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16

Nonconscious Forms of Human Memory

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The relationship between memory and consciousness is one of the most fascinating aspects of cognitive research. However, it is only recently that students of psychology have truly appreciated the intimate connection between these two aspects of mental life.

Systematic research on memory began with Ebbinghaus's (1885/1964) pioneering work on memory for nonsense syllables and has since progressed through a number of phases including studies of the learning and memory capabilities of nonhuman animals (e.g., Hull, 1943; Tolman, 1932), operant-behaviorist conceptualizations of memory in terms of stimulus control (Skinner, 1969), and neo-behaviorist studies of word-list learning and the mechanisms of forgetting (Underwood, 1957). These ideas set the stage for modern cognitive conceptions of memory whereby prior experiences are viewed as mental representations, encoded, stored, and retrieved in a human information-processing system.

In contrast to research on memory, research on consciousness and awareness, although never completely absent (e.g., Adams, 1957), has been relatively sparse since the early speculations and introspective studies of psychologists such as Wundt, Titchener, and James. Although it is probably safe to say that psychologists have never doubted the existence (or at least the problem) of consciousness, much of twentieth-century psychology assumed that consciousness did not play a large role in the production of thought and behavior. And even if this view was not universally held (by psychoanalysts, for example), few methods existed for empirically approaching the problem.

This all changed in the early 1980s, however, when memory and consciousness came together in such a way as to fundamentally alter the landscape of cognitive research. In essence, it was discovered that a person's thought and behavior could be influenced by prior events of which that person was not aware; and that the nature of such nonconscious mnemonic influences—the principles by which they operated—differed significantly from the more conscious forms of memory that researchers had traditionally investigated. These findings were so important that today any serious account of memory must acknowledge the dramatic difference that obtains between "memory with awareness" and "memory without awareness." So, too, observed differences in these two kinds of *memory* have been influential in making *consciousness* and *awareness* respectable topics of inquiry in psychology and neuroscience (Barrs, 1988; Cohen & Schooler, 1997; Picton & Stuss, 1994).

The purpose of this chapter is to provide an overview of nonconscious forms of human memory. The first section ("Phenomena and Phenomenology") provides more background

information and examples, essentially firming up the case that the qualitative distinction between conscious and nonconscious memory is a necessary one. This first section also introduces some of the terminology and research designs used in the field. The second section ("Paradigms") describes research methods in more detail and also provides an overview of major empirical findings. The final section ("The Future of Nonconscious Memory") briefly notes critical issues for future research and describes how ideas about nonconscious mnemonic processes are beginning to be integrated with other aspects of cognition, as well as with the study of the brain.

The reader may note the above organization does not include sections entitled "Findings" or "Theories." The reason for this is that there are simply too many relevant empirical results and theoretical positions to be included within this short chapter. More extensive reviews of the empirical literature can be found in Kelley and Lindsay (1996); Roediger and McDermott (1993); Moscovitch, Vriezen, and Goshen-Gottstein (1993); and Richardson-Klavehn and Bjork (1988). Readers interested in large-scale theoretical accounts of nonconscious processes in memory are directed to the following sources: Jacoby, Yonelinas, & Jennings, 1997; Moscovitch, 1994; Ratcliff & McKoon, 1996; Roediger, Weldon, & Challis, 1989; Schacter & Tulving, 1994a; Toth & Hunt, 1999.

Phenomena and Phenomenology

How might one establish that consciousness is a necessary concept in understanding memory? Perhaps the single most important source of evidence for answering this question comes from research with amnesic patients. Damage to the medial temporal lobes, usually involving the hippocampus and related structures, produces a profound inability to consciously recollect one's past. Patients with such damage can participate in common events, such as reading a list of words or conversing with their doctor, yet be totally unable to later recall or recognize those prior events. Indeed, for the majority of this century it was widely believed that such patients simply could not create (encode or store) a long-term record of their experience. But starting with studies by Warrington and Weiskrantz (1968; see also Rozin, 1976) this view was shown to be incorrect. If amnesic patients are given a task that is related to their prior experiences, but which makes no reference to those experiences—such as simply rereading the list of words or completing fragmented forms of those words (*me _ o _ y*)—these patients show incontrovertible evidence that their prior experiences were indeed recorded and subsequently used to influence their performance.

Amnesia, then, provides a crucial piece of evidence that memory can occur without awareness: the amnesic patient fails to experience the phenomenology of remembering—she believes she is *not* remembering—but her performance shows that memory is indeed being used.

The flip side of this memory-awareness relation is also available. Patients with damage to frontal lobes, often including the basal forebrain, demonstrate a phenomenon known as confabulation in which they relate events of their past, and steadfastly assert their reality, when in fact those events *never happened* (see Kopelman, 1987; Moscovitch, 1989). The confabulating patient thus exhibits the converse of the amnesic patient's unaware form of memory: he experiences the phenomenology of remembering—believes he *is* remembering—but historical records, such as those provided by relatives, show that no memory exists.

Amnesic and confabulating patients thus indicate a complex relation between, and *dissociation* of, the retention and expression of prior experience on the one hand, and a phenomenal awareness of that experience on the other. Such patients are fascinating because they suggest that to understand memory one must also understand the phenomenal awareness of remembering. But two more issues must be addressed before the relation between memory and awareness can be viewed as fundamental. First, it must be shown that similar phenomena (i.e., memory/awareness dissociations) can occur in persons without brain damage. And second, that memory with awareness and memory without awareness operate according to different rules or principles. As described next, there is strong evidence supporting both of these points.

Imagine that a normal (non-brain-damaged) individual is presented with a list of words, half visually, half aurally. Moreover, within each presentation modality, the person makes a superficial judgment for half of the words, such as counting the number of vowels, and a

more meaning-based judgment for the other half, such as deciding whether the word refers to a pleasant or unpleasant concept. If one were to assess this person's memory with an "explicit" (conscious) test of memory such as recognition or recall, it is highly likely that the individual would show superior memory for the meaningfully processed words, but that the modality of original presentation would have little impact on performance (figure 16.1).

