CHAPTER 2

Origin of Autonoesis in Episodic Memory

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Bob Crowder and I shared a passionate interest in the experimental psychology of human memory throughout our professional careers, although we followed somewhat separate paths in pursuing the object of our love. These differences extended to both substance and style. Bob always took his science soberly and straight and treated it as a serious business in which rules and traditions that served us well in the past were observed and honored and not messed with. His way of doing memory science seemed to have been patterned after that of his great mentor, the late Arthur Melton. As for Melton, so for Crowder; psychology of learning and memory was "normal science" in Thomas Kuhn's terms, a matter of testing hypotheses within the accepted theoretical and methodological framework. Deviations from these "right" ways of thinking about problems and solving them are not welcome in normal science and are therefore to be resisted. I, however, have tended to think of the psychology of learning and memory as a preparadigmatic science in search of a paradigm. If so, the existing standards are to be viewed skeptically, as strictly temporary holding devices, sometimes even potential obstacles on the road to the goal of getting nature to reveal her secrets. Therefore, the standards are to be considered perennial candidates for modification and revision.

I professed the new science of "cognitive psychology" at Yale University in the early 1970s; so Bob was familiar with aspects of my less traditional work. One of these aspects had to do with recognition failure of recallable words, a phenomenon that Bob resolutely refused to believe until I demonstrated it to him personally, with him as the participant. Another aspect and central to the story here was the idea of episodic memory. This idea had arisen as an afterthought to a meeting at the University of Pittsburgh in March 1971. I wrote an essay about it in the volume of the conference papers (Tulving, 1972). The idea was that the "kind of memory" that had been studied in the psychological laboratories since Ebbinghaus was in

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some ways different from the "semantic memory" that several participants—Allan Collins and M. Ross Quilian, Walter Kintsch, and Peter Lindsay, Donald Norman, and David Rumelhart—had introduced at the Pittsburgh meeting. I called the "not-semantic" memory "episodic" and speculated about how the two differed.

Episodic Memory

The idea of episodic memory was frequently under discussion at the weekly "memory lunches" that Bob Crowder and I had organized at Yale. Bob quickly became an outspoken and persistent critic of the notion that episodic and semantic memories are different in any important way. Consequently, the discussions about episodic memory at our meetings were always spirited and sometimes even heated. The idea that the kind of memory involved in remembering things, such as what happened on one's recent trip to New York or what items had appeared in a recently seen list, is somehow different from the kind of memory involved in knowing that canaries have wings and lungs or that people imbibe lager in taverns was pure anathema to Bob. He thought it was not only "irresponsible" but also "sinful" (my terms, not his) to fractionate a perfect, beautifully coherent whole—long-term memory—into separate domains. The fact that in the 1972 article I referred to the two domains as memory "systems" only aggravated the error.

Bob played his role of the defender of the faith in his own inimitable fashion, of course: always polite, always sincere, always friendly, but always utterly unyielding. Because my position, taken objectively, was admittedly rather frail—there was nothing known at the time that could be considered to provide clear empirical support for the distinction between episodic and semantic memory—and Bob was very articulate; he usually came out on top in these debates. His authority in this matter was clearly revealed by the fact that none of the younger members of the group, mostly graduate students of psychology at Yale, either then or later, became an advocate of episodic memory. Indeed, one of them, Roddy Roediger, has remained one of the best-known critics and nonbelievers in the deeper significance of the distinction (Roediger, Buckner, & McDermott, 1999; Roediger, Weldon, & Challis, 1989).

I left Yale in 1974, returned to Toronto, and took my sinful ideas with me—thereby solving the problem of episodic memory at Yale. Elsewhere, the rebellion was treated in a way that today would be recognized as "politically correct": Many people adopted episodic and semantic memories as purely descriptive terms of two different categories of memory studies, namely, those with and those without specifically identified learning episodes, although refraining from much discussion about the reality of the distinction at any higher level.

This "heuristic" distinction between episodic and semantic memory served as a happy compromise until the publication of *Elements of Episodic Memory* (Tulving,

1983). In my book, I renewed the claims for separateness of episodic and semantic memory and made a more determined attempt to spell out the differences between the two systems. One aspect of the proposal was the idea that an important distinguishing characteristic of episodic memory is a unique "flavor" of the phenomenal "recollective experience" that accompanies retrieval from episodic memory. It represents a feeling of "warmth and intimacy," which William James wrote about in his *Principles of Psychology* (James, 1890), a feeling that is missing when one thinks about the knowledge in semantic memory. I suggested that because all researchers of laboratory studies of verbal learning and memory up to that time had only looked at the participants' behavior and had not been concerned with the flavor of the retrieval experience, the study of episodic memory had not yet begun.

