny seeing (Weiskrantz 1990). Some indirect methods take advantage of bilateral interaction effects, in which the response to a stimulus in the sighted field is affected by a stimulus in the blind field. For example, in the *visual completion effect*, when a circle is flashed—centered on the fixation point, such that the left half falls in the sighted field and the right half in the blind field—subjects report that they saw a whole circle. But if only the left half-circle is flashed to the sighted field, they report that they saw a left half-circle, whereas if the right half-circle is flashed to the blind field, they report that they saw nothing (Torjussen 1978). Thus, a figure in the blind field can complete a figure in the sighted field, though the figure in the blind field cannot be consciously seen by itself. Other indirect testing methods use unconditioned reflexes to stimuli projected to the blind field. For example, Zihl et al. (1980) measured the galvanic skin response, and Weiskrantz (1990) measured pupil-contraction responses.

In all cases of blindsight, regardless of the behavioral measurement technique, subjects with striate damage respond to visual stimuli that they cannot consciously see. The implication is that only the primary visual pathway, via the striate cortex, connects to brain circuits that generate conscious visual experience. The primary pathway is necessary for the full range of visual perception, including object recognition and complex visually guided locomotion. But secondary visual areas are sufficient for some types of visual discriminative responding, without awareness. Thus, contrary to a behaviorist analysis that equates seeing with discriminative responding to visual stimuli, blindsight studies show that discriminative visual responding is not equivalent to conscious seeing.

AMNESIA

In the amnesic syndrome, the dissociation between consciousness and performance is a matter of explicit versus implicit memory. Patients may be able to perform certain tasks that require them to use remembered information or skills, but they have no conscious recollection of the information or of having learned the skill (Schacter 1987; Schacter et al. 1988; Weiskrantz 1988a).

Amnesia is a partial or total loss of memory due to brain injury or disease. There are two varieties of amnesia: (1) *anterograde amnesia*, the inability to learn new information or to recall events that have occurred since the injury; and (2) *retrograde amnesia*, the inability to recall information learned or events that occurred prior to the injury. In most cases amnesia is not com plete, but patchy, with some events being recalled and others not. Anterograde amnesia is the most characteristic feature of the *amnesic syndrome*; retrograde amnesia may or may not be present, depending on the nature and extent of the injury (Kolb & Whishaw 1990). This discussion concerns anterograde amnesia.

The full-blown amnesic syndrome is most likely to occur in patients with lesions of the medial temporal lobes, including the hippocampus, which is a part of the limbic system that intrudes into the inner region of the temporal lobes (Weiskrantz 1985, 1988a). Amnesic syndrome can also be caused in several other ways, including closed head injury, disrupted blood supply to part of the brain (due to plugged arteries [stroke] or broken arteries [ruptured aneurysms]). Amnesia is probably most common in cases of Alzheimer's disease and Korsakoff's disease. Alzheimer's is a mysterious, progressive, irreversible disease involving plaques and tangles of nerve fibers, which affects a significant minority of persons over sixty-five years old. Korsakoff's disease is characteristic of long-term alcoholics who suffer from malnutrition; specifically, it involves a deficiency in thiamine (vitamin B_1), which is critical for proper brain functioning.

Amnesia can occur despite preservation of perceptual, linguistic, and most intellectual skills. Short-term memory is usually intact, as is shown by the ability to repeat immediately a random string of digits or words. However, severe amnesics have no ability to recall information to which they were exposed only a minute or two earlier, or to recognize names or faces of people that they met a minute or so earlier. One of the classic amnesia cases is H.M., who had both of his medial temporal lobes surgically removed in order to eliminate severe, incapacitating epilepsy. Afterward, he could still carry on routine conversations, though he was unlikely to initiate them. He would sometimes read the same magazine over and over again, because he couldn't recall having read it the previous day, or earlier that same day. Neuropsychologists who studied H.M. described his experience:

> During three of the nights at the Clinical Research Center, the patient rang for the night nurse, asking her, with many apologies, if she would tell him where he was and how he came to be there. He clearly realized that he was in a hospital but seemed unable to reconstruct any of the events of the previous day. On another occasion he remarked "Every day is alone in itself, whatever enjoyment I've had, and whatever sorrow I've had." Our own impression is that many events fade for him long before the day is over. He often volunteers stereotyped descriptions of his own state by saying it is "like waking from a dream." His experience seems to be that of a person who is just becoming aware of his surroundings without fully comprehending the situation, because he does not remember what went before (Milner, Corkin, & Teuber 1968, pp. 216–17).

H.M. and other severe amnesics cannot perform tests of explicit memory, such as recalling and reporting lists of words or phrases to which they have been exposed. Nor can they perform tests of recognition memory for words or faces to which they have recently been exposed. Forgetting is most severe if there is a delay of a minute or more between exposure and test, and an opportunity for interference to occur. The amnesic syndrome, involving an intact short-term memory (STM) and an inability to transfer new information from STM to long-term memory (LTM) while still being able to retrieve old (pre-accident) information from LTM, is one of the main pieces of evidence supporting multistore theories of memory (Warrington 1982).

In contrast to their inability to learn semantic information and recall personal experiences, global amnesic patients are often able to learn new motor skills through practice, though they cannot consciously recall having practiced that skill. For example, H.M. improved with practice on the pursuit rotor task, which involves trying to track manually a dime-sized spot as it rotates around-and-around on a turntable. H.M.'s percent of time-on-target increased with practice. His ability to perform mirror drawing, accurately tracing patterns (such as a star) in a situation where he could see the pattern and pencil only in a mirror, also improved with practice. Thus, H.M. showed a dissociation between performance and consciousness. He had implicit memory of the prior practice sessions, insofar as his performance improved with practice, but he had no explicit, conscious memory of having practiced the tasks previously.