Consider now a different test in which the subject is shown word stems (e.g., *tru__*), some of which can be completed with previously encountered words, but is simply asked to complete each stem with the first word that comes to mind. When tested in this "implicit" way (figure 16.2), performance looks dramatically different from that found with explicit tests. In particular, the meaningfulness with which words were encoded has no influence on performance, but the modality of initial presentation has a large effect. Note that performance in such implicit tests is assessed relative to a baseline condition for which no study items were presented; the increase in performance for studied over nonstudied (baseline) items is called "priming."

Dissociations such as that shown in figures 16.1 and 16.2 have now been firmly established for a large number of experimental manipulations (see Roediger & McDermott, 1993) and thus make a strong case that conscious and nonconscious forms of memory operate according to different principles.

How do we know that the person tested implicitly is not consciously aware that his or her primed responses came from the prior encoding event (or that such awareness is not a necessary condition for the pattern of performance obtained)? This is a difficult issue that sets the stage for much of the recent research in the field (see below). But despite this difficulty, the bulk of evidence shows that neither awareness of a prior event nor an intent to remember that event is a necessary condition for prior experience to exert a significant influence on performance. Much of the research cited in the following sections shows this to be the case. Here, however, two phenomena can demonstrate the basic argument.

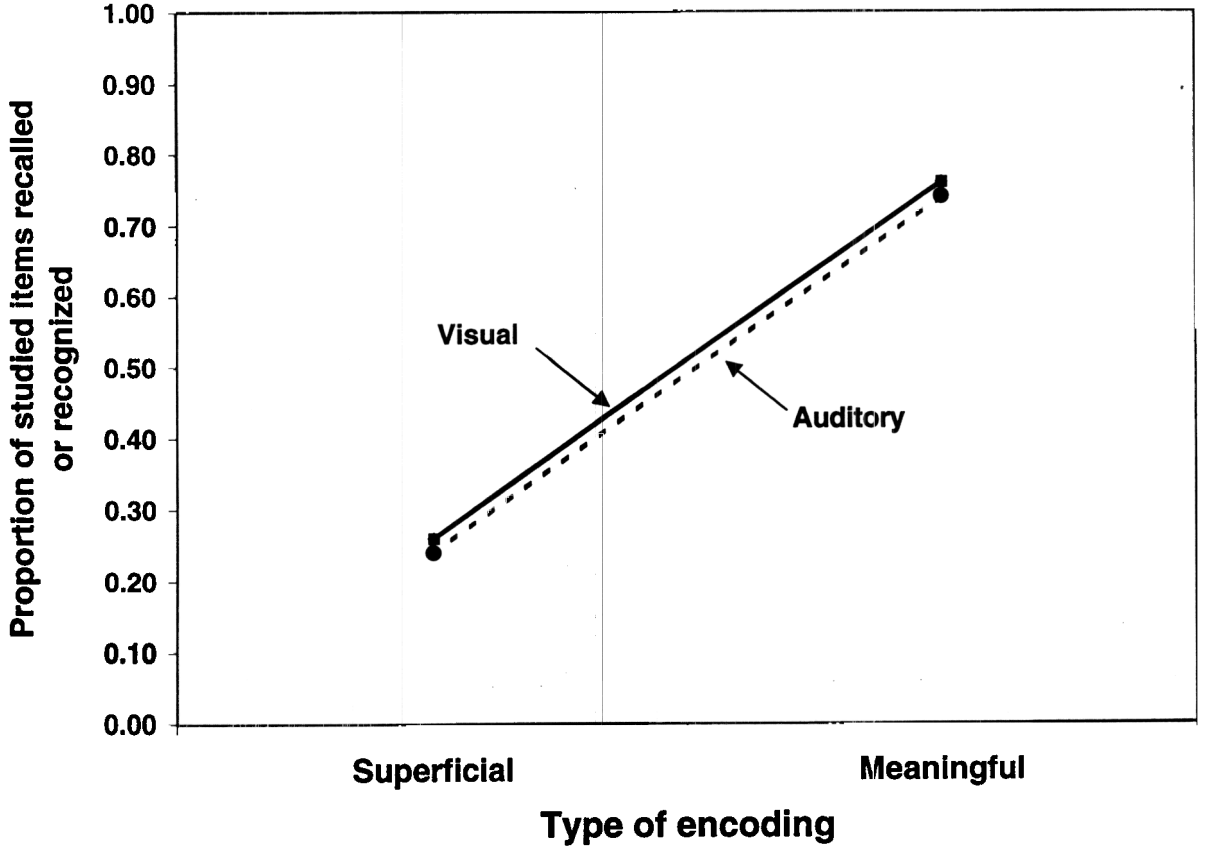

Figure 16.1 Idealized effects of semantic elaboration and study modality on an explicit test of memory.

