

Memory: Performance, Knowledge, and Experience

Endel Tulving

Department of Psychology, University of Toronto, Canada

The relation between three aspects of memory—behaviour, knowledge, and conscious experience—is discussed. Memory research of the past has tended to concentrate on memory performance, and to neglect memory as conscious experience. This neglect may reflect the acceptance of a tacit assumption that behaviour, knowledge, and experience are closely correlated, an assumption designated here as the doctrine of concordance. Some recent research, explicitly concerned with conscious experience in remembering, has thrown doubt on concordance as a general rule. Four examples of this research are briefly reviewed: repetition priming, source amnesia, remembering *vs* knowing, and neural correlates of episodic and semantic memory as revealed by regional cerebral blood flow. This research suggests that there is no general correlation between memory performance, retrieved knowledge, and conscious recollective experience, and that these relations in different situations must be discovered rather than just postulated under the aegis of some tacitly accepted doctrine.

INTRODUCTION

William James, a hundred years ago, defined memory in the way in which it had become known in Western thought over millennia: Memory is the present conscious awareness of an event that has happened in the rememberer's own past. Memory thus defined, James said, possesses the kind of subjectively experienced "warmth and intimacy" that mere conception, that is, mere thought about some previously learned fact, does not evoke.

A hundred years have not greatly changed this basic conception of memory. We may now refer to James' memory as episodic memory and to

Requests for reprints should be sent to Endel Tulving, Department of Psychology, University of Toronto, Toronto, Ontario, Canada M5S 1A1.

This article is based on a Keynote Address delivered at the XXIV International Congress of Psychology in Sydney, Australia, on 1st September, 1988. The author gratefully acknowledges the assistance of Janine Law, criticisms of the article by Fergus I. M. Craik and Robert S. Lockhart, and the financial support provided by the John Simon Guggenheim Foundation, the Natural Sciences and Engineering Research Council of Canada (Grant No. A 8637), and a Special Research Program Grant from the Connaught Fund, University of Toronto.

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the kind of awareness it entails as auto-noetic awareness, in order to distinguish them from other kinds of memory and other forms of awareness (Tulving, 1985a; 1985b; 1987). Another qualification we would add today would be that James's definition applies to the retrieval component of memory, the act of recollecting an earlier experience as such, rather than to the whole sequence of stages of cognitive and brain activity that constitutes remembering, stages such as encoding, storage, and retrieval. But this latter qualification is minor, since retrieval is the central defining feature of memory, distinguishing memory from other forms of cognition, such as perception and imagination, in a way that encoding and storage do not.

Recollective experience does not only possess an affective feeling-tone (James' "warmth and intimacy") that differentiates it from other forms of awareness, but also cognitive "contents" that differentiate the recollection of one event from that of another. The "contents" of recollection, or *ecphoric* information (Tulving, 1983), represent a type of knowledge; knowledge of and about personally experienced past events as experienced, interpreted, and understood by the rememberer at the time, and as modified by subsequent events and the conditions of retrieval. The "contents" of other types of retrieved information and knowledge do not come wrapped in the awareness of one's personal past. The knowledge carried by recollective experience, like other kinds, can be used by the rememberer to guide ongoing behaviour, to solve problems, to make plans for the future, and in many other ways. Such knowledge, expressed through behaviour, renders episodic memory biologically relevant (Shallice, 1988).

Thus we can distinguish between three aspects of episodic memory: conscious awareness of the personal past; acquisition and storage of information; and conversion of the information into behaviour. Under the circumstances, it would be natural to think that psychologists study, and have studied, all three basic aspects of memory, as well as the relations between them—recollecion as phenomenal experience, remembering as a means of recovering previously stored knowledge, and the utilisation of such knowledge in or through behavioural performance. But this is not so.

Psychologists who have studied memory have primarily been concerned with memory as expressed in behavioural performance: the amount of recall, the accuracy of recognition, the latency of response. Sometimes they explicitly identify these behaviours with retrieval of stored information, or knowledge, that the subjects have acquired in the experiment or in the outside world. But they have largely ignored memory as recollection or conscious re-experiencing of earlier experiences. Even the bulk of research within the general framework of cognitive psychology has not been greatly different from earlier work on verbal learning in its concentration on memory performance and in its neglect of conscious experience. Until recently, little systematic research was done on rememberers' conscious

awareness involved in memory performance, in retrieval of stored information, or in recollection of past events. Articulation of research problems and the interpretation of the results of learning and memory experiments have seldom contained terms such as “conscious awareness” and “phenomenal experience,” or their equivalents. In this regard, cognitive psychology is rather similar to behaviourist and early functionalist approaches to psychology; all three represent “behaviouralism”, which can be contrasted with mentalism, the study of consciousness (Leahey, 1987).¹

Thus, there exists a most curious paradox in the science of memory: Recollection is a “pure” mental phenomenon, conscious awareness of past experiences is the essence of memory, and yet psychologists and other scientists who have been studying memory for over a hundred years have paid scant attention to recollection as a phenomenon of consciousness.

The purpose of the present essay is to point out the paradox and to discuss it. I will do four things. First, I will briefly review the basic philosophy of cognitive psychology and reaffirm that it has had little to say about conscious experience. Second, I will speculate about the reasons for this neglect of experience, attributing it to a tacitly held assumption that I will refer to as *concordance*. In the third main part of the essay, I will describe four kinds of research that illustrate how the situation is now changing, and how conscious experience in memory is being studied empirically. In the concluding part I will argue that drawing a clear distinction between recollective experience and retrieval of stored information may be necessary before further progress in the understanding of the basic nature of memory can be expected.

The Credo of Cognitive Psychology

Cognitive psychology is supposed to be the “science of mental life” (James, 1890; Miller, 1980). Conscious experience is the hallmark of mental life. How then is it possible for the science of mental life to neglect experience in the study of memory, one of the central functions of the mind?