The implicit-explicit memory dissociation in amnesics has also been shown in cognitive tasks. For example, Warrington and Weiskrantz (1974) showed amnesics lists of words to study. Just a few minutes later the amnesics could not perform tests of explicit memory: that is, they could not consciously recall the words that they had studied or reliably recognize them in a list of old (previously exposed) words mixed with new words. However, they showed enhanced performance in an implicit memory test, the word-stem completion test. In the *stem completion test*, word stems are shown and subjects are required to fill in the blanks to complete the words. (Try it: tur__ __ __; spa __ __ __ __.) Normal people do stem completion tests more accurately for words to which they have recently been exposed than for words to which they have not recently been exposed; this is a type of *repetition priming effect* (Schacter 1987). Like normal people, amnesics show a repetition priming effect on word stem completion tests (as well as on word completion tests with blank spaces in the middle of the word, instead of the end; for example, s __ __ d __ r). Yet, amnesics do not consciously recall that they previously saw the words on a list; they treat the completion test as a sort of "guessing game." Table 6.1 shows data for amnesics and normal control subjects on stem completion and yes/no recognition tests involving words on lists seen ten to fifteen minutes before testing. Amnesics did much worse than normals on explicit recognition tests, but they did not differ significantly from normals on stem completion (implicit memory) tests. In a later

TABLE 6.1 Probabilities of Recognition and Stem Completion for Previously Exposed Words in Amnesic and Normal Subjects

	MEASURE OF MEMORY RETENTION	
Subjects	RECOGNITION	STEM COMPLETION
Amnesic patients	0.25	0.34
Control subjects	0.73	0.28

Data from Warrington, E. K., & Weiskrantz, L. (1974). The effect of prior learning on subsequent retention in amnesic patients. *Neuropsychologia*, *12*, 419–28. (Exp. 1).

study (Graf, Squire, & Mandler 1984), when amnesics were instructed to use the word stems deliberately to help them recall the previously studied words, they did worse than controls on the stem completion test. Apparently the instructions had the effect of changing the completion test from an implicit memory test to an explicit one, at which amnesics do poorly.

In another implicit memory test involving a repetition priming effect, Schacter (1985) showed amnesics a series of word pairs to study; the pairs were from common idioms (such as SOUR-GRAPES). Later, the subjects did well in an implicit memory test, in which the experimenter showed them the first word of each pair, and asked them to simply write down the next word that came to mind. Like normal subjects, amnesic subjects responded with the correct word to complete the idiom pair more often for pairs that they had previously studied than for control idiom pairs that they had not seen in the experiment. But the subjects did poorly in an explicit memory test, in which the experimenter showed them the first word of each pair and asked them to recall the second word. Again, it appears that the experimenter's instructions can change the task from a test of implicit memory, at which amnesics can do well, into a test of explicit memory, at which amnesics do poorly. Repetition priming effects indicate that amnesics can store and use information about words to which they have recently been exposed, though they cannot explicitly recall the words or the occasion when they saw them.

In describing the memory deficits and abilities of amnesics, we can sort out most of the effects in terms of different types of long-term memory: episodic, semantic, and procedural memory (Tulving 1983, 1985a). Amnesia affects episodic and semantic memory, but not procedural memory. The most consistent memory deficits involve episodic memory, the recall of personal experiences. For example, severe amnesics cannot remember reading a particular magazine or meeting a particular person earlier in the day. Recalling or recognizing lists of words learned in an experiment is a special case of episodic memory, and amnesics fail at explicit recall and recognition attempts. However, amnesics may have normal semantic memory of prior knowledge about the words, that is, they can still read and understand words that they knew prior to their injury.

Explicit memory for newly presented semantic information, such as impersonal facts and the meanings of new vocabulary words, is ordinarily poor in amnesics. However, some ability to acquire new semantic information often remains. When amnesics are able to recall newly presented factual (or fictitious) information (such as "Bob Hope's father was a fireman") they are usually unable to recall when and where they learned the information (Schacter, Harbluk, & McLachlan 1984; Shimamura & Squire 1987). This dissociation between semantic and episodic memory is termed *source amnesia.*

Amnesics also show a dissociation between episodic and procedural memory. They can learn new sensory-motor skills (such as pursuit rotor) that involves procedural memory, but they do not recall the experience of practicing the skill on previous occasions. Skills in procedural memory can be executed without direct conscious control. Procedural memory apparently involves different brain mechanisms than episodic memory.

The pattern of deficits and abilities in amnesics is complex, and no theory accounts for all of the findings (Schacter 1987). In particular, repetition priming effects cannot be readily explained in terms of the episodic-semantic-procedural memory types. It is noteworthy that repetition priming occurs in normal subjects as well as amnesics, and it has been demonstrated in normals using faces and drawings of objects and abstract geometric figures, as well as words. The effect can last for several days or more, though it decreases with time. In normals, repetition priming occurs regardless of whether subjects can explicitly recall or recognize the stimuli seen previously in the experimental context. Thus, in normals as in amnesics, priming can occur even when subjects do not consciously recognize the stimuli as familiar (Schacter 1987; Tulving & Schacter 1990). Also, normal subjects tested during posthypnotic amnesia show repetition priming effects for words previously memorized during hypnosis, though they cannot explicitly recall the words previously seen (Kihlstrom 1980).

The ubiquity of repetition priming and its independence from explicit (recognition) memory have led Schacter and Tulving (Schacter 1990a; Tulving & Schacter 1990) to suggest that repetition priming—which they now call *perceptual priming*—indicates a newly discovered type of memory, the *perceptual representation system* (PRS). The PRS is "hyperspecific," in that it concerns the exact appearance of objects (or printed words) rather than their abstract characteristics or meaning. The PRS involves specialized brain modules, probably in the anterior occipital lobes (forward of the striate area) for visual stimuli. The PRS is normally connected with episodic-semantic memory systems, but it can become disconnected from them and continue to function on its own, as in amnesia. The PRS can operate nonconsciously. Thus, the PRS can produce repetition (perceptual) priming effects, without subjects being aware that they were previously exposed to the stimuli in the experimental context.

In conclusion, amnesics are able to perform certain tasks involving implicit memory, despite a lack of conscious knowledge of the information used in performing those tasks, and without being able to recall when and where they learned the relevant information or skill. The parallel to blindsight is that whereas blindsight patients show an effect of current stimuli on performance, without conscious awareness of the stimuli, amnesics show an effect of past stimuli on performance, without conscious recall of the stimuli. In a later section I will describe Schacter's DICE model that attempts to account for both blindsight and implicit memory effects, but first I will briefly describe some related neuropsychological phenomena.

OTHER NEUROPSYCHOLOGICAL DISSOCIATION SYNDROMES

Several other syndromes have been discovered where, as in blindsight, brain-damaged patients can perform certain perceptual tasks even though they are not consciously aware of the stimuli or cannot consciously discriminate between them (reviews by Schacter et al. 1988; Weiskrantz, 1988a).

Blind-touch. "Blind-touch" is a tactile analogy to blindsight (Paillard et al. 1983). A patient with damage to the somatosensory cortex had no conscious awareness of being touched on her hand, yet in a forced-choice procedure she could discriminate between different touch locations.