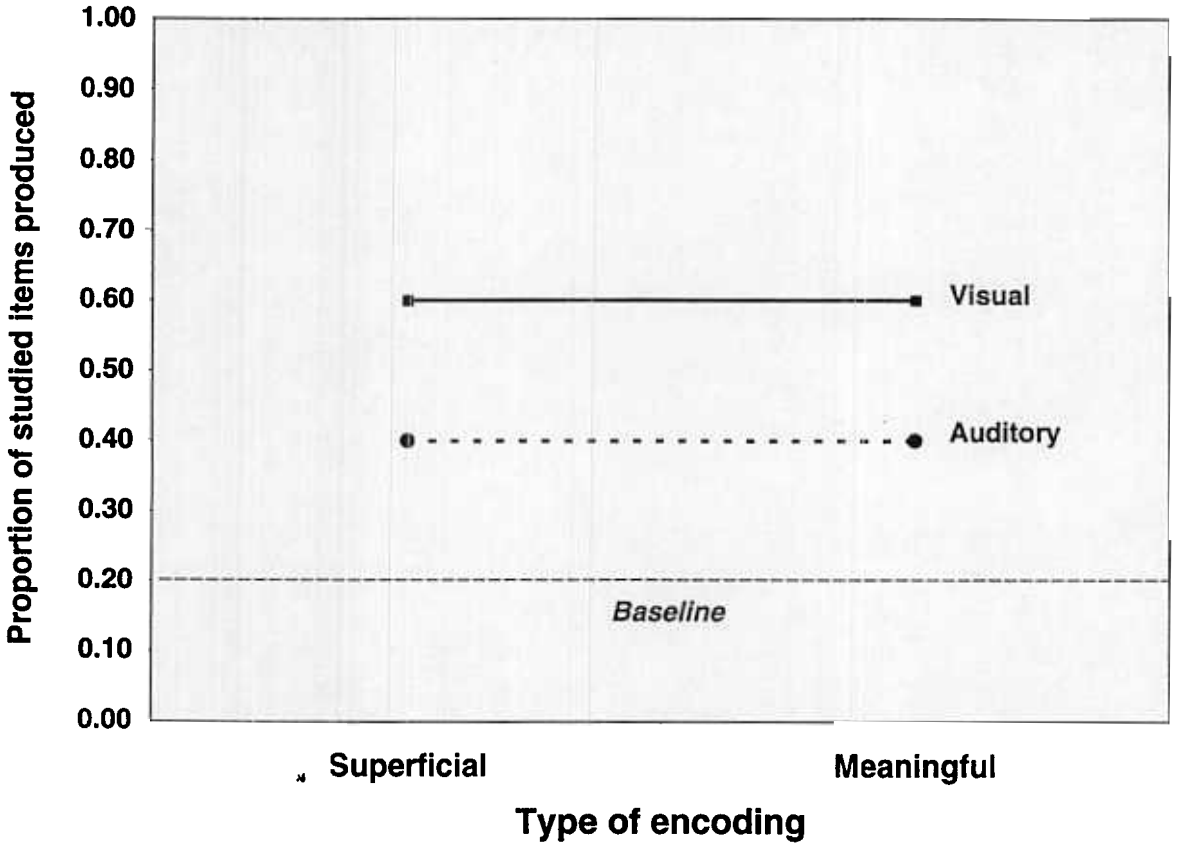

Figure 16.2 Idealized effects of semantic elaboration and study modality on a visual perceptual") implicit test of memory.

First, consider what is known as *stochastic independence* between memory tests. In studies examining stochastic independence, a subject is, for example, shown a list of words and then given two consecutive memory tests. One of these tests (e.g., word-fragment completion) is implicit such that, although some of the fragments can be completed with previously presented words, the subject is simply asked to complete each fragment without reference to any prior experience (with "the first word that comes to mind"). In the other test, the subject is asked to consciously recognize words from the original list, some of which are the same as those tested on the fragment test. By examining the relation between the two tests, one can ask whether performance is correlated—that is, whether recognizing a particular word predicts one's ability to complete a fragment with that word, or vice versa. In fact, results show that there is often *no* relation between performance on the two tests (i.e., the tests show stochastic independence); recognizing a word tells us nothing about whether the subject will use that word to complete a fragment; and completing a fragment with a studied word tells us nothing about whether the subject will recognize that word as being on the study list (Jacoby & Witherspoon, 1982; Tulving, Schacter, & Stark, 1982).

Stochastic independence thus shows that conscious memory of a particular event is not a necessary condition for that event to influence performance. An even more dramatic illustration of this point comes from studies manipulating the amount of attention available for encoding an event. If subjects are asked to read a list of words while at the same time performing a difficult secondary task (such as monitoring a series of digits for a particular sequence), subsequent conscious memory (e.g., recall) will be much impaired relative to the case when the subject devotes full attention to study. In contrast, implicit tests of memory such as stem and fragment completion show little or no effect of such attentional manipulations (see figure 16.3). Such dissociations as a function of attention have been produced with a variety of tests and measurement techniques (Parkin, Reed, & Russo, 1990; Ja-