To approach this question, let us first draw a thumbnail sketch of the basic philosophical underpinnings of cognitive psychology, or its credo. Behaviourists and early functionalists, at least in the standard fable, had always been quite content with describing and explaining the correlations between inputs into and outputs from the proverbial “black box”; they

¹Mentalism has sometimes been defined as the psychological study of mental phenomena and mental processes, and contemporary cognitive psychology has been seen as a prime example of it (e.g. Bunge & Ardila, 1987). The argument in this essay is that cognitive psychology has largely ignored the mental phenomenon of consciousness.

seldom displayed any curiosity about what was in it. The main thrust of the cognitive revolution in psychology, beginning some 30 years ago, was the explicit avowal that psychology's mission is the understanding of the human mind, inner happenings, or *cognitive processes*. Cognitive processes are the happenings in the black box that mediate and make possible the acquisition, storage, transformation, and utilisation of information and knowledge. They are revealed to the observer through subjects' behaviour and performance in cognitive experiments. In the prototypical account, information is presented to a person in the form of sensory stimulation, actively and interactively processed through the system, and eventually transformed into an appropriate output. The "mental life" that cognitive psychologists study is defined by these mental processes. Cognitive psychologists necessarily, of course, had to rely on observations of overt behaviour of the people whose mental life they wished to understand, but they did so only because no other window existed through which external observers could peer into their subjects' minds. Everyone knows, according to the credo, that various behaviours and their measured aspects, the subjects' "performance", serve only as indicators, external meter readings, of the internal cognitive processes that are cognitive psychologists' main, or sole, interest. A "real" cognitive psychologist has little interest in behaviour as such, because some behaviours are not particularly relevant from the point of view of psychology, and other behaviours would be understood once we understand the cognitive processes that mediate them.

Although grotesquely simplified, this account of cognitive psychology would be accepted by most cognitive psychologists as reasonably authentic. In the present context the important point about the account has to do with the absence of any reference to conscious awareness or phenomenal experience in it. The human mind of cognitive psychology consists of cognitive processes; it reveals itself in behaviour. Conscious experience as such does not seem to be part of it.

The cognitive processes studied by cognitive psychologists must not be confused with the conscious experience of rememberers: they are neither identical with, nor do they represent, people's conscious experiences. Cognitive processes are designed to be systematically related to observed performance, and not necessarily to conscious experience. These processes, with which cognitive psychologists fill the black box, are postulated, not discovered. They are little more than intervening variables and hypothetical constructs, based on the observed correlations between inputs into and outputs from the black box, and designed to render such correlations meaningful. They are inferences and abstractions of the experimenter, and neither components nor representations of the conscious experience of the subject.

The absence of any systematic relation between hypothesised cognitive processes and the conscious subject's experiences is easy to overlook,

because the hypothetical processes frequently have labels assigned to them that imply conscious experience. Thus, in models of memory we have constructs such as searching, scanning, generating, matching, and recognising. These terms invite one to think of them as mental activities of which the person is consciously aware, and hence to imagine that a model of memory containing these constructs somehow reflects the conscious experience of the remembering person. Such, of course, is not at all the case. These constructs, like others that carry fewer connotations about phenomenal experience—activating, computing, copying, discriminating, locating, marking, transferring, and the like—are pure abstractions; they could be named by Greek letters without changing by one iota the models in which they occur.

This brief discussion of the credo of cognitive psychology, and its ramifications for the study of memory, should not be construed as a criticism of past research. Ebbinghaus's creative trail-blazing was of momentous import to the study of memory, and much of value has been achieved by his successors. We have learned a great deal about human memory through carefully controlled experiments, and some of it no doubt will turn out to have been indispensable for future progress. Our conceptual accomplishments to date may be more modest, but we are making progress here, too. Moreover, there is no guarantee that we could have done better in this respect with any other empirical approach. Memory is an extraordinarily complex subject, and wagging a finger at our intellectual ancestors is not going to make the complexity vanish. So, I am not criticising what has been.

What I am doing is this. I am describing the factual situation in memory research as I see it, and I see little explicit concern with conscious awareness in remembering. Although a number of writers—Roberta Klatzky (1984), George Mandler (1986), and Geoffrey Underwood (1979) among them—have discussed the problem of conscious awareness in memory, very little systematic empirical work has been explicitly directed at it. Psychologists, scientists of human behaviour and human experience, have by and large studied memory performance, and have neglected the recollective experience.

Why? What has happened? Why this remarkable, one might even say scandalous, neglect of an essential aspect of human memory? We will consider this matter next.

Behaviour and Experience: Doctrine of Concordance

One can think of at least two plausible reasons for the neglect of conscious experience in the study of memory. The first one is that researchers have been aware of the neglect, but not capable of remedying it, because of lack

of suitable methodology, because no one has been able to think of an acceptable way of studying, analysing, and measuring conscious awareness in remembering and its relations with other aspects of memory. The second reason is that researchers, under the influence of the prevalent behaviouralist *Zeitgeist*, have been unaware of the neglect, because they have mistaken their study of cognitive processes for a study of conscious experience. The second reason is probably closer to the truth than the first one.

The lack of awareness of the neglect of experience in the cognitive psychology of memory may have been an inevitable consequence of the acceptance of a nearly universally held, implicit, pretheoretical postulate, or tacit assumption. This assumption has been so pervasive, so much part of the pretheoretical framework within which problems of cognitive psychology have been pursued that it has remained nameless, even though it has sometimes been discussed (e.g. Nisbett & Wilson, 1977): Pervasiveness and the absence of an explicit designation are two criteria of tacit knowledge.

In order to deal explicitly with this tacit, unnamed assumption, it is first necessary to name it. I will refer to it as the *doctrine of concordance of cognition, behaviour, and experience*, or simply *concordance*. 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 required for, and therefore accompanies, the acquisition of knowledge, or its retrieval from the memory store; retrieved knowledge *guides* behaviour, 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.

The doctrine of concordance sets up expectations regarding what we should find, and what we should not find, in the world under our scientific scrutiny; it defines for us the "natural givens", about which we raise no questions, and "phenomena", deviations from these, about which we do (Toulmin, 1961). Its proscriptive role is as important as its prescriptive role. According to concordance as a general principle there should be no behaviour without accompanying knowledge; knowledge could not be acquired or expressed without conscious awareness; no instances should exist where changes in awareness could not be expressed in corresponding behaviour. When someone claims such "impossible" relations, the doctrine of concordance dictates a vehement denial and vigorous counter-attack (e.g. Marcel, 1983; Holender, 1986).

There are generally accepted exceptions to concordance, but they are just that, exceptions. They are not perceived as invalidating it as a general rule. Thus, we know that many unlearned behaviours may be "uncon-

scious", but, following Wilhelm Wundt, we leave such behaviours to physiologists to study. We also know that many learned behaviours may become "unconscious" after extended practice, but we save the doctrine of concordance by assuming that in these cases conscious awareness has not been lost but only temporarily suspended, in a position to be re-evoked, when necessary.² And we know that most of the time we are not consciously aware of the knowledge that is stored and potentially available in memory, but this fact does not violate concordance, since concordance does not deny the necessity of the fulfilment of certain conditions before behaviour is emitted, before knowledge can be utilized, or before a particular conscious act occurs. The actualisation, or retrieval, of such stored "unconscious knowledge", however, according to concordance, necessarily occurs in the rememberer's conscious experience.