Prosopagnosia. Prosopagnosia is a deficit in the ability to identify familiar faces. It is usually caused by bilateral (both sides) lesions to the occipital-temporal cortical regions, though it occurs in some cases with only right-side damage. Prosopagnosics are unable to identify familiar people, such as family members and famous people, by their faces alone. In most cases they are still able to identify other familiar visual objects, and they can distinguish between faces and objects that are not faces, but they cannot consciously discriminate between familiar and unfamiliar faces. They continue to recognize familiar names, and know who the names represent, but they cannot name familiar faces. Special procedures have shown that some prosopagnosics have nonconscious, implicit knowledge of familiar faces. For example, Bauer (1984) showed a prosopagnosic patient pictures of famous faces, such as actors and politicians. The patient could not name the faces, and on multiple-choice tests in which the experimenter read five names aloud (all from the same category, such as actors), the patient selected the correct name at only a chance level (20 percent correct). Yet on a physiological measure, the skin conductance response (SCR), the subject responded maximally to the correct name on 60 percent of the trials. (Normal control subjects could name almost all of the faces, and made correct SCRs on 90 percent of the multiple-choice trials.) The well-above-chance SCR performance of the prosopagnosic patient showed that he had implicit knowledge of the face names.

Dyslexia. Dyslexia refers to disruptions of the ability to read, due to some sort of brain damage or developmental abnormality. Dyslexias usually involve damage or abnormalities in the left posterior (rear) temporal lobe and adjacent areas of the occipital cortex. There are several varieties of dyslexia, of greater or lesser severity, associated with different brain conditions. In the syndrome of *alexia without agraphia*, patients can identify individual letters but they cannot read whole word patterns. They can identify words by the slow process of decoding them letter-by-letter. Landis et al. (1980) tested such a patient's implicit word recognition ability by flashing words (object names) very briefly on a screen, making the flash much too brief for the patient to decode the word letter-by-letter. The patient could not consciously identify the word. Yet on a forced-choice test he was able "intuitively" to choose the correct object (such as a pencil) from among a large array of objects on a table. The choice could not be based on the word's first letter alone, since there were always at least two objects whose name started with the same critical letter (pencil and paper). When the patient was asked to deliberately base his choice on the first letter (instead of choosing intuitively), his performance deteriorated. Landis et al. (1980) concluded that the patient was capable of pure "iconic reading"—in which visual word stimuli automatically access semantic information about the words, which is sufficient for correct "intuitive" object choices—though the words were not translated to verbal-acoustic codes with conscious recognition. Apparently, attempts to explicitly translate the visual word to a verbal-acoustic code interfered with the rapid iconic reading process.

Aphasia. In general, aphasia is a disruption of language processes, including either production or comprehension processes, as a result of brain damage. It occurs as a result of damage to the left temporal lobe and/or nearby areas of the frontal, parietal, or occipital lobes. There are several types of aphasia, associated with damage to different brain areas. Of particular interest here is *Wernicke's aphasia,* characterized by problems in both speech comprehension and speech production. Though their speech may be quite fluent and often grammatically correct, sentences produced by Wernicke's aphasics are largely meaningless. They include mispronounced words, substitution of inappropriate words, and sometimes neologisms (invented words). Aphasics' speech has been characterized as a "word salad." It appears that connections between consciousness and semantic memory are disrupted in Wernicke's aphasics, insofar as they are unable to retrieve suitable words to express their conscious intentions. In a test of explicit semantic knowledge, Wernicke's aphasics performed at a chance level when asked to make yes/no judgments of the semantic relatedness of various word pairs (such as sport, football; fruit, rose; see Milberg & Blumstein 1981). However, their semantic memory seemed to be functioning normally in a test of implicit semantic knowledge: In the *lexical decision task*, they were required to judge, as quickly as possible, whether a string of letters was a word (such as "monkey" or "murdey"). Like normals, Wernicke's aphasics responded faster to words ("bank") when they followed semantically related words ("money-bank") than when they followed unrelated words ("monkey-bank") or nonwords ("murdey-bank"). It appears that though Wernicke's aphasics could not judge the semantic relatedness of words at a conscious level, they had implicit, nonconscious knowledge of semantic relatedness.

Hemineglect. Hemineglect (unilateral neglect) is one of the strangest of the neuropsychological syndromes. Patients with parietal lobe damage may neglect the side of space contralateral to the lesion. Most commonly this occurs in patients with damage to the right parietal lobe. Subsequently, if asked to draw a scene, they will draw only the right side of it. If asked to bisect a horizontal line, they will place their bisecting mark to the right of center, as if they did not see all of the left side of the line. Some patients fail to groom the left side of their body. This left-side neglect occurs even though the patients are free to move their head and eyes to see the whole scene in either the left or right visual field. Hemineglect is a disorder of space perception, rather than of vision. Patients sometimes report objects from the left side of space, but mistakenly locate them in the right side.

Nonconscious perception of the neglected side of space has been shown in hemineglect patients in a study of the phenomenon of extinction to double simultaneous stimulation (Volpe, LeDoux, & Gazzaniga 1979). Some patients can accurately describe single stimuli (pictures, words) placed in either their left or right visual field, but if stimuli are presented simultaneously in both fields, only the right-side stimulus can be accurately described; they are either unaware of the left-side stimulus, or vaguely aware of it but unable to describe it. Yet, if required to judge whether the two stimuli are the same or different in a forced-choice procedure, their performance is well above chance (88 to 100 percent).

Marshall and Halligan (1988) reported a novel case of implicit knowledge in a hemineglect patient. The patient was presented simultaneously with two line drawings of a house, aligned centrally, one above the other. The drawings were identical except that one of them had flames coming out the left side. On repeated trials, the patient reported that the two drawings were identical; she did not notice the flames. When asked which house she would prefer to live in, she thought it was a silly question "because they're the same," but nonetheless she reliably chose the house that was not burning. In another series of trials, one of the houses had flames coming out the right side, and she immediately noticed the flames. Finally, during another series of trials with flames on the left side, she suddenly exclaimed "Oh my God, this one's on fire!"

Schacter et al. (1988) pointed out that the interpretation of hemineglect is still a matter of debate. One view is that it is analogous to other neuropsychological dissociation phenomena, such as blindsight: in hemineglect, spatially coded information cannot gain access to consciousness. An alternative view is that hemineglect is a disorder of attention, in which left-side spatial information is potentially available to consciousness, but attention is systematically directed away from it. At this point, it is uncertain whether the explanations applied to syndromes such as blindsight can also be applied to hemineglect.

EXPLAINING DISSOCIATION SYNDROMES

In blindsight, amnesia, and other neuropsychological syndromes involving dissociations between performance and consciousness, the claim that the patients are not consciously aware of the stimuli that control their performance is based mainly on their introspective verbal reports. For example, blindsight subjects *say* that they cannot see the test stimuli, even though their forced-choice performance is good and indicates that at some level the stimuli are perceived. Thus, in trying to explain the dissociation syndromes, we should first consider the alternative that the patients really are aware of the critical stimuli, but that there is a defect in their subjective verbal reports. How might the introspective verbal reporting process be defective in these patients?