These extended ideas about episodic memory did not sit well with the critics. A summary of the book, "Précis of Elements of Episodic Memory" (Tulving, 1984), was subjected to peer review in the journal *Behavioral and Brain Sciences*. In the course of the review, many shortcomings of the ideas in the book were discovered. Bob Crowder (1986) graciously agreed to write one of the reviews. In the first part, he provided a masterly overview of that section of *Elements of Episodic Memory* that deals with the distinction between episodic and semantic memory. Indeed, when I read it at the time, I felt that he might have been one of the very few readers of the book who had really understood what the new proposal was. Bob (Crowder, 1986), with his characteristic astuteness, went straight to the heart of the matter: "The heuristic distinction between episodic and semantic memory is now so widely accepted, it is easy to get well into the book before realizing that Tulving proposes here a radical new focus of episodic memory" (p. 566). This radical new focus was the idea, precisely put by Bob, that the "subjective experience of having a past event from one's life projected into the present is not just an additional criterion for defining episodic memory, it is the controlling definition of episodic memory" (p. 566).

Then after having precisely located the foreign intruder in the body psychologic, Bob, with the exquisite skill of a surgeon, proceeded to dissect the evidence that I had used in arguing the case for the distinction and the role of experience. When he had finished, there was little left of the episodic–semantic duality—just isolated bits and pieces of trivia in a shapeless and formless clutter.

After having thus disposed of the threat to the prevailing order, Bob had only wonderfully pleasant things to say about the rest of the book, the sections that dealt with phenomena of memory in the good old functionalist tradition of "let's do experiments and report and discuss the results."

In retrospect, it is easy to see that Bob Crowder was justified in resuming his 1972 stand in 1983. The picture of empirical support for the episodic–semantic distinction was brighter in 1983 than it had been in 1972 but not a lot brighter. In chapter 3 of *Elements of Episodic Memory*, I listed and discussed the differences between the two systems that were more numerous by then, but these were explicitly designated as hypotheses or as starting points of discussion. Although in another

chapter of the book (chapter 5), I dealt with empirical evidence for the episodic–semantic distinction, the evidence was strained. Objectively, it was clear that the idea of the distinction was a bit ahead of solid data. At the time of the writing of *Elements of Episodic Memory,* the theoretical status of yet another then recently discovered "new" kind of memory, repetition or perceptual priming—episodic? semantic? procedural?—was unclear. This fact further contributed to the fuzziness of the whole scenario. Thus, by the middle of the 1980s, as Bob Crowder and other solid observers knew, the idea that episodic memory might be basically different from other kinds of memory was little more than an armchair thought in search of scientific respectability.

Changing Concepts

All this happened long ago. Today, *episodic memory* has become if not a household word then at least a less disruptive thought. Many students of memory, especially those with a neuropsychological orientation, have woven the concept into their own experiments and theories. In the meantime, the idea of episodic memory has also changed greatly. Compare two definitions. Consider first the following 1972 definition:

> Episodic memory is an information processing system that a) receives and stores information about temporally dated episodes or events, and about temporal–spatial relations among these events, b) retains various aspects of this information, and c) upon instructions transmits specific retained information to other systems, including those responsible for translating it into behavior and conscious awareness. (Tulving, 1972, p. 385)

This definition shows clear signs of having been shaped by the then-prevailing information-processing approach to studying verbal learning and memory in word-list experiments. The emphasis was on the processing of information about *events*, such as occurrences of words in a list: "receiving" (encoding), storing, and "transmitting" this information to output systems, in other words, retrieving it. The term *conscious awareness* was in the definition, but there was nothing unique about it, being shared by both episodic and semantic memory.

Now, consider the 1999 definition: Episodic memory is a recently evolved, late developing and early deteriorating, past-oriented memory system, and probably unique to humans. It makes possible mental "time travel" through subjective time, from the present to the past and to the future, and it allows re-experiencing, through autonoetic awareness, experiences as such. Its operations depend on semantic memory, and it is subserved by multiple brain regions including medial temporal lobes and prefrontal cortex.