The tacit acceptance of the doctrine of concordance has encouraged cognitive psychologists to study memory behaviour, and to construct models of recall and recognition performance, without worrying about conscious experience. After all, if a close, harmonious relation between behaviour, knowledge, and experience does exist, then we need to study and explain only one to gain some understanding of them all.³ For instance, if a rememberer is always consciously aware of what he or she has retrieved from memory in a typical recall or recognition experiment, then observing the rememberer's responses provides evidence not only about memory performance but also about stored and retrieved knowledge, as well as about the recollective experience. For cognitive psychologists steeped in the doctrine of concordance the situation as described sounds perfectly natural; indeed, they would find it difficult to see how or on what grounds such a self-evident truth could be questioned. And yet it not only can be questioned, it must be, on grounds and for reasons to be discussed later in this article.

²Other writers have discussed the problem of the relation between behaviour and cognition (e.g. Nisbett & Wilson, 1977) but they have been primarily concerned with people's awareness of cognitive *processes*. Already the 19th century thinkers knew perfectly well that human beings cannot become aware of mental *processes*, although they can consciously contemplate the products of such processes. Contemporary cognitive psychologists concur in this view (e.g. Mandler, 1975; Miller, 1980; Neisser, 1979). The present analysis, taking these previous ideas for granted, focuses on the relation between behaviour and the *products* of cognitive processes, and between such products and conscious awareness.

³In the philosophy of mind, the general issue under scrutiny in this essay has been intensively debated under the rubric of the mind-body problem. The solutions that have at various times been proposed for the problem—theories such as epiphenomenalism, interactionism, and emergentist materialism (Bunge & Ardila, 1987; Churchland, 1984)—all assume a close covariation among behaviour, cognition, and conscious experience. The notion of concordance is inherent in all of them.

One of the interesting facts about the doctrine of concordance is the virtual absence of systematic *research* designed to test its validity. No article has been published under a title such as, "Evidence concerning the nature of the relation between behaviour and consciousness"; nor has one ever appeared that began with a statement such as, "The purpose of the three experiments reported in this paper was to elucidate the nature of the relation between knowledge and conscious awareness." The concordance of cognition, behaviour, and experience is something that is assumed, presumed, postulated; it is regarded as true simply because it is intuitively obvious that nature or evolution would not have it otherwise. This is why I have referred to it as the *doctrine* of concordance. It must have been based on people's own casual impressions of general correlations between their thought and their action, their action and their inner experience, their knowledge and their conscious awareness. Because it is difficult to become aware of lack of awareness, and hence of lack of correlation between awareness and behaviour, the faith in concordance has remained largely unshaken.

Its origin in casual observation and the absence of experimental tests of its validity do not mean, of course, that the doctrine of concordance is false. It may be a perfectly good general rule. Nevertheless, the realisation that the problem concerning the relation between our science's subject matters—behaviour, cognition, and experience—has been "solved" by assumption rather than through the application of the scientific method may strike many as remarkable. Surely a better *modus operandi* would be to study the relation or relations in the same way that we study other phenomena of interest, that is, relying on empirical methods.

If we explicitly concede that the tacit acceptance of the doctrine of concordance may have been responsible for the neglect of conscious experience in the cognitive psychology of memory, the way will be open for more direct, empirical approaches to the study of conscious experience in memory, and to the study of the relations between such experience and other aspects of memory. Initially, as frequently happens with any new phenomenon, research questions have to do with the presence and absence of particular kinds of conscious awareness in various memory performances.

Research concerned with such questions has recently begun, perhaps a bit timidly, without a clearly articulated theoretical objective, reminiscent of investigations conducted by "scientific sleepwalkers" (Koestler, 1959), but its future seems reasonably secure. These early ventures, whose outcomes have begun to throw doubt on concordance as a general principle, may well lead to an eventual frontal attack on what may turn out to be the fundamental issue of cognitive psychology—the relation between behaviour, cognition, and experience.

We will briefly review four illustrative examples of this research next. The four examples are: (a) repetition priming, a non-conscious form of modification of complex cognitive behaviour; (b) source amnesia, retrieval of recently learned information without awareness of the learning; (c) remembering and knowing as two conscious modes of retrieval of recently learned information; and (d) differences in the regional cerebral blood flow associated with the recollection of past events and the recall of impersonal knowledge.

Priming: Nonconscious Learning

The first example concerns repetition priming, or simply priming, a recently discovered, or rediscovered, form of learning that seems to be at variance with the expectations based on the doctrine of concordance in that it involves the retrieval of particular, complex, symbolic information in the absence of learners' conscious awareness that they are doing so. A prototypical example is the following. The learner sees a word such as ASSASSIN in a study list containing many other words, and is subsequently asked to complete a number of graphemic word fragments with words that fit the fragments. One of the test fragments might be U__V__SE, another might be A__A__IN; the subject's task is to fill in the missing letters to complete each word. Priming refers to the fact that the subject is more likely to complete the ASSASSIN fragment than the UNIVERSE fragment, because he saw one in the list but not the other.

In the last ten years or so, a large amount of research has been done on priming, and the pace is quickening. Research with both normal subjects and with amnesic patients has led to the unassailable conclusion that priming represents a rather different form of learning and memory than does episodic recall or recognition. Many striking functional dissociations between measures of priming and measures of episodic memory have been demonstrated: An independent variable has an effect on one measure, but not on the other. Dissociations reported by researchers such as Jacoby and Dallas (1981), Jacoby and Witherspoon (1982), Graf and Mandler (1984), Graf and Schacter (1985), Roediger, Weldon, and Challis (1989), Gardiner, Dawson and Sutton (1988), Mitchell (1989), Mitchell and Brown (1988), Parkin and Streete (1988), and many others, have convincingly demonstrated that priming represents a different form of learning and memory than forms already known. Thorough reviews of priming have been reported by Shimamura (1986), Schacter (1987a), and Richardson-Klavehn and Bjork (1988).