One possibility is that in blindsight, for example, there is a dissociation between consciousness (that is, the conscious brain structures or circuits) and the verbal reporting mechanisms of the brain. Such an explanation is appropriate for split-brain patients, whose mute right hemisphere cannot verbally report what it consciously sees; only the left hemisphere can verbally describe its visual experiences. However, there are reasons to doubt that this explanation applies to blindsight, amnesia, and so forth (Schacter et al. 1988). First, the patients can verbally report aspects of conscious experience that are not affected by brain damage. For example, blindsight patients can verbally report visual perceptions from their sighted field. And amnesics can verbally describe memories of experiences that occurred prior to the onset of amnesia. Second, claims of lack of explicit, conscious knowledge of stimuli do not depend entirely on introspective verbal reports. The lack of explicit knowledge has also been shown with tests involving forced-choice procedures, for example, prosopagnosics failing to select the correct names for familiar faces in multiple-choice tests. Third, the patients' subjective experiences in the dissociation syndromes are quite different from those in certain syndromes that specifically involve disruption of language processes. For example, *anomia* is a type of aphasia in which patients cannot name familiar objects. Yet, anomic patients can consciously recall and use knowledge about such objects: what they do, where they are found, how to use them. There is a big difference between consciously knowing something while being unable to verbally describe it (as in anomic patients), versus not consciously knowing something and saying that you do not know it (as in the dissociation syndromes). Thus, the idea that subjects with blindsight and other dissociation syndromes cannot make introspective reports of their conscious experience can be rejected.

A second possible explanation of dissociation effects in terms of subjective report failures is that dissociation patients have a *conservative response bias*. For example, Campion et al. (1983) suggested that blindsight patients might actually have *degraded* subjective visual experiences of stimuli in their blind fields (rather than *absence* of subjective visual experiences), but they are reluctant to say that they see something when they really do not see it very well. However, this explanation fails to capture the essence of blindsight patients' actual subjective experiences. The subjective reports of blindsight patients clearly distinguish between stimuli presented in their blind area, where they say that they cannot consciously see the stimuli at all, versus stimuli presented in amblyopic areas, where they say that they see the stimuli but that the stimuli are very fuzzy. Yet, forced-choice tests with line gratings show that visual acuity may be as sharp, or sharper, in parts of the blind area as in the amblyopic area (Weiskrantz 1986).

The evidence indicates that dissociation syndromes cannot be explained simply as a disconnection between consciousness and verbal reporting mechanisms. Rather, there is a disconnection between consciousness and mechanisms that perform the tasks that reveal implicit knowledge. It is important to note that the dissociation syndromes are *domain specific*, that is, the failure of awareness is limited to specific types of information (Schacter et al. 1988). For example, blindsight patients are not amnesic; prosopagnosics cannot consciously recognize faces but they can still read and identify other objects. An important implication of domain specificity is that different types of cognitive tasks may be carried out by different specialized *cognitive modules* of the brain. The dissociation syndromes apparently involve disconnection of specific modules from consciousness.

DICE: A model to explain dissociation syndromes. Daniel Schacter (1989) developed a theoretical model to explain dissociation syndromes. The model is nicknamed DICE, for Dissociable Interactions and Conscious Experience. The model, shown in Figure 6.2, includes several subsystems (boxes) and arrows to indicate the direction of information flow or control

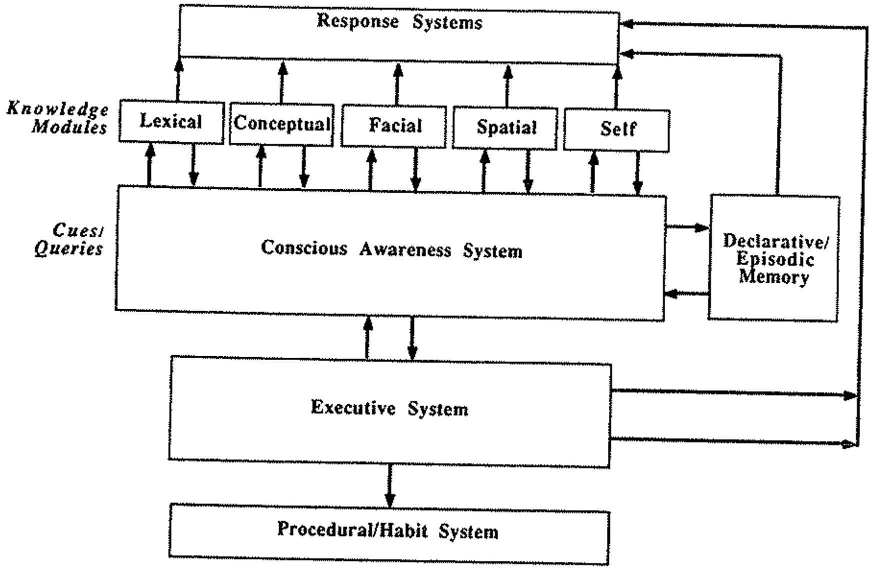

FIGURE 6.2. A schematic depiction of Schacter's DICE model. Conscious awareness of specific types of information depends on intact connections between the Conscious Awareness System (CAS) and individual knowledge modules or declarative/episodic memory. [From Schacter, D. L. (1989). On the relation between memory and consciousness: Dissociable interactions and conscious experience. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of Memory and Consciousness* (pp. 355–389). Hillsdale, NJ: Lawrence Erlbaum. By permission of the publisher.]

between subsystems. The subsystems include: (1) The *Conscious Awareness System* (CAS), which enables subjective awareness of many types of information coming from various knowledge modules. (2) *Knowledge modules*, each one specialized for different types of tasks. Knowledge modules store thoroughly learned information (semantic memory knowledge) relevant to their type of processing, control responses (such as verbal, manual) to carry out their tasks, and produce outputs to the conscious awareness system about the information contents being processed. (3) The *executive system*, which makes decisions and initiates voluntary actions; it is especially important for flexible responding in novel situations. Note that the conscious awareness system does not control actions, though it provides information to the executive system to use in making its decisions about voluntary actions, and to the specialized modules to use for controlling their responses. The executive system produces outputs to CAS, so CAS knows about the executive decisions. (4) The *procedural/habit system*, which is used by the executive system to carry out learned, automatic cognitive and motor skills. The procedural/habit system produces no inputs to CAS; thus its activities occur nonconsciously. (5) The *declarative/episodic memory system*, which stores knowledge of recent events, indexed according to their context in time and space. It provides CAS with recently learned information, as well as knowledge of the context in which that information was learned or in which the person had a particular personal experience.