Even a casual inspection shows that this definition is only superficially similar to the earlier one. The two formulations bear a family resemblance to each other,

much like the resemblance of an adult to himself or herself in early childhood. In the current definition, no mention is made of processing information through the stages of encoding, storage, and retrieval because these stages characterize most memory systems. Past "events" become past "experiences" because it is necessary to distinguish between semantic memory events (e.g., "Lavoisier was guillotined during the French Revolution in Paris") and personal events ("I remember well my first visit to the Louvre"). Added are specific emphases on the past and "mental time travel" to underscore the fact that episodic memory is the only memory system whose explicit function is to allow the individual to re-experience (remember) the subjectively experienced past. Added also are ideas about the (phylogenetic) evolution and (ontogenetic) development of episodic memory, although factual information about the former is lacking and about the latter is still sparse. Furthermore, the 1999 definition mentions some neural substrates of episodic memory, a component of the definition that was not only impossible in 1972 but essentially unimaginable in the then current zeitgeist. Finally, the tentative proviso regarding the probable restriction of episodic memory to humans was inserted to distinguish episodic memory as defined here from episodic memory as used in the literature on memory of nonhuman animals. Although many nonhuman species possess sophisticated semantic memory (knowledge-of-the-world) systems, there is no evidence that any possess humanlike episodic memory (for a discussion, see Clayton & Dickinson, 1998; and Tulving & Markowitsch, 1998).

In the context of this chapter, the most important change in the definition of episodic memory is the shift from the general idea of "consciousness" that applied to both episodic and semantic memory in 1972 to "autonoetic consciousness" in 1999. What is this autonoetic consciousness? The remainder of this chapter revolves around this question. It is discussed here because it fits into the episodic memory story the beginnings of which Bob Crowder witnessed and partially shaped. The idea of autonoetic consciousness, or "autonoesis" as it is referred to henceforth, is a part of the continuation of the story.

The Remarkable Case of K. C.

The concept of autonoesis (autonoetic consciousness) literally has its roots in an accident. The accident was one that befell a now densely amnesic man known as K. C. whom we have been studying at the Rotman Research Institute in Toronto, Ontario, Canada, for many years. In 1981, at the age of 30, K. C. rode his motorcycle off the road and suffered brain damage of a highly unusual kind. Today, K. C. lives in Mississauga, near Toronto, in his parents' house. Because his mental state has not changed greatly over the intervening years, I describe K. C. in the present tense, although much of the evidence for the case comes from the studies conducted in the past (Hayman, Macdonald, & Tulving, 1993; Tulving, 1989b; Tulving, Schacter, McLachlan, & Moscovitch, 1988).

K. C.'s intellectual capabilities are in many ways indistinguishable from those of a healthy adult. His intelligence and language are normal, and he can read and write. He has no problem recognizing objects and naming them; he can close his eyes and give an accurate description of the CN Tower, Toronto's famous landmark, from imagining it. His knowledge of mathematics, history, geography, and other school subjects is not greatly different from other individuals at his educational level (a graduate of a community college); he can define and tell the difference between stalagmites and stalactites (a distinction either not yet mastered or already lost by some people who test him). His thought processes are clear; he can play the organ, chess, and various card games; he has no problem with immediate memory (his digit span has been measured to eight); his social manners are exemplary; and he possesses a quiet sense of humor.

Even K. C.'s memory, broadly speaking, seems normal in many ways. It would be inaccurate to say that his memory is impaired, because his brain damage did not noticeably affect most known forms of memory. He has no particular problems with many perceptual motor and cognitive skills, with the retrieval of premorbidly acquired general knowledge, or with short-term memory for recent (1 to 2 min. ago) happenings, as the examples in the previous paragraph show. When it comes to perceptual priming, his performance is embarrassingly higher than that of an average University of Toronto student (Tulving, Hayman, & Macdonald, 1991). He can readily answer questions, even about semantic (public, objective, shared) aspects of his autobiographical knowledge, such as his date of birth, the address of his home for the first 9 years of his life, the names of the some of the schools he attended, the make and color of the car he possessed, and the fact that his parents owned and still own a summer cottage. He knows the location of the cottage, can easily find it on the map, knows its distance (90 mi.) from his home, and how long it takes to drive there from Toronto in weekend traffic. He also knows that he has spent a lot of time there. All this accessible factual ("declarative," "cognitive," "propositional") knowledge, regardless of what it is about, is classified as semantic because it is impersonal, objective, public, and shared. K. C. knows things about himself and his past in the same way that he knows similar things about other individuals, friends, and family. It is knowledge of one's life from the point of view of an observer rather than that of a participant, the same kind of knowledge that people have about many other aspects of their world.