Although the first systematic work on priming, and the term itself, originated with students of verbal learning (Clifton, 1966; Cofer, 1967; Cramer, 1968; Storms, 1958), the present wave of interest can be traced

TABLE 1
Probabilities of Recognition and Primed Stem
Completion

<i>Subjects</i>	<i>Measure of Retention</i>	
	<i>Recognition</i>	<i>Stem Completion</i>
<i>Amnesic patients</i>	0.28	0.34
<i>Control subjects</i>	0.72	0.25

Data from Experiment 1, Warrington and Weiskrantz, 1974.

back to the research that Elizabeth Warrington and Lawrence Weiskrantz did with amnesic patients in England (Warrington & Weiskrantz, 1968; 1970; 1974; Weiskrantz & Warrington, 1970). They tested their subjects for recently seen words with initial letters of these words as cues, in what is now usually referred to as the stem-completion task. They found that in such tests amnesic patients did as well as control subjects, despite the fact that the amnesics' recognition of the words as recently seen was very much inferior to that of the controls, and despite the fact that the amnesics did not remember the initial episode in which they saw the words. The results of one of Warrington and Weiskrantz's experiments are summarised in Table 1.

The important discovery made by Warrington and Weiskrantz was not the dissociation between the outcomes of the two types of test. Dissociations between measures of memory were already well known in the literature. The important discovery was the fact that the amnesics' enhanced performance in completing word stems had been influenced by an event that they did not remember, in a manner of which they were not consciously aware. The inability to remember the "source" of some particular knowledge is a familiar phenomenon to all normal people: We all know many things without knowing how and where and when we acquired that knowledge. But the same phenomenon in amnesics is especially striking because of the short retention intervals involved. True amnesics forget seeing a set of words or faces after a few minutes filled with some other attention-demanding activity. And yet their performance on priming tests shows that something is retained from the encounter, and that what is retained is frequently indistinguishable from that found in normal controls.

Since amnesics do not remember the learning episode, it is not surprising that they are unaware of their improved performance in stem completion. What is surprising, however, is the fact that normal subjects, who always do remember the study episode, act like amnesics in the same kind of experiment. They show improvement in completing fragments of words

they have recently seen even if they do not remember having seen the words during the study episode that they do remember (Tulving, Schacter, & Stark, 1982). Their phenomenal experience in a performance that is enhanced by virtue of recent learning is identical with their phenomenal experience in the performance that precedes learning. Thus, memory performance changes whereas conscious experience does not.

It is this disparity, or dissociation, between the change in learners' performance and the absence of any corresponding change in their conscious awareness that is intriguing by conventional standards. Why, following the study of a list, does memory performance increase in both the episodic recognition task and the fragment completion task, but the subject is consciously aware of the fact of the increase, and the origin of the increase, on only one of the tasks? Why is conscious awareness not uniformly co-ordinated with memory performance? As long as we think in terms of concordance, the phenomenon is remarkable, straight out of science fiction: Perfectly intelligent people act like Descartes's automations, or like modern computing machines made of silicon: They have learned something without knowing that they have done so.

Similar discrepancies between doing and knowing, behaviour and awareness have, of course, been reported before, throughout psychology's history. In earlier times, such deviations from the tacitly held doctrine of concordance could be attributed to plausible causes (e.g. subliminal stimuli are perceived but very quickly forgotten), or just explained away (e.g. they represented only minor, unimportant, or uninteresting exceptions to the general rule). But priming, an unconscious but apparently quite complex form of learning, is being treated differently. The striking nature of the phenomenon and the large number of people who have personally been able to convince themselves of its reality promise to greatly enhance cognitive psychology's interest in the relation between memory performance and conscious experience.

Source Amnesia

Our second illustration is of research whose results help to distinguish between knowledge of learned facts and recollection of past experiences. These results, too, are not easily reconciled with concordance as a general principle.

The research is known under the rubric of "source amnesia", the retention of particular event-specific knowledge without conscious remembering of the event. The phenomenon was named by Evans and Thorn (1966) who observed it in hypnotised subjects. Recent systematic demonstrations of source amnesia with amnesic patients have been reported by Schacter, Harbluk, and McLachlan (1984) and Shimamura and Squire

(1987). Comparable studies with normal elderly subjects have been described by McIntyre and Craik (1987) and Craik, Morris, Morris, and Loewen (submitted), and variations on the theme have been offered by Daniel (1988) and McAndrews, Glisky, and Schacter (1987).

In a prototypical experiment, subjects learn facts not previously known to them, facts such as "The Angel Falls are located in Venezuela." This learning takes place at a particular time, in a particular place, in active interaction with one or more other persons, the experimenter or experimenters. In the subsequent test, subjects are tested for their retention of the learned facts and for their recollection of having learned the retained facts in the earlier study episode.

The interesting finding from this research concerns the dissociation between retention of facts and recollection of the learning episode. A representative set of relevant data, from Experiment 2 in Shimamura and Squire (1987), is shown in Table 2. The performance of amnesic patients was compared with that of nonamnesic control subjects. The amnesic subjects were tested five minutes after the learning episode; control subjects were tested after two hours. This difference in the length of the retention interval had the desired effect of equating the two groups' recall of facts, thus rendering meaningful the comparison of their recollection of the "source" of the remembered facts. As the data in Table 2 show, there was a striking difference in such recollection: whereas the control subjects remembered the learning of the facts perfectly, the amnesic patients could recollect the source of only 31% of the remembered facts.

These data indicate a sharp discontinuity between retrieval of factual knowledge and recollection of particular past episodes: Retrieval of know-

TABLE 2
Probability of Recall of Learned Facts and Recollection of the Learning Episode by Amnesic Patients Tested Five Minutes after Learning and Alcoholic Control Subjects Tested Two Hours after Learning

<i>Subjects</i>	<i>Measure of Retention</i>	
	<i>Recall of Facts</i>	<i>Recollection of Episode</i>
<i>Amnesic patients</i>	0.32	0.31
<i>Alcoholic controls</i>	0.30	1.00

Data from Experiment 2, Shimamura and Squire, 1987.

ledge can occur in the absence of any conscious awareness as to the circumstances under which the knowledge was acquired. Such a discontinuity can sometimes assume extreme forms. We have recently reported a case study, describing a closed-head injury patient, K.C., who cannot recollect, that is, cannot consciously bring back to mind, any past episodes whatever, from any part of his life, but who possesses a great deal of factual knowledge about the world, acquired through the now inaccessible episodes (Tulving, Schacter, McLachlan, & Moscovitch, 1988b).

If we regard a fact presented to the subject in a particular learning situation as a miniature episode embedded in the total episode, and view the phenomenon of source amnesia against the backdrop of the doctrine of concordance, source amnesia appears to be paradoxical if not illogical. How can a part of an experience be retained if the whole is lost? If one does not remember having learned something, how does one now know that particular thing? The resolution of the paradox is simple, but it requires that we reject concordance. Knowledge of a learned fact need not be correlated with the recollection of the fact of learning.