According to the DICE model, all conscious experiences of perceiving, remembering, and knowing depend on the Conscious Awareness System (CAS). The specific nature of a conscious experience depends on an interaction between CAS and a specific knowledge module or declarative/episodic memory. In dissociation syndromes there is a disconnection between CAS and a specific knowledge module or declarative/episodic memory. Implicit knowledge can still be used because of the connections between the specialized modules and the response systems, but the individual has no awareness of the knowledge being processed. For example, blindsight subjects are not consciously aware of the location of a spot because the spatial-perception module is disconnected from CAS, but the spatial module can still control pointing responses. Also, amnesics can show repetition priming effects because the declarative/episodic memory system can control responses, such as filling in the blanks on word-completion tests—though as a result of the declarative/episodic system being disconnected from CAS, the subject is unaware that the words were previously presented in the experimental context.[2]

Schacter (1989) pointed out that one risk of a theory that attempts to identify conscious experience with a particular mechanism (such as CAS) is that that mechanism will come to be endowed with homunculus-like properties, and used to explain all sorts of activities that are associated with consciousness. To avoid the homunculus fallacy, it is important to try to specify what the consciousness mechanism does and does not do. Schacter explicitly separated CAS from the executive control system, so CAS is not a decision-maker or response-implementer. Rather, CAS is a monitoring system that can integrate and relate information from several specialized knowledge modules. CAS constructs a "global database" (Baars 1983) that can share information between modules and which provides inputs to the executive system to use in making its decisions. The idea that consciousness—phenomenal awareness—is the function of a monitoring system, not of an executive system, has also been advocated by other researchers (Weiskrantz 1988a).

What is the neuroanatomical basis for CAS and the executive system? Schacter cited Dimond (1976), who described evidence for a "consciousness circuit" in the posterior cerebrum, critically involving the inferior (lower) parietal lobes and the cingulate area in posterior corpus callosum. The inferior parietal lobes receive inputs of highly processed information from various perceptual modules, and thus are a plausible candidate for a global database. The cingulate area is part of the bridge that links the left and right parietal lobes. Lesions of the cingulate area have been associated with confusional states, "which are characterized by disordered thought, severe disorientation, and a breakdown of selective attention—in short, a global disorder of conscious awareness" (Schacter 1989, p. 371). Unilateral damage to the parietal lobes can also produce attentional disorders. On the other hand, executive functions appear to be localized mainly in the frontal lobes, especially the prefrontal area. Damage to the frontal lobes can disrupt the ability to make appropriate new voluntary responses, though the ability to make habitual responses to stimuli is maintained. Habitual responses may persist even when they become inappropriate.

The DICE model is not intended as a general theory of mind and consciousness. It was designed specifically to explain dissociations between performance and consciousness. Schacter (1989) acknowledged that the DICE model is speculative, and that it will undoubtedly have to be modified or abandoned when researchers learn more about the relations between brain, behavior, and consciousness. We do not yet know how many specialized modules there are, or exactly what their functions are. Alternative interpretations of some dissociation effects have been offered that do not assume a central conscious system (CAS), but which assume that each module has its own conscious mechanism that can become disconnected from other parts of the module (Schacter 1990b). However, at this stage of understanding, DICE is useful as a heuristic model, to help us organize our knowledge about dissociation effects, and to suggest new lines of research.

NONCONSCIOUS PROCESSING IN NORMAL SUBJECTS

Several different types of evidence support the claim that nonconscious processing occurs in normal people (that is, non-brain-damaged people). Some of this evidence has been controversial, though there is no doubt about the overall conclusion to which it leads: that peoples' behavior and task performance can be influenced by stimuli and memories of which they are not consciously aware. It is beyond the scope of this book to go into detail on most of these types of evidence, but I will briefly describe them here.

Nonconscious processing in psychopathology. Pierre Janet (1889) described dissociations between consciousness and perception or memory in hysterical patients, for example, hysterical blindness, functional amnesia, and multiple personality (discussed in Chapter 1). Freud described the influence of repressed motives and memories on neurotic symptoms, and generalized his ideas to the "psychopathology of everyday life"—for example, in slips of the tongue and forgetting of unpleasant appointments. (For more on nonconscious processing in psychopathology, see Nemiah [1984] and Perry and Laurence [1984].)

Hypnotic dissociations. Hilgard (1977) argued that hypnotic analgesia (pain reduction) and posthypnotic amnesia are cases of dissociation between consciousness and perceptual or memory systems. I will discuss his theory and research on the "hidden observer" effect in Chapter 15.

Subliminal perception. In general terms, subliminal perception refers to nonconscious recognition of stimuli that cannot be consciously recognized. Operationally, subliminal perception may be defined as a change in behavior or performance caused by the identity or meaning of a stimulus, where the stimulus is presented in such a way that the subjects cannot consciously detect or recognize it. In most tests, subliminal stimuli are too brief or too weak to be consciously recognized.

Public interest in subliminal perception was first stimulated in 1957 by a book by Vance Packard called *The Hidden Persuaders*. The author claimed that advertisers could use subliminal messages—messages below the detection threshold—to induce people to buy specific products. For example, it was claimed that the subliminal message "DRINK COKE," flashed very briefly on a movie screen, could induce people to go out and buy Coca Cola, even though they had not consciously perceived the message. The general public reacted to Packard's book with alarm, while psychologists reacted with skepticism. The main reason for skepticism was their implicit "doctrine of concordance" (described at the beginning of this chapter). Another reason was the lack of convincing research evidence.

There have been numerous attempts to demonstrate subliminal perception in controlled experiments, some successful, some not (see reviews in Dixon 1971, 1981). Critics have argued that many of the apparently successful experiments have methodological flaws and/or that the results can be interpreted in terms of other processes besides subliminal perception (Eriksen 1960; Holender 1986). Nonetheless, the best experiments show that subliminal perception can occur under some conditions.

Nowadays many experimental psychologists accept the idea of subliminal perception. The main reason for the shift in attitude is that subliminal perception is consistent with some modern cognitive psychological theories of perception, pattern recognition, and attention (such as "preattentive processing," discussed in Neisser 1967; Kihlstrom 1987). If anything, theoretical acceptance may be ahead of the research evidence, though there is some good research evidence. It is important to note, however, that neither the theories nor the research support the notion that subliminal stimuli can be used effectively in advertising to induce people to go out and buy products that they do not need (Bowers 1984; Kihlstrom 1987). The effects are more subtle.