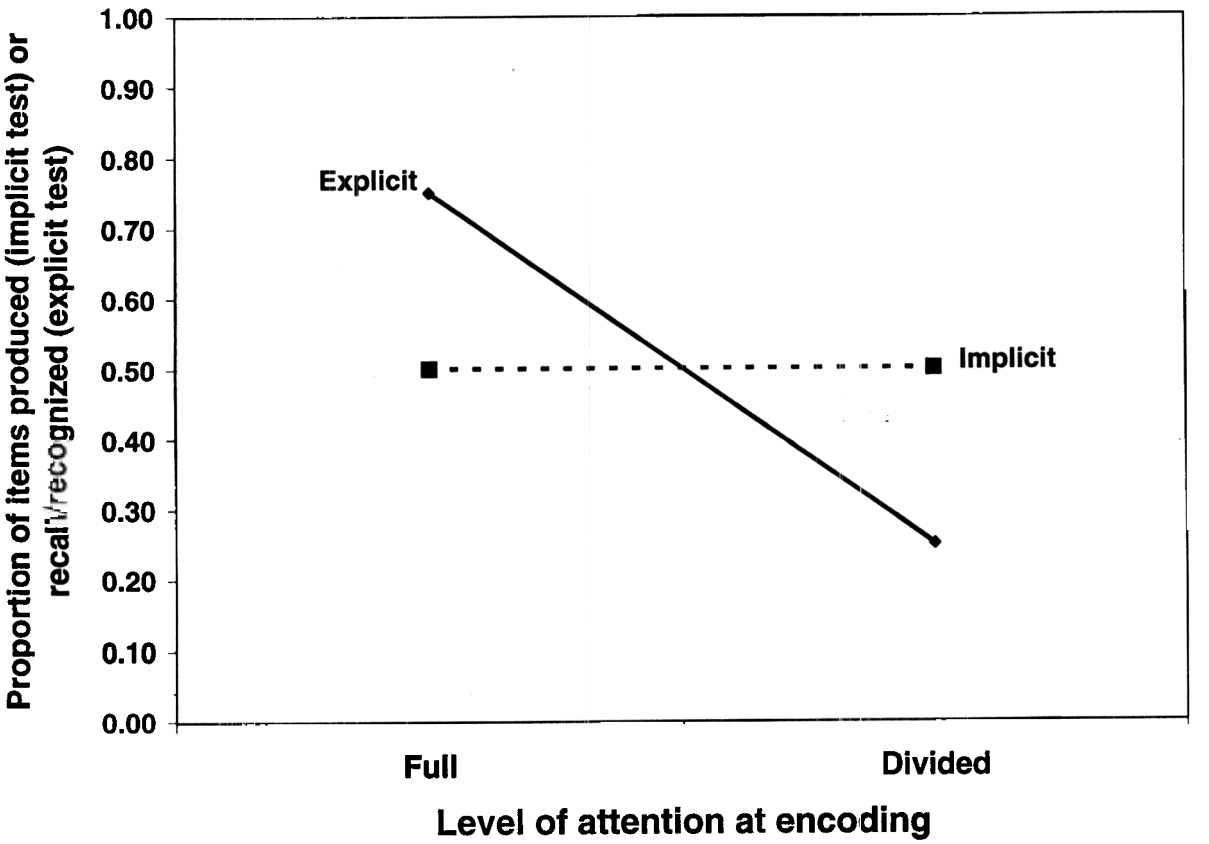

Figure 16.3 Idealized effects of full and divided attention on implicit and explicit tests of memory.

coby, Toth, & Yonelinas, 1993) and further strengthen the case that memory can occur in the absence of conscious awareness.

Stochastic independence and the effects of divided attention make a strong case that conscious and nonconscious forms of memory are distinct, qualitatively different ways in which the past can influence the present. A skeptic might further insist, however, that in both cases, the subject is aware of the earlier event and, more important, of the fact that the test bears some relation to that event. Even these worries can be addressed, however, as is shown in the following sections.

Paradigms

Mere-Exposure

How might one guarantee that subjects cannot become aware of, or attempt intentional retrieval of, a prior event? One method is to present stimuli below the threshold for awareness. The notion here is that, if subjects are unaware that an item has been encoded, they cannot subsequently become aware of the relation between a later memory test and that prior encoding experience. This is exactly the strategy employed in the mere-exposure paradigm in which subjects are exposed to stimuli, such as randomly generated geometric shapes, for a "mere" 1 millisecond (one one-thousandth of a second!). As you might expect, stimuli "shown" at this duration are very difficult to see; and, in fact, subjects in such experimental conditions claim to have not seen anything (except a blank screen) and later are unable to recognize any of the briefly flashed shapes. Yet when later shown pairs of shapes and asked to choose the shape they "like best," previously flashed shapes are chosen significantly more often than shapes that were not presented earlier (Kunst-Wilson & Zajonc, 1980; Seamon et al., 1995).

Results from mere-exposure studies thus show that subjects need not even be aware

that a prior event occurred for that event to influence their subsequent performance. However, mere-exposure studies are limited because, if subjects are unaware that an encoding event has occurred, they cannot act on it or process it in different ways. And getting subjects to process events in various ways is crucial to determining the different operating characteristics of conscious and nonconscious forms of memory. Thus, paradigms discussed in the following sections use the more typical procedure of showing items at easily perceivable levels, having subjects process those items in different ways, and then employing various test conditions designed to elicit nonconscious forms of memory.

Implicit Tests

The most popular way of eliciting nonconscious memory is with implicit tests such as the stem- and fragment-completion tests described above. The defining feature of an implicit memory test is simply the instructions: subjects are told to respond to test stimuli (e.g., produce a word, classify an object, solve a puzzle) without reference to past experience. Although there has been a good deal of debate as to whether such instructions are a sufficient basis on which to infer nonconscious memory (see Jacoby, 1991; Reingold & Merikle, 1990; Toth, Reingold, & Jacoby, 1994), there is no question that such tests show striking dissociations (i.e., different patterns of performance) in comparison with more traditional (conscious/explicit) tests of memory.

Table 16.1 provides a relatively comprehensive list of the many implicit tests currently in use, although new tests are invented every year. Note that the organization of this table—based on a distinction among perceptual, conceptual, and procedural processes—is not theoretically neutral. Nevertheless, it allows an extensive classification scheme that captures most, if not all, of the tests available: perceptual tests, such as word identification and fragment completion, are those that challenge the various perceptual systems in some way—for example, with a fast presentation or a degraded/fragmented stimulus. Conceptual tests, in contrast, employ retrieval cues such as category labels or general-knowledge questions designed to elicit responses that are meaningfully related to these cues. Finally, procedural implicit tests require subjects to perform extended sensory, motor, or cognitive tasks, such as learning a new perceptual-motor skill.

Most of what is known about nonconscious forms of memory is based on implicit tests. As noted earlier, this chapter will not attempt to describe all of the relevant findings. However, the major conclusions of this research can be summarized briefly: On perceptual implicit tests, nonconscious mnemonic processes appear insensitive to conceptual manipulations (i.e., they appear "presemantic") and yet show high sensitivity to changes in surface form from study to test (see figure 16.2). In contrast, conceptual tests reveal the opposite set of characteristics, being *insensitive* to changes in surface form, but showing sensitivity to conceptual-encoding manipulations such as level of processing (but see Vaidya et al., 1997).