Knowledge of learned facts and recollection of past events seem to represent operations of different memory systems. Retrieval of information from one system, semantic memory, that mediates the acquisition and retention of facts, can occur independently of the same kind of conscious awareness that accompanies recollection of past events, mediated by another system, episodic memory (Tulving, 1985a; 1987). If so, it also becomes clear that when a subject, in a typical laboratory experiment, recalls or recognises material presented earlier, the only inference we can legitimately draw is that he has knowledge of the fact that the material was presented. We cannot infer that he recollects the act of learning, or that he has any conscious access to the learning episode.

In earlier publications (Tulving, 1985a; 1985b) I have referred to the kind of phenomenal awareness that accompanies retrieval of factual knowledge, or semantic-memory information, as *noetic* awareness, and the kind of conscious awareness that constitutes recollection of episodes from one's personal past as *autonoetic* awareness. For the sake of completeness, I have also proposed that we label the consciousness associated with non-symbolic behaviour, behaviour that does not represent anything outside the organism's momentary environment, as *anoetic* consciousness. Using these terms, we can say that the existence of the phenomenon of source amnesia seems to be at variance with concordance, in the sense that noetic awareness of information or knowledge retrieved from memory can be dissociated from the rememberer's autonoetic awareness of the origin of such knowledge, even in a situation where both the knowledge and recollection of the source of the knowledge are determined by one and the same episode in the person's life.

Remembering versus Knowing

The third example of research on conscious experience in memory represents a direct attack on the problem of the distinction between the noetic awareness (knowledge) of a past event and the auto-noetic awareness (recollection) of the event. Following up on some preliminary work reported by Tulving (1985b), John Gardiner (Gardiner, 1988; Gardiner & Java, submitted) has recently reported a number of experiments in which memory performance, measured in terms of the proportion of previously studied items recognised, was found to be differentially associated with two kinds of conscious awareness of what was retrieved.

We consider here his first two experiments (Gardiner, 1988). He was interested in the nature of subjects' conscious awareness that accompanies episodic recognition of previously studied words. He reasoned that subjects might identify some test words as "old" because they could consciously recollect the act or event of studying the word earlier in the experiment, that is, that the subject had auto-noetic awareness of the words' earlier appearance. He referred to this category of words as the "remembered" words. Other test words might be identified as "old" only because of a cognitive disposition to do so, without any auto-noetic recollection of the words' appearance in the study episode, but with noetic awareness of the fact that they were members of the studied list. He referred to this category as the "known" words.

The main independent variable manipulated in the first experiment was the level of processing (Craik & Tulving, 1975): Subjects studied each word in a long list paying attention to either its meaning ("associative" encoding) or its sound ("rhyme" encoding). In the subsequent episodic recognition test, subjects had to identify the words that they had seen in the study list. The critical part of the experiment was this: For each word that a subject recognised as having occurred earlier, he was asked to judge whether he (auto-noetically) *remembered* the word's appearance in the list, or whether he simply (noetically) *knew* on some other basis that it was a list word. The second experiment was a generation experiment (Slamecka & Graf, 1978): The to-be-remembered words were either read or generated to relevant cues at the time of study, and their recognition was tested either one hour or one week later. Again subjects were asked to identify each recognised target word as having been consciously remembered or simply known on a basis other than auto-noetic awareness.

Gardiner's findings are shown in Tables 3 and 4. In Experiment 1 (Table 3), as expected, associative encoding produced a higher level of recognition than rhyme encoding. However, the important new finding was that this difference pertained only to those words that the subjects judged as having been remembered. The proportion of recognised items that subjects