K. C.'s sole but substantial problem is that he cannot remember anything that has ever happened to him. However hard he tries and however powerfully he is prompted, he cannot bring into his conscious awareness a single event, happening, or situation that he witnessed or in which he participated. This global episodic amnesia covers the period from his birth to the present day: He cannot recollect anything from his life before or after the accident. He knows the address and, when standing in front of it, recognizes the house where he lived for the first 9 years of his life, but does not remember a single event that took place in the house. He does

not remember a single visit to the family cottage and not a single event there in which he participated. Nor is he capable of remembering anything ever having happened in the house where he has now lived for over 30 years.

In the course of studying his amnesia, I collected descriptions of a number of poignant events from his life that would be regarded as highly memorable by everyone—a fight he had in a pub resulting in a broken arm that took him to the hospital; a traffic accident that caused his jaw to be "wired shut" for a week; the accidental death of his older brother to whom he was close; a huge chemical spill near his home that caused a 10-day evacuation of over 100,000 people in his neighborhood, including himself. The idea was to test his autobiographical memory with increasingly complete cues about the events. (I also made up a collection of descriptions of otherwise comparable events that had not happened to him and used these as controls.) The results are clear. Even when he was given full descriptions of the real events, his responses were the same as those he gave to the fabricated events: He said he did not remember the events and did not feel any familiarity toward them.

This contrast between what K. C. does not remember of his past and what he does know is very much in keeping with the hypothesis that episodic memory, memory of one's personal past, and semantic memory, general knowledge of the world, are subserved by different neural mechanisms. Although it must represent a one-in-a-million chance, it looks as if the brain damage that K. C. suffered from his accident resulted in a serious impairment in the functioning of the episodic memory system in the absence of a comparable impairment in the semantic system (Tulving et al., 1991).

From Episodic Memory to Autonoesis

The general pattern of K. C.'s lost and preserved mental capabilities can be economically described in terms of two kinds of consciousness. One is involved in tasks on which K. C. does very poorly. These are tasks that require him to mentally travel back in time to a particular episode, to relive it, to observe it again, to re-experience it. I named this kind of consciousness autonoetic (Tulving, 1985). *Autonoetic consciousness* (*autonoesis*) is defined as the neurocognitive capability of normal adults to become aware of their existence in subjectively experienced time. It includes but transcends self-awareness.

K. C. has normal self-awareness and has even learned his new "self" as revealed by trait judgments (Tulving, 1993; see also Klein, Loftus, & Kihlstrom, 1996). His autonoesis, however, is largely dysfunctional or perhaps even nonexistent. He lives in a timeless world, that is, in a permanent present. When he is asked to try to "travel back in time" in his own mind, back either a few minutes or many years, he says he cannot do it. When he is asked to describe the state of his mind when

he tries to turn his mind's eye toward the past, the best he can do is to say that it is "blank." Nor can he think about the future. Thus, when asked, he cannot tell the questioner what he is going to do later that day, or the day after, or at any time in the rest of his life, any more than he can say what he did the day before or what events have happened in his life. When he is asked to describe the state of his mind when he thinks about his future, whether the next 15 minutes or the next year, he again says that it is blank. Indeed, when asked to compare the two kinds of blankness, one of the past and the other of the future, he says that they are "the same kind of blankness" (Tulving, 1985). Thus K. C. seems to be as incapable of imagining his future as he is incapable of remembering his past.

When K. C. is engaged in activities that do not require mental time travel into his own past or future, his awareness is normal. When he is asked the name of the capital of France, or the difference between stalagmites and stalactites, or thousands of other such facts, there is no sign of any deficiency. In these situations he is naturally consciously aware of what he is doing, but the kind of consciousness involved is different from autonoesis: It contains no awareness of personal time. I named the kind of consciousness that accompanies retrieval of impersonal factual information (semantic memory information) "noetic" (Tulving, 1985). (For the sake of completeness, a third kind of consciousness in memory, one corresponding to the lack of awareness of the mental contents of a task, was named "anoetic.") Thus, although K. C.'s autonoesis is severely impaired, his capability of conscious awareness of the world beyond subjective time, that is, his noetic consciousness or noesis, is well preserved.