The best evidence for subliminal perception comes from research with masked visual stimuli. In the *pattern masking procedure*, a stimulus word is briefly flashed on a screen, followed after a short delay by a masking stimulus (a jumbled mixture of broken letters). The interval between the onset of the stimulus word and the onset of the pattern mask is called the *stimulus onset asynchrony* (SOA). If the SOA is too long the stimulus word can always be consciously detected, but if the SOA is short enough the stimulus cannot be consciously detected; the key is to find an SOA that is short enough to prevent conscious recognition, but long enough to allow nonconscious recognition. In most subliminal perception studies the SOA has been set at the *objective detection threshold*. The objective detection threshold is measured by a forced-choice procedure: stimulus trials are mixed randomly with blank trials (no word presented), and subjects are required to respond "yes" or "no" on each trial to indicate whether a stimulus word occurred. The objective detection threshold is the longest SOA at which detection is at a chance level (50 percent correct yes/no detection). Presumably, stimuli at this level cannot be consciously recognized.

Anthony Marcel (1983a, 1983b) demonstrated subliminal perception of masked words in a lexical decision task. In a *lexical decision task*, subjects are presented with a series of letter strings that are either words (such as "doctor") or nonwords ("tordoc"), and they have to push one of two buttons as quickly as possible to indicate whether or not the letter string was a real English-language word. The critical finding concerns the *associative priming effect*, in which the reaction time to a word (such as "nurse") is shorter if it is immediately preceded by a semantically related "priming" word ("doctor-nurse") than if it is preceded by an unrelated prime ("butter-nurse"). Marcel (1983a, Exp. 4) showed equal associative priming effects for words preceded by unmasked primes and those preceded by masked primes. The prime-to-mask SOA was at the detection threshold, so subjects could not consciously recognize the masked primes, though they could consciously recognize the unmasked primes.[3] Thus, performance (RTs to critical words) was affected by masked prime words that were subliminally perceived. Apparently, pattern masking allows the pattern recognition process to proceed up to the point of nonconscious recognition, but blocks it from proceeding to the point of conscious recognition (Marcel 1983b).

Holender (1986) criticized Marcel's experiments and similar ones by other researchers, mostly in regard to the question of whether the objective detection thresholds were accurately measured. But Jim Cheesman and Philip Merikle (1986; Merikle & Cheesman 1986) argued that Holender's point is moot, because the objective detection threshold is not the correct threshold to use for subliminal detection research, anyway.

"Subliminal perception" has always implied perception without awareness, which is not the same thing as perception without discriminative responding. In fact, discriminative responding—as in forced-choice measures of stimulus detection—can sometimes be done successfully even though subjects do not consciously see the stimuli; for example, in blindsight. Cheesman and Merikle (1984, 1986) found discriminative responding without awareness in masking experiments with normal subjects, where at short prime-mask SOAs the subjects could detect the presence of masked words at better-than-chance levels, while at the same time they insisted that they did not really "see" the words and that their responses were just guesses. They argued that the correct SOA for masking experiments on subliminal perception is not the objective detection threshold, but the *subjective threshold*. The subjective threshold is the longest SOA at which subjects say that they cannot consciously detect or recognize the stimuli at a better-than-chance level.

Cheesman and Merikle (1984, Exp. 2) carefully measured both objective and subjective threshold SOAs for prime words. As expected, objective detection threshold SOAs were consistently shorter (mean 30 msec) than subjective threshold SOAs (mean 56 msec). At the subjective threshold SOA, when subjects thought that their detections were just guesses (25 percent correct), their detection performance was actually well above chance (mean 66 percent correct). Subsequently, Cheesman and Merikle found significant priming effects for masked words at subjective threshold SOAs, but not for words at objective threshold SOAs. The authors suggested that previous experiments that claimed to show subliminal perception of masked stimuli at objective detection threshold SOAs probably used SOAs that were really closer to the subjective threshold. This appears to have been the case in Marcel's (1983a, Exp. 4) lexical decision experiment (see Footnote 3). (There were several procedural differences between Cheesman and Merikle's experiment and Marcel's experiment; see the original articles for details.)

One problem with subjective thresholds is that they depend on subjects' subjective judgments about what they saw, and they can be affected by response biases (such as saying "I saw it" when they aren't certain). As an additional, more strict criterion for subliminal perception, Cheesman and

Merikle (1986) recommended that *qualitative* differences between conscious and nonconscious perception should be demonstrated. (Dixon [1971] and Marcel [1983b] made similar suggestions.) For example, a qualitative difference between conscious and nonconscious perception would be shown if an independent variable (such as subjects' expectancies) had different effects for consciously perceived (unmasked) stimuli versus nonconsciously perceived stimuli (masked at subjective threshold SOAs). Such qualitative differences have been demonstrated by Cheesman and Merikle (1986) and Marcel (1980), though the experiments are too complex to describe here.

Nonconscious perception of unattended stimuli. Some stimuli are nonconsciously perceived, though they are not consciously noticed (Bowers 1984). The difference between this category and subliminal perception is that subliminal stimuli *cannot* be consciously perceived, because they are too brief or too weak, whereas unnoticed (unattended) stimuli are potentially capable of being consciously perceived (in that they are strong enough, and long enough in duration), but they are not consciously perceived because attention is directed elsewhere.

Selective attention is often illustrated by the "cocktail party effect," in which, while standing in the middle of a room where several people are talking, you can selectively attend to one of the voices at a time while ignoring the others. You hear the other voices as a background rumble, but you do not consciously recognize what they are saying. In the "lunch line effect" you are engaged in conversation with someone while ignoring other conversations, when suddenly you notice that someone has mentioned your name in a nearby conversation, even though you had not been attending to that conversation and you cannot recall anything that was said before your name was mentioned, and it was mentioned in a normal tone of voice. The lunch line effect is evidence for a nonconscious monitoring process that automatically recognizes all incoming stimuli, and automatically shifts your attention to personally significant stimuli. Besides your own name, significant stimuli might include other personally significant names (such as that of a girlfriend or boyfriend), certain emotionally charged words ("sex," "blood," and so forth), and conditioned emotional stimuli.

Norman's Pertinence Model of attention (1968) provided for nonconscious recognition of all incoming stimuli, with the selective attention process selecting for consciousness only those nonconsciously recognized stimuli that are most pertinent to the task at hand. For example, in listening to a conversation, certain words are most pertinent according to how their meaning fits expectations generated by the context: the topic, the preceding statements, and the current sentence (syntax effects).[4]

Most research on nonconscious perception of unattended stimuli has used the dichotic listening procedure, a laboratory analog of the cocktail party situation (review in Best 1989). Subjects are presented with two simultaneous verbal messages, one in each ear through stereo headphones. They are instructed to focus attention on the designated *target message* (in either the left or right ear). To force them to focus attention closely, subjects are required to *shadow* the target message, that is, to repeat it word for word as it is spoken. A number of dichotic-listening experiments have shown that subjects usually recall nothing of the content of the nontarget message. Even when the same word or digit is spoken several times in succession in the nontarget message, subjects usually do not notice it and cannot later recall it. On rare occasions when they do recall words from the nontarget message, it is because they briefly shifted attention from the target to the nontarget message.