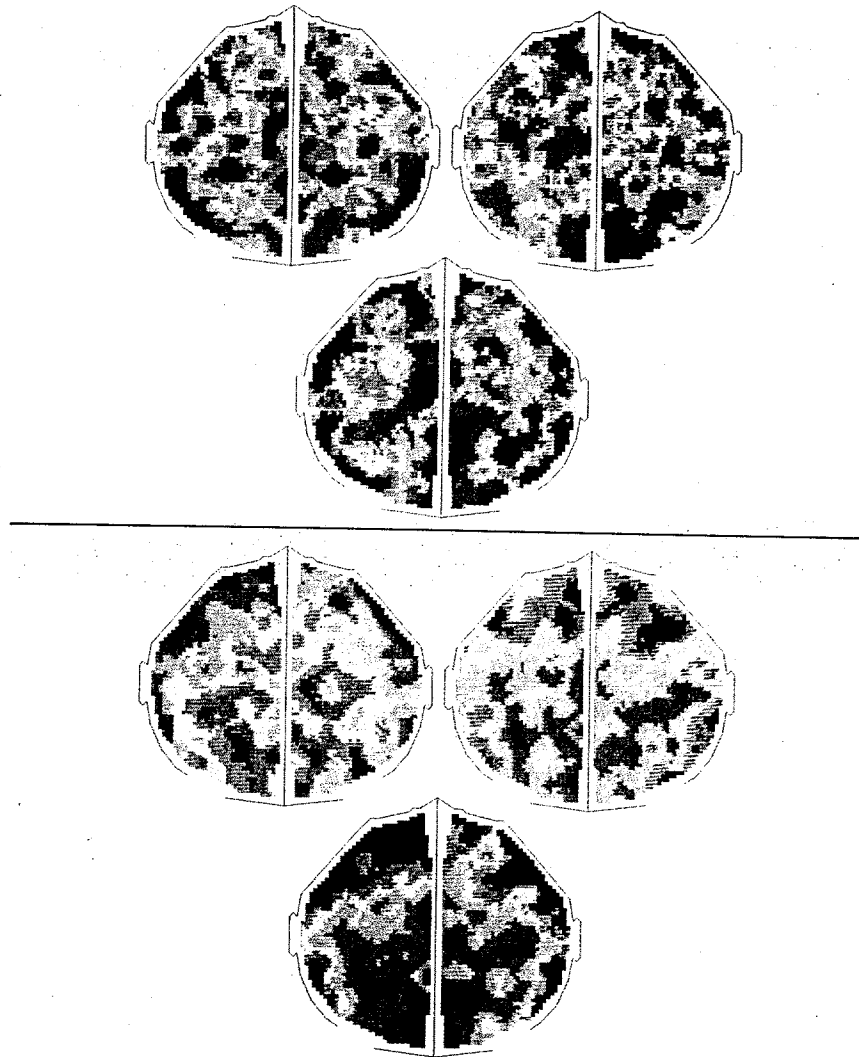


FIG. 1. Regional cerebral bloodflow patterns of individual subjects. The upper set of three patterns shows the results for one subject, the lower set of three for another. In each set, the pattern at the top right was obtained while the subject silently recollected personal events that had happened many years ago (upper set) or a few days previously (lower set). The pattern at the top left in each set was obtained while the subject was silently thinking about a particular topic of general (semantic) information, initially acquired many years previously (upper set) or within the previous days and weeks (lower set). In these patterns, the yellow colours indicate the level of bloodflow near the mean of the hemisphere, the red colours indicate relatively higher levels of activation, and the green colours relatively lower levels. The bottom figure in each set shows the difference between the episodic and semantic patterns. Here yellows indicate little difference between the two kinds of mental activity, the reds show relatively greater activation of the region during episodic retrieval, and the greens show relatively greater activation during semantic retrieval.

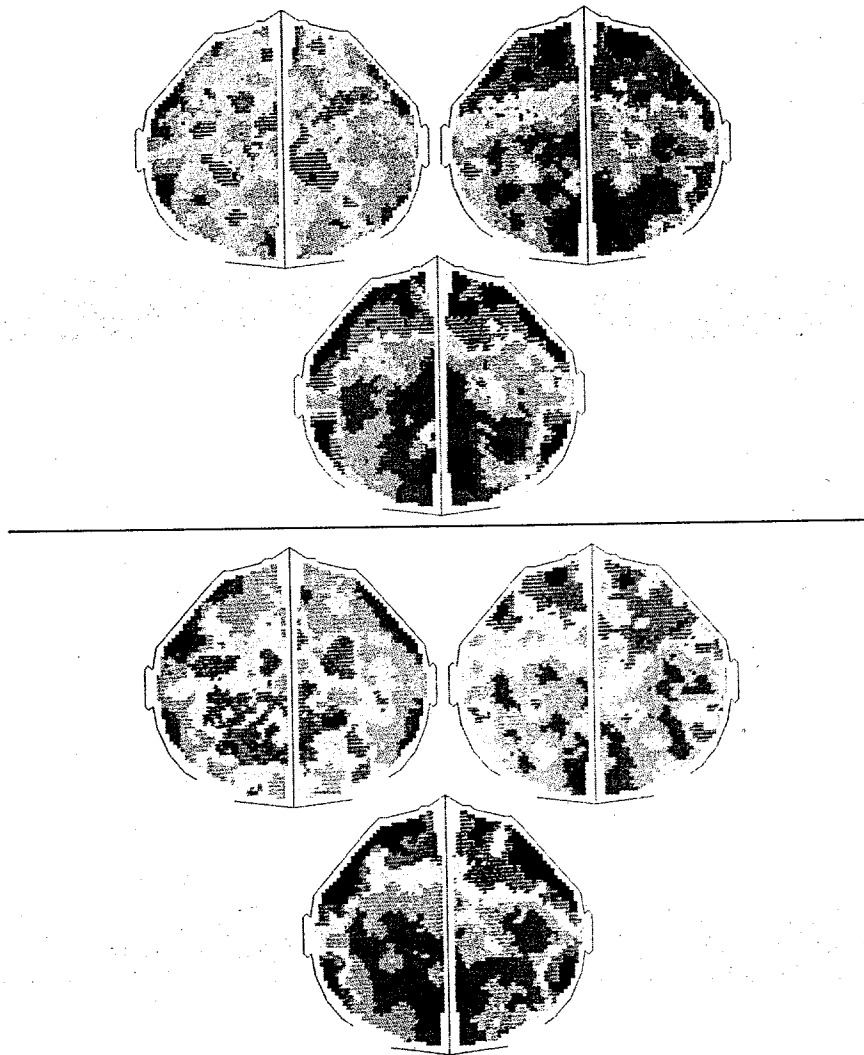


FIG. 2. Average regional cerebral bloodflow patterns for three subjects. The upper set of three patterns shows retrieval of "remote" information, the lower set shows retrieval of "recent" information. The pattern at the top right in each set of three represents episodic retrieval, the pattern at the top left, semantic retrieval. Each of these patterns is an average of six measurements, two from each of the three subjects. The yellow colours indicate the level of bloodflow near the mean of the hemisphere, the red colours indicate relatively higher levels of activation, and the green colours relatively lower levels. The bottom figure in each set represents the difference between the average episodic bloodflow and the average semantic bloodflow. The yellow colours indicate little difference between the two, red colours show relatively greater activation of the region during episodic retrieval, and the green colours indicate relatively greater activation during semantic retrieval.

TABLE 3
 Joint Probability of Recognition and Identification
 of Recognised Items as "Remembered" and as
 "Known"

<i>Encoding Condition</i>	<i>Measure of Retention</i>	
	<i>Recognised and "Remembered"</i>	<i>Recognised and "Known"</i>
<i>Associative</i>	0.66	0.18
<i>Rhyme</i>	0.46	0.16

Data from Experiment 1, Gardiner, 1988.

judged as having occurred in the list on a basis other than by conscious recollection was almost identical for the two encoding categories. In Experiment 2 (Table 4) a similar pattern emerged. Words that had been generated at study were recognised more readily than words that had been read, and words tested after one hour were recognised more readily than words tested after one week. But again these two effects held only for the recognised words identified by subject as having been (autonoetically) consciously remembered. The proportion of words correctly recognised, but not consciously remembered ("known" words), was affected neither by generation nor by the retention interval.

Gardiner's (1988) experiments are directly concerned with the relation between memory performance, retrieval of knowledge, and recollective experience. His treatment of conscious awareness as a dependent variable resulted in a new discovery: Subjects are capable of discriminating between

TABLE 4
 Joint Probability of Recognition and Identification of
 Recognised Items as "Remembered" and as "Known"

<i>Encoding Condition</i>	<i>Measure of Retention and Interval</i>			
	<i>Recognised and "Remembered"</i>		<i>Recognised and "Known"</i>	
	<i>1 hour</i>	<i>1 week</i>	<i>1 hour</i>	<i>1 week</i>
<i>Generate</i>	0.68	0.15	0.41	0.16
<i>Read</i>	0.35	0.14	0.26	0.19

Data from Experiment 2, Gardiner, 1988.

qualitatively different states of conscious awareness accompanying one and the same kind of cognitive performance, that of identifying a test item as one previously seen.