The perceptual/conceptual theme running through the above conclusions, as well as table 16.1, has become central in theorizing about nonconscious mnemonic processes. Indeed, this distinction is the cornerstone of both "process" theories of memory (Roediger, 1990; see also Jacoby, 1983; Kolers & Roediger, 1984) as well as more "structural" multiple-memory systems approaches (see Tulving & Schacter, 1990; Schacter & Tulving, 1994a). It is important to note, however, that the perception/conception distinction, while undoubtedly important, is clearly insufficient to capture the most crucial aspect of implicit/explicit memory dissociations—namely, that in one case, the subject is aware of remembering a past event, while in the other case such awareness is absent (or at least unnecessary). This has led some researchers to deemphasize the perception/conception distinction in favor of distinctions more closely related to the phenomenological status of conscious and nonconscious memory. For example, Jacoby (1991), noting relations between nonconscious memory effects and similar phenomena in the field of attention, has advocated a distinction between mnemonic control and automaticity (see also Logan, 1990). Jacoby's view is also supplemented by a sophisticated analysis of how subjects *infer* the role of memory—thus, effectively constructing their subjective experience of remembering—on the basis of their performance and relevant task demands (see Jacoby, Kelley, & Dywan, 1989). This attributional approach is discussed more fully below.

Further questioning the usefulness of a perception/conception distinction, Masson and McLeod (1992) have conceptualized implicit/explicit dissociations in terms of the differ-

Table 16.1 Implicit tests of memory (with representative references).

Verbal tests	
Perceptual	
Word ("perceptual") identification	Jacoby & Dallas (1981)
Word stem completion	Graf et al. (1982)
Word fragment completion	Tulving et al. (1982)
Lexical decision	Duchek & Neely (1989)
Word naming	Hashtroudi et al. (1988)
Anagram solution	Srivinas & Roediger (1990)
Homophone spelling	Jacoby & Witherspoon (1982)
Temporal (duration) judgments	Witherspoon & Allan (1985)
Conceptual	
Word association	Shimamura & Squire (1984)
Category-instance (exemplar) generation	Blaxton (1989)
Fact (general knowledge) generation	Kelley & Lindsay (1993)
Category verification	Vaidya et al. (1997)
Categorization/classification judgments	Vaidya et al. (1997)
Fame judgments	Jacoby et al. (1989b)
Truth/credibility judgments	Begg et al. (1992)
Procedural	
Word-based problem solving	Adams et al. (1988)
Probability judgments	Knowlton & Squire (1994)
Reading normal text	Levy & Kirsner (1989)
Reading altered (e.g., mirror inverted text)	Kolers (1976)
Artificial grammar learning	Reber (1989)
Non-verbal tests	
Perceptual	
Identification of fragmented pictures	Weldon & Roediger (1987)
Picture naming	Mitchell & Brown (1988)
Object/non-object decision	Kroll & Potter (1984)
Possible/impossible object decision	Schacter et al. (1990)
Noise judgments	Jacoby et al. (1988)
Action-decision test for dynamic events	Nilsson et al. (1992)
Aesthetic/preference judgments	Kunst-Wilson & Zajonc (1980)
Sensory conditioning	Benzing & Squire (1989)
Affective conditioning	Bechara et al. (1995)
Conceptual	
Person/trait attributions	Smith & Branscomb (1988)
Object categorization	no published studies
Common-uses decisions for objects	no published studies
Procedural	
Serial reaction time	Nissen & Bullemer (1987)
Control of complex systems	Berry & Broadbent (1984)
Motor tracking	Corkin (1968)
Mirror drawing	Milner (1962)
Jigsaw puzzles	Brooks & Baddeley (1976)
Tower of Hanoi	Cohen et al. (1985)
Maze learning	Milner (1965)
Motor conditioning	Weiskrantz & Warrington (1979)

ence between an initial "interpretive encoding" that involves an integration of perceptual and conceptual components, and a second, more elaborative processing phase that is predominantly conceptual. And Toth and Reingold (1996; see also Toth & Hunt, 1999) have stressed the importance of context-goal configurations in understanding both conscious and nonconscious forms of memory. It is likely that all of these ideas will figure in more mature theories of memory.

A potential problem with comparisons among implicit and explicit tests concerns the different cues they provide for access to memory. Although implicit/explicit dissociations are often taken to support a qualitative difference in memory, and thus to reveal the operating characteristics of nonconscious mnemonic processes, it is widely known that even different conscious tests of memory can show dissociations as a function of the retrieval cues they provide. As one classic example, recall and recognition dissociate as a function of frequency in the language: high-frequency words are more likely to be recalled whereas low-frequency words are more likely to be recognized. In extending such observations to implicit memory, the worry is that implicit/explicit dissociations occurring between tests that provide different retrieval cues (e.g., fragment completion and recognition) may not reflect differences in awareness or intent but rather differences in the retrieval properties of the test cues (Dunn & Kirsner, 1989).

An important development in this regard is a method known as the retrieval intentionality criterion (Schacter, Bowers, & Booker, 1989), which recommends providing *identical* cues at test (e.g., word stems) and varying only the instructions given to the subject (implicit or explicit). If one finds qualitative differences in performance as a function of instructions, one can then make a much stronger case that awareness (or intent) was the crucial factor, rather than the nature of the retrieval cues. Although the logic underlying this strategy is not unassailable (see Toth et al., 1994; Reingold & Toth, 1996) there is no question that it represents an important methodological advance in the study of implicit memory.