Several dichotic-listening experiments have claimed to show that even though words in the nontarget message cannot later be recalled, they are recognized nonconsciously when they occur. For example, MacKay (1973) showed that words in the nontarget message can affect the interpretation of ambiguous statements in the target message. Other studies (Corteen & Wood 1972; Von Wright, Anderson, & Stenman 1975) showed that critical words in the nontarget message can elicit a physiological response (the GSR, galvanic skin response), when those words have previously been established as conditioned emotional stimuli through a classical conditioning procedure.

Holender (1986) argued that dichotic-listening experiments have not convincingly demonstrated nonconscious perception of unattended stimuli because they have not ruled out the possibility that subjects briefly shifted their attention to the nontarget message, so that the critical words were perceived consciously rather than nonconsciously. However, Michael Venturino (1983) carefully assessed attention-shifting to the nontarget message, in an experiment that measured skin responses to critical words in the nontarget message.

In Venturino's (1983) experiment, in a preliminary classical conditioning procedure, subjects heard a list of random nouns (one every 10 seconds), with CS+ words (three different bird names) being paired with electric shock on several occasions. After this training, the CS+ words reliably elicited a SCR (skin conductance response, similar to GSR), but CS− words (not previously paired with shock) did not elicit SCRs. Next, subjects were tested in a dichotic-listening procedure, in which different random word lists were presented at a rapid pace (one word every 0.8 seconds) in each ear (read by different voices), and subjects had to shadow the words in the target message. From time to time, test words were presented in either the target or nontarget message. Test words included the original CS+ words, semantically related words (other bird names), acoustically related (rhyming) words, and control words unrelated to the CS+ words. SCRs to the test words were measured, but shocks were not presented during dichotic listening testing.

In order to identify occasions in which subjects might have momentarily shifted attention to the nontarget message, Venturino carefully analyzed tape recordings of their shadowing performances for errors. Errors included omissions (the most common type), mispronunciations, hesitations, fusions, and intrusions. On the conservative assumption that all shadowing errors indicated attention shifts, all test-word trials with shadowing errors were eliminated from the main data analysis. (About half of the trials with CS+ words in the nontarget message, and fewer of the other test trials, were eliminated by this restriction.)

Figure 6.3 shows the probability of a SCR response (greater than a cri-

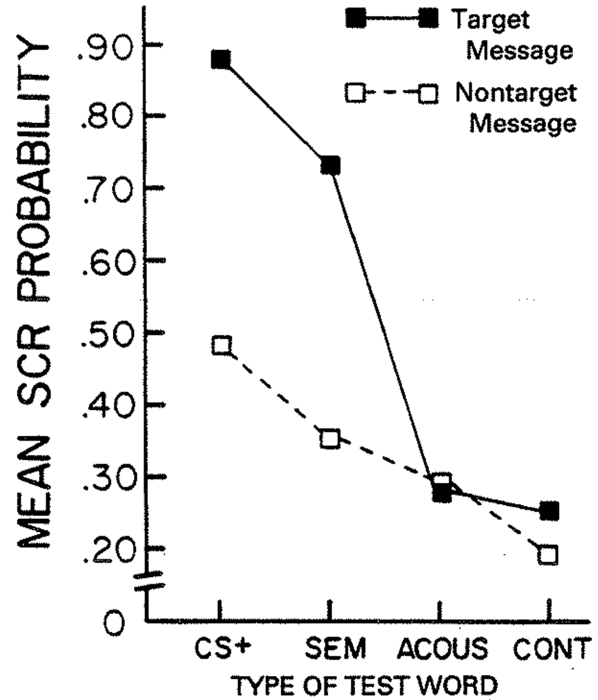

FIGURE 6.3. Mean skin-conductance-response (SCR) probability for four types of test words presented during dichotic listening: CS+ words (paired with electric shock in preceding classical conditioning procedure); SEM (semantically similar to CS+ words); ACOUS (acoustically similar to CS+ words); and CONT (control words, unrelated to CS+ words). The words were presented at unpredictable times in either the target (shadowed) message (filled squares) or the nontarget (nonshadowed) message (open squares). [From Venturino, M. (1983). *Perceptual Monitoring and Allocation of Attention*. Doctoral dissertation, University of Maine, Orono. By permission of the author.]

terion amplitude) for the four types of test words, for words presented in either the target message or the nontarget message. These data come only from trials in which there were no errors in shadowing the target message. Several aspects of the results are noteworthy: (1) When CS+ words occurred in the nontarget message, conditioned SCRs were elicited on almost half of the trials. SCR probability was reliably greater for CS+ words than for control (CONT) words in the nontarget message. (2) SCR probability was reliably greater for words semantically similar (SEM) to the CS+ words than to control words, in both the target and nontarget messages (semantic generalization effect). But SCR probability for words acoustically similar (ACOUS) to CS+ words was not reliably greater than for control words, for either the target or nontarget messages. These results show that words in the nontarget message were nonconsciously perceived. Further, the finding of semantic generalization but not acoustic generalization shows that SCRs to CS+ words occurred due to their meaning, not merely due to their sound. (3) SCR probability was greater for CS+ words in the target message than in the nontarget message. Thus, words that are consciously perceived elicit conditioned responses more reliably than words that are nonconsciously perceived.

An additional interesting finding of Venturino's experiment was that shadowing errors were more likely to occur during (or immediately after) CS+ words in the nontarget message (50 percent) than during unrelated non-test words in that message (14 percent). This result indicates that shadowing errors during CS+ words were rarely a result of spontaneous switching of attention from the target to the nontarget message. Rather, in most cases in which shadowing errors occurred during CS+ words in the nontarget message, they resulted from the CS+ word *drawing* attention to the nontarget message. As a consequence, shadowing of words in the target message was disrupted.

The fact that CS+ words in the nontarget message caused shadowing errors is further evidence that unattended words are nonconsciously perceived. If the CS+ words in the nontarget message had not been nonconsciously perceived, then they would not have drawn attention away from the target message. Finally, it is noteworthy that while all of the subjects sometimes had shadowing errors during CS+ words in the nontarget message, only 45 percent of them recalled after the experiment that they had sometimes noticed a CS+ word in the nontarget message. Apparently, briefly attending to a word that is irrelevant to the task-at-hand (shadowing) is not sufficient to guarantee that it will subsequently be recalled.