We see here again that concordance breaks down: The subjects' own assessments of the nature of their conscious experience systematically distinguish between categories of events—copies of study-list words classified as “old”—that are identical in terms of memory performance or retrieved knowledge.

Regional Cerebral Blood Flow and the Conscious Experience of Remembering

The last illustrative example has to do with the measurement of regional cerebral blood flow (rCBF) in conscious subjects. The measurement of regional cerebral blood flow is a widely used technique for studying physiological changes in the living brain (Ingvar, 1978; 1979; Lassen, Ingvar, & Skinhoj, 1978). Cerebral blood flow is determined by functional neuronal activity and the metabolic requirements of such activity. The measurement of relative distribution of blood flow in different cortical regions thus provides information about the level of neuronal activity in these regions.

A good deal of previous research has shown that different regions of the brain are differentially involved in the carrying out of different cognitive tasks (e.g. Deutsch et al., 1986; Maximilian, Prohovnik, Risberg, & Hakansson, 1978; Petersen et al., 1988; Roland & Friberg, 1985; Wood, 1987). Recently I had the good fortune of being able to collaborate with Jarl Risberg and David Ingvar at the University of Lund in Sweden, in some preliminary rCBF studies in which we wanted to see whether different cortical regions are involved in the recollection of previously experienced episodes and retrieval of general knowledge, that is, whether different patterns of cortical activity are associated with the auto-noetic and noetic consciousness (Tulving, Risberg, & Ingvar, 1988a).

The study was carried out with the high-resolution Cortexplorer 256-HR system under the general procedure described by Risberg (1987; 1989). A small dose of radioactive gold (Au 195m) with a physical half-life of only 30sec serves as tracer. It is injected intravenously into the blood-stream of a fully conscious subject who has volunteered for the experiment. The tracer in the blood is carried to and distributed intravascularly throughout the brain. The blood flow in the cortex is recorded by a battery of 254 extracranial gamma-ray detectors that surround the subject's head snugly. Each detector, collimated to scan an area of approximately one square centimetre, measures the rate of arrival of the radio-

active indicator in its field of "view" for separate intervals of 0.2sec in duration. The computer is programmed to integrate these readings over a suitable interval of time, which in our study was 2.4sec. These integrated readings from each of the 254 detectors are converted into *relative* blood-flow rates. Measures of blood flow, and hence neuronal activity, can be calculated from such data with the help of appropriate algorithms. Data storage and necessary calculations are carried out by a computer.

Risberg, Ingvar, and I tested several subjects in our exploratory study. Each subject underwent eight successive measurements, or trials, in a single session. During each trial, which lasted 80sec, the subject, lying on a couch with eyes closed, engaged in either episodic or semantic retrieval. Such retrieval consisted in silent mental activity, "pure thought"; it did not involve concurrent external stimulation or overt behaviour. The subject himself or herself decided on different topics to think about. Some of the topics were episodic, having to do with personally experienced events or happenings, for instance a holiday or a trip. Other topics were semantic, having to do with general, impersonal knowledge, acquired through secondary sources, such as the media or books. The overall design was $2 \times 2 \times 2$ within subjects: two kinds of thinking (episodic versus semantic), two levels of acquisition of retrieved information (remote versus recent), and repetition of the procedure in two successive blocks of four trials (first and second).

On a given trial, the subject began thinking about the specified topic on a signal from the experimenter, the gold isotope was injected 60sec later, and the measurement taken another 7–8sec later, when the bolus and the tracer arrived at the recording sites. The calculation of the rCBF distribution values is based on the initial slope of the function representing the accumulation of the isotope in the region per unit time. On each trial the total measurement period was 2.4sec, consisting of 12 successive periods of 0.2sec each. The four episodic and the four semantic trials were alternated in sequence, but otherwise different subjects received different sequences. Individual trials were separated by two minutes of rest, the interval between the two blocks of four trials was five minutes.

Three of the subjects we tested provided inconsistent data, for reasons that we can only speculate about. The data from three other subjects, however, showed a reasonably consistent picture of a general difference between episodic and semantic "thinking" that is illustrated here in Figs 1 and 2.

Figure 1 shows two sets of three cortical blood-flow patterns that represent the results on single trials of an individual subject. The one on the top left in each set represents retrieval of semantic knowledge, the one on the top right represents episodic recollection, and the bottom pattern represents the difference between the two top patterns.

The upper set of rCBF patterns in Fig. 1 shows the results for one of the subjects, a professor of psychology at the University of Toronto. On the right is the picture of his cortical activity while he was recollecting remote events, namely, thinking about the events of a summer 47 years ago. On the left is a picture from the trial during which he was retrieving remote semantic information, namely thinking about the history of astronomy, and the work of Copernicus, Brahe, and Kepler, that he had first learned about many years ago. In each figure, the yellow colour indicates the blood-flow and neuronal activity levels near the mean of the hemisphere, the red colours indicate relatively higher levels, and the green colours relatively lower levels. The bottom figure depicts the *difference* between the episodic and semantic patterns, with yellows indicating little difference, reds showing relatively greater activation of the region during episodic retrieval, and greens showing relatively greater activation during semantic retrieval. This difference pattern shows a relatively greater degree of activation of the anterior regions of the cortex during recollection of personal episodes, and a relatively greater degree of activation of the posterior regions during retrieval of impersonal semantic information.

The set of comparative blood-flow patterns in the lower half of Fig. 1 represents the results from a "recent" semantic trial and the corresponding "recent" episodic trial of another subject, namely the professor's wife. Here the top right figure shows her reminiscing about a trip from Copenhagen to Lund that had taken place a few days previously, the top left figure represents her thoughts about the then current unrest in the Middle East and the war between Iran and Iraq, known to her second-hand through the media, and the bottom figure depicts the difference between the two. The difference pattern is roughly similar to the difference pattern shown in the upper half of Fig. 1: Greater activation of anterior regions associated with episodic (autonoetic) thinking, and greater activation of posterior regions with semantic (noetic) thinking.

Figure 2 shows two sets of *average* blood-flow patterns for the three subjects who did provide consistent data. Two of these subjects have already been mentioned; the third one was a professor of clinical neurophysiology at the University of Lund, who has been measuring the regional cerebral blood flow patterns of other people for over 25 years. The layout of the cortical maps in Fig. 2 is similar to that in Fig. 1: semantic on the left, episodic on the right, and the difference pattern below the two. The upper set of three patterns represents the outcomes of rCBF measurements associated with retrieval of "remote" information, information originally acquired many years ago, whereas the lower set represents corresponding data for "recent" information, only a few days old. Each cortical pattern represents the mean of six separate measurements, each of the three subjects being tested twice.