It is important to note that K. C. has no greater difficulty in thinking about physical time than he has thinking about physical space. He knows and can talk about what most other people know about physical time units, structure, and measurement by clocks and calendars. But such knowledge of time in and of itself does not allow him to remember events as having happened at a particular time. It is necessary but not sufficient. Something else is needed, and this something else—the awareness of time in which one's experiences are recorded—seems to be missing from K. C.'s neurocognitive profile. He thus exhibits a dissociation between "knowing" time and "experiencing" time, a dissociation that parallels knowing the facts of the world and remembering experiences.

Remembering and Autonoesis

The story about K. C.'s two kinds of consciousness, one (autonoesis) dysfunctional, the other (noesis) largely preserved, is based on two critical assumptions. First, the claim that K. C.'s brain damage resulted in the loss of autonoesis but not noesis implies that before his accident, he, like any normal healthy non-brain-damaged person, possessed both of these kinds of consciousness: One cannot lose, or retain,

something that one does not possess. If so, all normal human beings ought to be in possession of the same two kinds of consciousness. Second, the claim implies that there must exist specific, at least to some extent dissociable, neuronal correlates of the two kinds of consciousness in normal brains: One cannot lose, or retain, one of two functions of the brain if they are not neurally separable.

To test these two implications experimentally, one needs to solve two problems, among other things. The first consists in the creation in the laboratory of situations in which participants are known to be in one or the other conscious state: noetic or autonoetic. The second problem consists in the identification and measurement of brain activity that is correlated with the two mental states.

Note that the first problem is related to but goes beyond a problem that has already been tackled by students of memory who are interested in the relation between consciousness and memory. This standard problem concerns the separation of conscious from nonconscious processes of memory. The historically latest approach to the standard problem is associated with the concepts of priming and other forms of implicit memory (Roediger, 1990; Schacter, 1987; Toth, 2000; Tulving, Schacter, & Stark, 1982) and with the well-known process-dissociation procedure introduced by Jacoby (1991). Identification of autonoesis and noesis requires that we go beyond the standard problem inasmuch as the task calls not only for separating conscious from nonconscious processes but also for distinguishing one kind of consciousness from another. (For a further discussion, see Richardson-Klavehn, Gardiner, & Java, 1996.)

A beginning has been made in solving these problems. As a result, some initial evidence is available about neural correlates of autonoetic consciousness and its differences from noetic consciousness and nonconscious states.

The creation of autonoetic, noetic, and nonconscious (anoetic) mental states has become possible through what is known as the "remember/know paradigm" (Gardiner, 1988; Gardiner & Java, 1993; Gardiner & Richardson-Klavehn, 2000; Tulving, 1985). The basic idea is simple: When participants in an episodic memory test report that a particular event occurred at a particular time in a particular place they are further asked to describe the nature of the mental experience that accompanied the act of retrieval. Specifically, they are asked to offer either a "remember" or a "know" judgment. Remember designates recollection of the event of an item's occurrence in the study list, whereas know means that the participant's belief in the item's presence in the study has some other basis.

The initial remember/know experiments with word lists (a) show that people are capable of distinguishing between remembered and known successfully retrieved items and (b) provide a hint that the probability of occurrence of the two kinds of conscious awareness varies reliably and systematically with experimental conditions. Subsequent numerous studies confirmed the initial findings and generated a great deal of systematic data both with normal healthy participants (e.g., Gregg & Gardiner, 1991; Hockley & Consoli, 1999; Jones & Roediger, 1995; Mäntyla, 1997; Mungan

& Peynircioglu, 1999; Rajaram, 1993; Roediger & McDermott, 1995) and with special populations, such as amnesia patients (Knowlton & Squire, 1995; Yonelinas, Kroll, Dobbins, Lazzarra, & Knight, 1998), epilepsy patients with unilateral temporal lobectomies (Blaxton & Theodore, 1997), schizophrenia patients (Huron et al., 1995), Alzheimer's patients (Dalla Barba, 1997), and high-functioning people with autism (Bowler, Gardiner, & Grice, 2000). Space does not allow covering this research here; the burgeoning literature on remembering and knowing has been reviewed elsewhere (Gardiner & Richardson-Klavehn, 2000; Rajaram & Roediger, 1997; Wheeler, 2000). One of the unexpected methodological insights gained from all this research is that most of the research on recognition memory has inadvertently conflated the behavioral measures of two separable sets of processes. A corollary is that the conclusions about recognition drawn in research may hold for both, one, or neither of the two component processes taken individually.