Before leaving implicit tests, it is worth noting another line of research—*implicit learning*—that, while proceeding somewhat independently, effectively employs the same strategy as that underlying implicit memory tests (see Reber, 1989; Seger, 1994). In studies of implicit learning, subjects are exposed to a series of stimuli that embody a complex underlying rule structure that is not readily apparent. For example, subjects may see stimuli (e.g., VTTRM) that appear to be a random collection of letters but which are actually generated by a complex rule system or grammar. In later transfer (implicit) tests, subjects are able to discriminate "legal" from "nonlegal" letter strings (i.e., those conforming vs. not conforming to the underlying grammar) despite being unable to describe the basis for their decision. Similarly, when reacting to a series of events that appear random (e.g., a sequential pattern of lights) but which actually conform to complex transition rules, reaction times become faster despite the subjects' inability to describe the underlying rule (e.g., Nissen & Bullemer, 1987). In general, implicit learning appears to be most similar to procedural implicit memory tests and it is likely that both phenomena draw on similar neurocognitive mechanisms (see Curran, 1998).

As noted above, one problem with studies employing implicit tests is the possibility that subjects are aware of, and potentially trying to retrieve, prior events. In the context of implicit/explicit test comparisons, the retrieval intentionality criterion is one way to address this problem. The next three sections describe alternative approaches to solving the vexing issue of awareness and intent in the study of nonconscious memory.

Self-Report

One strategy for isolating nonconscious processes in memory is simply to ask subjects whether they were aware of, or tried to retrieve, prior events during performance of an implicit test. Although this strategy is not widely utilized, the available research suggests two major conclusions: First, subjects *are* often aware that items presented or produced on an implicit test were previously encountered in an earlier task (e.g., Richardson-Klavehn, Lee, Joubran, & Bjork, 1994). Second, and as might be expected, subjects who are aware of the relation between an encoding event and a subsequent test are more likely to attempt intentional retrieval of items from that encoding event (Bowers & Schacter, 1990; Toth et al., 1994).

Given these potential problems, some researchers (e.g., Roediger & McDermott, 1993) have recommended disguising implicit tests through the use of long study and test lists, test lists with a high ratio of new to old items,

filler tasks presented before the implicit test, and instructions that encourage fast responses to each test cue. Such techniques may indeed help disguise the nature of an implicit test, but they do so at the expense of being able to investigate variables that may turn out to be critical for understanding nonconscious mnemonic processes (e.g., long vs. short lists, high vs. low new/old ratios, fast vs. slow responses).

Self-reports themselves are not without problems. For one, subjects cannot be asked to report on their level of awareness (or intent) for each test item, at least in experiments that attempt to disguise the relation between study and a later implicit test. This means that self-reports of awareness must be assessed retrospectively (after the test is completed), a procedure that depends on the accuracy of memory for prior states of awareness and intent. Perhaps even more problematic is the questionable validity of self-reports because test demands and subsequent questions about test awareness may interact in complex ways. Implicit test instructions effectively tell subjects not to intentionally retrieve prior study items. If subjects are later asked whether they used intentional memory, answering yes is tantamount to saying that they ignored prior instructions. Subjects may be reluctant to do this, thus falsely confirming an experimenter's expectations.

Despite these problems, the available studies using self-reports suggest that test awareness does not fundamentally alter the basic expression of nonconscious (or unintentional) memory (Bowers & Schacter, 1990; Richardson-Klavehn et al., 1994). Additional research using self-report methods, as well as variations on these methods—such as the remember/know technique developed by Tulving (1985)—may provide important insights into the nature of nonconscious forms of memory, as well as how the influences of these forms of memory are "interpreted" by more conscious processes (see chapter 15; and Jacoby, 1998).

Opposition and the Process-Dissociation Procedure

One of the most important advances in the study of nonconscious influences of memory is the opposition procedure developed by Jacoby and colleagues (e.g., Jacoby, Woloshyn, & Kelley, 1989). For example, subjects might study a list of words and then later be given a test of word-stem completion. However, instead of asking subjects to complete stems with studied words, or to respond with the first words that come to mind, subjects are told to complete the stems only with words that were *not* studied. If, in contrast to instructions (and thus conscious intent), subjects complete stems with previously studied words, one has gained strong evidence for the operation of nonconscious memory because conscious memory would have resulted in the word being *excluded* as a test response.

Using the opposition procedure as a starting point, Jacoby (1991) developed a more elaborate *process-dissociation procedure* designed to quantify the strength of conscious and nonconscious forms of memory. The procedure involves combining results from the opposition (or *exclusion*) condition, with those from an *inclusion* condition in which subjects are told to *use* old words to complete test stems. By casting these two conditions into equations that embody the logical relation between conscious and nonconscious memory, one should be able to combine performance in the two conditions so as to analytically estimate the separate contributions of the two kinds of memory. And, indeed, mnemonic estimates gained from this procedure have produced a number of interesting dissociations. For example, divided attention (Jacoby, Toth et al., 1993), speed of response (Toth, 1996a; Yonelinas & Jacoby, 1995), elaborateness of study processing (Toth et al., 1994), aging (Jennings & Jacoby, 1993, 1997), and traumatic brain injury (Ste-Marie, Jennings & Finlayson, 1996; Toth, 1996b) all have been shown to affect estimates of conscious memory, but to leave estimates of nonconscious memory unchanged. Variations on the procedure have shown the opposite pattern—effects on nonconscious, but not conscious, memory (Hay & Jacoby, 1996). Importantly, many of these results agree with those from implicit/explicit test comparisons (e.g., Toth et al., 1994; Reingold & Goshen-Gottstein, 1996).