Venturino's (1983) experiment provides evidence for a nonconscious monitoring process that nonconsciously recognizes unattended stimuli. Most nonconsciously recognized stimuli are ignored and produce no further effects, since they are unimportant. But in some cases, when the stimuli are significant the monitoring process will automatically shift attention to them, so that previously unattended stimuli are consciously noticed. In other cases, though attention shifting does not occur, significant nonconsciously recognized stimuli produce measurable physiological responses. They may produce other subtle effects, too, such as effects on our interpretations of consciously perceived events (MacKay 1973) and our emotional responses to them.

Stimuli noticed but not appreciated. In some cases, events are consciously noticed when they occur, and they influence our moods or behavior but we do not consciously appreciate the fact that they affected us (Bowers 1984). Events may influence our moods or behavior without us being introspectively aware *that* they influenced us, and/or without us being aware *how* they influenced us. For example, while watching a TV advertisement you surely notice the sexy bodies of the models, but subsequently when you buy the advertised product you may not be aware that your decision was influenced by your association of the product with sex symbols. In such cases, consciously noticed stimuli subsequently affect our behavior through nonconscious processes, so we do not know why we do what we do. The idea that people do not have introspective access to the causes of their own behavior has been controversial, as it challenges the idea of people having full, conscious, volitional control of their behavior. I will discuss this issue in the next chapter.

SUMMARY

Tulving argued that, until recently, cognitive psychologists largely ignored the question of the relationship between consciousness and cognitive processes of perception and memory, due to an implicit *doctrine of concordance*. The doctrine assumes that consciousness accompanies and is necessary for perception, memory, and the control of behavior. This chapter presented evidence for nonconscious perception and memory processes that is contrary to the doctrine of concordance.

Neuropsychologists have studied several types of dissociations between consciousness and performance in brain-damaged people. Schacter discussed such cases as dissociations between *explicit knowledge*, in which people are consciously aware of the knowledge that they use to perform a task, and *implicit knowledge*, which can be used to perform a task without the person being consciously aware that they possess the knowledge. For example, damage to the striate cortex of the occipital lobe produces scotomas, blind areas in the visual field. Weiskrantz showed that some people with cortical blindness have *blindsight*, a condition in which they are able to respond accurately to certain visual stimuli presented in their blind areas—for example, pointing to the position of a spot of light—even though they insist that they cannot *see* the stimuli. Patients with *amnesia*, caused by damage to the temporal lobes, have little or no ability to learn new vocabulary words or impersonal facts (semantic memory) or to recall recent personal experiences (episodic memory). However, they can learn new sensory-motor skills (procedural memory), even though they do not recall practicing the skill. Also, implicit knowledge is shown by *repetition priming effects*, in which amnesics show improved performance on certain verbal tasks (such as completion of word fragments) if they have previously been exposed to the words in the experimental context, even though they do not consciously recall that they were previously exposed to the words. Other neuropsychological dissociation syndromes include blind-touch, prosopagnosia, some types of dyslexia (alexia without agraphia), Wernicke's aphasia, and hemineglect.

Schacter proposed the DICE model to account for neuropsychological dissociation syndromes. In the DICE model, the performance of cognitive tasks involves various specialized brain modules that normally connect with a conscious awareness system (CAS). When the modules are disconnected from CAS they can continue to perform simple or overlearned tasks nonconsciously. CAS is a monitoring system that provides a global data base for the specialized modules and for the executive system, which makes decisions and controls voluntary actions.

Several types of evidence for nonconscious processing in normal (non-brain-damaged) subjects was described, including: (1) nonconscious processing in psychopathology (e.g. dissociation states such as hysterical blindness, multiple personality); (2) hypnotic dissociations, as in hypnotic analgesia; (3) subliminal perception, in which stimuli are nonconsciously recognized even though they cannot be consciously perceived because they are too brief or too weak; (4) nonconscious perception of unattended stimuli that could potentially be consciously perceived (long enough, strong enough), but are not noticed because attention is directed elsewhere; and (5) stimuli noticed but not appreciated, where events may influence our moods or behavior without us being introspectively aware *that* they influenced us, and/or without us being aware *how* they influenced us. All of these types of evidence, from brain damaged and normal patients, support the claim that behavior is influenced by nonconscious information processing.

ENDNOTES

[1]Tulving's (1989) remarks may be compared with a comment made by Marcel in replying to a critical, largely negative review of subliminal perception research: "A peculiar state of affairs seems to exist in cognitive psychology. Most current accounts of perception, cognition, and task execution have no place for consciousness. Phenomenal experience and subjectivity are apparently unnecessary for models of cognition, and there is certainly no evidence of them in the behaviour of artificial intelligence programs and automata, from which information processing [theory] is derived. Yet information-processing theorists react with skepticism when models and data are offered that explore the idea that phenomenal experience is dissociable from or not a prerequisite for the processing of sensory data" (Marcel 1986, p. 40, in commentary on Holender 1986).

[2]Schacter's (1989) DICE model was published before he and Tulving proposed the perceptual representation system (PRS), a "hyperspecific" memory system that stores the exact appearance of objects (Schacter 1990a; Tulving & Schacter 1990). Thus, Schacter (1989) did not say how PRS fits into the DICE model. However, Tulving and Schacter said, "We view PRS as a complex system that comprises several subsystems, including word form, structural description, and other subsystems" (Footnote 10, p. 305). Thus, in a revised DICE model, PRS might be a set of special modules interconnected with each other and with the declarative/episodic memory system.

[3]Strictly speaking, the prime-to-mask SOAs used by Marcel (1983a, Exp. 4) were very slightly longer than the 50 percent chance detection threshold. He used SOAs (measured individually for each subject) that produced between 50 and 60 percent correct detections of word stimuli. This was done so the critical SOAs could be measured reasonably quickly, while avoiding accidentally making the SOAs so short that subliminal perception could not occur. Even with the 50 to 60 percent detection criterion, Marcel's subjects reported that their detection responses were mostly guesses, and they were not sure that they had actually seen the primes (Cheesman & Merikle 1986). The SOAs ranged from about 30 to 80 msec for different subjects.

[4]The *orienting response* (OR) to novel or unexpected stimuli is a special case in which unrecognized stimuli may attract attention. When a novel or unexpected (markedly out of context) stimulus occurs—such as an odd noise—you are likely to shift attention to it long enough to determine whether it is significant. Besides a shift of conscious attention, the orienting response has physiological correlates, such as the GSR, brief changes in heart rate, and blocking of alpha brain waves (Rohrbaugh 1984). The orienting response is further evidence for the claim that all incoming stimuli are nonconsciously processed, though in this case it is nonrecognition or surprise that elicits attention shifting. Norman's (1968) pertinence model of attention would have to be modified to account for the orienting reaction.