Because of the preliminary nature of the study, it would be inappropriate to read much theoretical significance into these data. The study needs to be, and will be, repeated; the reasons for the inconsistent results of some subjects need to be identified; and possible confounds of episodic and semantic thinking—correlations of episodic and semantic information with “difficulty”, affect, visualisation, “executive functions”, etc.—should be systematically evaluated. For the time being, we can regard the study and its results only as an illustration of the possibilities in this kind of research.

Keeping these caveats in mind, it is nevertheless not without interest to note the general feature shared by the results of individual subjects and revealed in the averages: Episodic recollection (autonoetic consciousness) is accompanied by a relatively greater degree of activation of the anterior (frontal and temporal) cortical regions, whereas retrieval of semantic knowledge (noetic consciousness) is accompanied by a relatively greater degree of activation of the posterior (parietal and occipital) regions. The involvement of the frontal lobes in episodic recollection is encouraging inasmuch as it agrees with observations of brain-damaged patients that have pointed to the involvement of the frontal lobes in the carrying out of temporally organised and spatially bound episodic memory tasks (Milner, Petrides, & Smith, 1985; Schacter, 1987b; Squire, 1987).

The main import of our preliminary study, in the context of the present discussion, lies in the demonstration of the possibility of objective observation and measurement of neural activity correlated with conscious mental activity in nonbehaving subjects. Neuroimaging has provided a new window into the conscious minds of nonbehaving subjects. There is little doubt that neuroimaging techniques will be greatly improved in the future. The evidence these techniques will yield about purely mental processes and different conscious experiences will supplement evidence from purely psychological experiments.

Knowledge and Experience

It is possible to imagine the existence of highly intelligent creatures, masters of their environment and builders of complex civilisations, who are not consciously aware of the world in a way that human beings are. The existence already, a mere few hundred years after the beginning of the scientific-technological revolution, of relatively sophisticated computers and robots allows one to think that in another few hundred years, or a thousand, or a million, highly intelligent and universally capable non-human beings will have been created. Their ability to absorb information, to store it, to process it, and to transform it into outputs that can operate on the world will probably far outstrip that of today's human beings. They

will be processors of information and knowledge *par excellence*. What these intelligent systems will probably not possess is the kind of human consciousness that has evolved as a unique emergence in the known universe.

There is no logical necessity for a close connection between behaviour and cognition, between cognition and conscious awareness, between knowledge and experience. The tacitly accepted doctrine of concordance assumes that there is, and the assumption has driven memory research throughout its short history. Until recently, there were no compelling reasons to doubt concordance. But now the situation is changing. The four illustrative examples of research on conscious awareness in memory briefly reviewed here do not gracefully fit the doctrine of concordance. They do not overthrow it, of course, but they do make it somewhat less than compelling. At the very least they suggest that the time may have come for us to begin thinking about alternative conceptualisations of the relation between behaviour, knowledge, and experience.

The simplest alternative would be the hypothesis that there is no *necessary* correlation of any kind between performance and knowledge, or between knowledge and conscious experience, although there *may* be concordance of some kind in some situations. I will refer to this idea as the hypothesis of *indifference* of cognition, behaviour, and experience. It holds that (a) the behaviour of human beings does not necessarily depend on individuals' knowledge or experiential awareness of what they do, why they do it, or how they act, and (b) even highly complex knowledge need not be reflected in the same kind of conscious awareness that characterises recollection of past events. The hypothesis of indifference holds that the nature of the relation between behaviour, knowledge, and conscious experience depends on what the behaviour, knowledge, and experience are, and the particular circumstances under which they occur.

Two corollaries of the hypothesis of indifference are worth mentioning. First, it is perfectly meaningful to study behaviour independently of cognition, and independently of experience. A great deal of behaviour has nothing to do with either, and to try to understand it in terms of cognition or experience may be counter-productive. Similarly, it is perfectly meaningful to study cognition or experience independently of behaviour, as the success of cognitive psychology to date has already demonstrated. The psychological study of cognition and experience may rely on behavioural indicators of internal happenings, but the selection of these indicators is optional and not obligatory. Thus, psychology is at least two sciences, one of behaviour, the other of experience, and the two need not have anything in common.

The second corollary of the hypothesis of indifference is that the elucidation of the relation between behaviour, cognition, and experience in general, or between performance, knowledge, and recollection in the

study of memory in particular, should be an important objective of research. Such elucidation should be primarily a matter of empirical study, even if, as is always true in any science, the empirical study must be complemented by rational analysis. Thus, the specification of the nature of relations among behaviour, cognition, and conscious experience in the complex manifold of human existence should be regarded as an important mission of psychology, as well as of the science of memory.

SUMMARY

Now, to sum up. I have argued that psychologists have largely ignored one of the main defining features of memory, namely the conscious recollection of the past. Although cognitive psychologists have studied memory in terms of cognitive processes, these are theoretical abstractions uncertainly correlated with rememberers' phenomenal reality. The neglect of recollective experience reflects psychologists' wide acceptance of the tacit assumption that behaviour, cognition, and experience are harmoniously co-ordinated, an idea that I have referred to as the doctrine of concordance. Accepting the doctrine, many psychological students of memory have acted as if explaining memory performance also yielded the understanding of the conscious experience of recollection. Recent research in several areas has demonstrated how conscious recollective experiences can be objectively analysed, and distinguished from both memory performance and the overall retrieval of stored knowledge. This research has included (a) repetition priming, a non-conscious form of change in complex cognitive behaviour, frequently strikingly dissociated from episodic remembering; (b) source amnesia, the retrieval of recently acquired new knowledge without auto-noetic conscious awareness of the origin of the knowledge; (c) people's ability to systematically classify into different categories their conscious awareness that accompanies the behaviour indicating retrieval of recent information; and (d) differences in the regional cerebral blood flow patterns that are associated with recollection of past events and implicit recall of knowledge acquired in the past, or with the auto-noetic awareness of past experiences and noetic awareness of the act of learning in the past. All these developments suggest that it may be useful to contemplate alternatives to the doctrine of concordance. The simplest alternative is the hypothesis of *indifference* of cognition, behaviour, and experience, the notion that there is no single, general relation between behaviour, cognition, and conscious experience, or between performance, knowledge, and recollection. The acceptance of the hypothesis will naturally lead to an empirical and rational elucidation and specification of these relations.

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