Subjects in opposition and process-dissociation experiments are aware that their memory is being tested. If this is the case, how can one speak of nonconscious processes in memory? Indeed, research based on the process-dissociation procedure breaks with tradition in this regard by assuming that nonconscious memory rarely occurs in isolation, but rather works in combination with conscious forms of memory to produce a variety of mnemonic phenomena. That is, it assumes that most acts of memory reflect a blend or co-action of con-

scious and nonconscious processes and thus attempts to separate the two kinds of memory within a single test. This contrasts with the implicit/explicit test approach, which attempts to create tests that selectively measure either conscious or nonconscious forms of memory. Correspondence between the two approaches, including the absolute magnitude of estimated mnemonic influences, provides some evidence that they are assessing the same underlying constructs. Yet the two approaches are obviously different, a difference that has led to numerous debates in the literature (e.g., Graf & Komatsu, 1994; Jacoby, 1998; Reingold & Toth, 1996; Toth, Reingold, & Jacoby, 1995). Irrespective of these debates, most researchers agree that nonconscious processes play a powerful role in conscious memory judgements. Thus, we next consider research that explores the complex interplay between conscious and nonconscious memory.

Fluency, Memory Attributions, and Subjective Experience

On the basis of their experiments with the implicit word-identification test, Jacoby and Dallas (1981) suggested that initial experience with a stimulus may result in more fluent (faster or more efficient) processing of that stimulus when it is encountered at a later time. They also suggested that such fluent reprocessing may be the basis for implicit memory effects (see also Masson, 1989) and that, under some conditions, subjects might use differences in fluency as the basis for conscious memory decisions. These claims have turned out to be very fruitful, and have led to a number of experiments that reveal the complex nature of nonconscious memory processes.

Research has shown that fluent processing as a function of prior experience can change how stimuli are processed in the present, and this change can have interesting, nonconscious influences on a person's subjective experience. For example, fluent reprocessing as a function of prior presentation can increase the apparent fame of nonfamous names (Jacoby, Woloshyn et al., 1989), can lengthen the apparent exposure duration of a briefly flashed word (Witherspoon & Allan, 1985), can lower the apparent loudness of background noise (Jacoby, Allan, Collins, & Larwill, 1988), and can increase the apparent truth of false statements (Begg, Anas, & Farinacci, 1992). These effects are conceptually similar to those found with the mere exposure paradigm (Seamon et al., 1995) and are relevant, not only to understanding nonconscious memory and the nature of subjective experience but also to real-world decisions and actions because people often act on the basis of their subjective experience (see Jacoby, Kelley et al., 1989; Jacoby, Bjork, & Kelley, 1994).

In addition to influencing a person's interpretation of events in the present, fluent processing has been shown to influence interpretation of the past (i.e., conscious memory judgments). That is, by manipulating how fluently a stimulus is processed on an explicit memory test, one can increase subjects' beliefs that they are remembering, *irrespective of whether the test stimulus was actually presented earlier.* For example, Whittlesea (1993; see also Jacoby & Whitehouse, 1989) manipulated the visual clarity or semantic context in which recognition-test items were presented and found that more fluently processed items (i.e., those presented more clearly or in more congruent semantic contexts) were more likely to be judged "old." Lindsay & Kelley (1996) produced similar "illusions of memory" by manipulating the ease with which subjects completed word fragments. In addition to extending the range of nonconscious memory effects, these results may have significant implications for the interpretation of self-reports of awareness and the intention to remember. For example, fluent reprocessing may help account for the phenomenon of confabulation described earlier: even though a particular mental event may not have occurred in the past, if that event is processed fluently in the present, people may incorrectly infer that it must have occurred earlier in their life.

Taken together, the results cited in this section provide stronger evidence for a dissociation between memory and the phenomenal experience of remembering. Moreover, they reveal the operation of nonconscious processes, not only in the use of memory but also in the attribution processes that subjects use to make judgments about the past and present (Whittlesea, 1993).

The Future of Nonconscious Memory: Problems and Prospects

The reader may have noticed a change in tone that has occurred throughout this review. In particular, despite a "good start" in showing the existence of nonconscious processes in

memory (based mainly on amnesic patients and implicit/explicit dissociations in neurologically intact subjects), more recent research has been characterized by increasing complexity and debate about the nature of such influences and the most appropriate way to measure them. This is to be expected, perhaps, given the relatively short time in which researchers have investigated the relationship between memory and consciousness. In this final section, a set of issues are noted that may help researchers develop more precise forms of measurement and more comprehensive conceptualizations of nonconscious mnemonic processes.

The Relation between Awareness and Intent

Schacter (1987) defined implicit memory as a facilitation of task performance "that does not require conscious or intentional recollection" (p. 507). However, recent work suggests that consciousness and intentionality can be dissociated and may even reflect different neural mechanisms (Schacter, Alpert, Savage, Rauch, & Albert, 1997). Richardson-Klavehn et al. (1994) argued that many of the mnemonic phenomena labeled as "unconscious" or "unaware" are better conceptualized as unintentional or involuntary. That is, subjects can be aware that the items they encounter or produce on a memory test were in fact encountered earlier, yet their performance can still reveal the types of dissociations normally attributed to implicit memory. However, although it seems clear that awareness and intentionality are distinct concepts, it is less clear that they are completely separate from one another, as some have suggested (e.g., Richardson-Klavehn, Gardiner, & Java., 1996). The problem is that awareness is a prerequisite for intentional control (see Jacoby, Toth, Lindsay, & Debner, 1992; Toth, Lindsay, & Jacoby, 1992) and, indeed, may sometimes even *encourage* such control. Important goals for future research are therefore to determine whether awareness per se can change the expression of memory, and the degree to which awareness and intent are dissociable.

The Role of Context and Goals

Early research and theory on nonconscious influences of memory suggested that such influences were "context free" in comparison to more explicit, episodic forms of memory that were thought to be closely tied to a specific past context (e.g., Mandler, Graf, & Kraft, 1986). Recent research, however, suggests that nonconscious memory is much more context bound than previously thought, and that such contextual specificity may even be a defining characteristic of nonconscious memory. As one striking example, Hayman and Tulving (1989) presented subjects with a list of words and then gave them two consecutive fragment completion tests. They found that when fragments on the two tests had little or no overlap (e.g., *a* __ *a* __ *in* and _ *ss* _ *ss* __) subjects showed stochastic independence between the two tests—that is, completion of one fragment did not predict a subject's ability to solve the other fragment, despite the fact that *the target word was the same.* Another example of context specificity is provided by Oliphant (1983), who showed that words presented as part of the instructions for an implicit test may produce *no* priming on that test (see also Levy & Kirsner, 1989; MacLeod, 1989).

Related to the issue of context is a subject's goals in performing some act for which nonconscious influences of memory may be operating. This is important because mental events make up a large part of the context for processing; and goals, in turn, are arguably a central aspect of mental life (Bargh, 1997; Toth & Reingold, 1996). Research on memory attributions, described above, suggest that goals may play a major role in how nonconscious memory effects are consciously interpreted. On the basis of this, and other research, Jacoby, Ste-Marie, and Toth (1993) argued that nonconscious memory processes may be relative to the goals set by conscious intentions. Research by Goschke and Kuhl (1996; see also Marsh, Hicks, & Bink, 1998) seems to confirm this: subjects who expected to perform a future action showed greater implicit memory for words describing that action, as compared to words describing similar actions that the subject did not expect to perform.

Similar to conclusions from the previous section, then, results reviewed here recommend more research into the relation between nonconscious memory and a subject's goals and intentions. As discussed next, such research would be useful, not only in helping us better understand the nature of nonconscious memory but also in bridging the gap between memory phenomena occurring in the laboratory and those occurring in the "real world."

Nonconscious Memory in Real-World Thought and Behavior

The majority of research discussed so far has been based on the processing of rather simple stimuli, such as isolated words, presented in the context of rather simple tasks, such as identifying briefly flashed stimuli. If, however, nonconscious memory processes are truly a critical aspect of everyday cognition, research must link laboratory demonstrations with phenomena observed outside of the lab. Fortunately, this enterprise has begun and the initial results, mainly reported in the social-cognition literature, are exciting (see Bargh, 1997; Greenwald & Banaji, 1995). Already, strong links have been drawn between nonconscious processes in memory and socially relevant phenomena such as impression formation, stereotyping, and prejudice (see Banaji & Greenwald, 1994; Devine, 1989). Moreover, techniques for the measurement of nonconscious forms of memory are being developed for personality assessment in the applied (e.g., job-related) sector (e.g., Dovidio & Fazio, 1992).

The role of nonconscious memory processes in clinical assessment is also maturing. Most memory-impaired populations (e.g., amnesics, the elderly) lose only conscious memory; nonconscious forms of memory appear to remain relatively intact throughout the life span. However, because people only have conscious access to the forms of memory that decline, their subjective experience may often be of a complete loss of memory. This may lead memory-impaired individuals to give up on adequately performing memory-related tasks, despite the fact that a proper arrangement of contextual cues could be used to maintain adequate levels of performance. This possibility speaks again to the complex interplay between conscious and nonconscious memory and deserves further scrutiny in the future.

Nonconscious Memory and the Brain

A final area of interest concerns the neural substrates of nonconscious memory. As was noted in the introduction, much of the modern interest in nonconscious memory was based on research with amnesic patients, and exploration of the memory capabilities of these patients continues. For example, in an extended case study of one patient (KC), Tulving, Hayman, & MacDonald (1991) uncovered a *triple dissociation* between conscious memory and two forms of nonconscious memory. That is, KC showed no conscious memory for learning episodes in which he was taught to make correct responses in a semantic knowledge task, and his semantic responses were found to be stochastically independent of his performance in an implicit fragment-completion test. Perhaps even more impressive, both forms of nonconscious memory were found to be largely intact 12 months after initial learning. Thus, detailed studies of amnesic patients continue to provide important insights into the functional (cognitive) organization of memory, a strategy that is likely to continue in the future.

Insights into the neuroanatomical organization of nonconscious forms of memory have also advanced in recent years, based largely on our ability to use modern neuroimaging techniques such as PET and fMRI to measure the neural activity of normal patients while they perform memory tasks (Buckner, chapter 39). These studies support lesion-based research in showing that the neural systems underlying nonconscious memory are anatomically distinct from the medial-temporal structures underlying conscious memory. In particular, perceptual and conceptual priming is thought to occur in the very same neocortical structures that mediate initial perception and meaning-based thought, while more procedural forms of nonconscious memory appear to rely on subcortical structures such as the basal ganglia (Gabrieli, 1998). An obviously important goal for future neurocognitive research will be to better understand the details of these brain systems, including their neuroanatomy and chemistry, as well as their points of interaction.

Summary and Conclusions

Although research on nonconscious forms of human memory can be traced back at least a hundred years (see Schacter, 1987; Schacter & Tulving, 1994b; Toth & Reingold, 1996), modern research on the subject began with the discovery that amnesic patients, previously thought unable to store their experience, could show memory for the past when tested implicitly. Subsequent research showed similar nonconscious memory phenomena in normal subjects. Since these initial demonstrations, research on nonconscious mnemonic processes has been directed toward the de-

velopment of more precise methodologies for revealing and measuring these processes. These methodologies include the mere-exposure paradigm, implicit tests, and self-reports of awareness, intent, and the phenomenology of remembering. More recent methods include those that put conscious and nonconscious forms of memory in opposition, and those that attempt to quantitatively estimate their separate strengths (e.g., the process-dissociation procedure). A central theme in many of these approaches is the distinction between perception and conception (meaning-based processes), although contextual and goal-related processes are also starting to be recognized as fundamental.

Nonconscious memory plays a critical role in everyday thought and behavior both directly (e.g., by bringing a particular thought to mind) and indirectly (by influencing a person's subjective experience). These influences extend beyond the "cold cognition" studied in the lab, and into the "hot" areas of emotional and social information processing. So, too, neuroscientists are beginning to uncover the neural substrates of nonconscious memory. This will no doubt be an exciting time to remember.

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