For my present purposes, the important point made by the results of remember/know studies is that people can reliably distinguish between two states of conscious awareness and have no difficulty expressing the difference. These facts can be related to the dual-process theories of recognition that were proposed several decades ago (Atkinson & Juola, 1974; Jacoby, 1991; Mandler, 1980). The central idea in these theories is that episodic recognition can be based on one or both of two processes, recollection and familiarity. The nature of the relation between the two processes of dual-process theories and the two states of conscious awareness revealed by the remember/know paradigm is currently under intense scrutiny. The debate is enlivened by yet another theoretical stance according to which the processes and conscious states represent quantitative differences on a single continuum of recognizability (Donaldson, 1996; Gardiner & Gregg, 1997; Hirshman, 1998; Yonelinas, Dobbins, Szymanski, Dhaliwal, & King, 1996).

Autonoesis in the Brain

The remember/know paradigm can be used to create autonoetic and noetic states, thus solving the first of the two problems discussed earlier, and opening the doors to the search for their neural correlates. A handful of such studies have been conducted to date. The initial results can be described as variable but promising.

In an early study, Smith (1993), using the event-related potentials (ERP) technique (Rugg, 1995), reported a difference between the electrophysiological "signatures" of remembered and known word-recognition judgments. In a similar study, Düzel, Yonelinas, Mangun, Heinze, and Tulving (1997) added a novel feature to the basic design: By adopting the Deese–Roediger–McDermott (DRM) procedure (Deese, 1959; Roediger & McDermott, 1995), they created numerous discrete test events in which participants made false-positive judgments about test words that had not been physically presented for study ("critical lures"). Studies of the DRM

procedure show that participants make both remembered and known judgments, even about such falsely recognized test words (Payne, Elie, Blackwell, & Neuschatz, 1996; Roediger & McDermott, 1995). The question concerned the similarities and differences between brain activity associated with true and false recognition.

The results of the Düzel et al. (1997) experiment show that autonoetic awareness is correlated with an increase in the amplitude of the ERP signal in the 500–800-ms time window, in relation to the no-recognition baseline, whereas noetic awareness is correlated with an amplitude decrease of the *N*400 component of the waveform and a decrease of the "negative going" waveform in the 500–800-ms window. Both these components have been observed in the studies of episodic memory retrieval (Rugg, 1995). The Düzel et al. (1997) experiment provides a basis for the interpretation of the earlier findings in terms of physiologically based states of conscious awareness. Remarkably, the same pattern of data was obtained for true and false recognition, that is, for hits and false alarms. This latter outcome reinforces the interpretation of the data in terms of qualitatively different states of conscious awareness, independent of the presence or absence of the specific physical stimuli in the study list.

Electrophysiological measures yielded by the ERP technique can provide evidence that differential brain activity, associated with a task or process, does occur, as does evidence about the temporal parameters of the differences. But they are relatively uninformative about "localization of function," about what brain regions are differentially involved in the tasks, processes, or mental states under scrutiny. Such information can be gained from the recently developed technique of event-related functional magnetic resonance imaging test (fMRI; Buckner, 2000; Nyberg & Cabeza, 2000). With this technique as with ERPs, behavioral and physiological data can be collected "on line" about any sequence of events, such as the presentation of items to study or test, and then sorted into different "bins" defined by the specified characteristics of the events. Thus, study events can be sorted into those that resulted in successful subsequent recognition and those that did not. When such an analysis is conducted, different brain regions are differentially active at encoding of subsequently recognized and nonrecognized items (Wagner et al., 1998).

Using the event-related fMRI technique, Henson, Rugg, Shallice, Josephs, and Dolan (1999) obtained evidence for differences in neuroanatomical regions where activity is correlated with the mental states that underlie "remember," "know," and "new" responses. In their study, they revealed a complex picture of brain activity associated with different states of conscious awareness of test events. Among other things, it looked as if remember judgments were more associated with left-hemispheric regions, especially in prefrontal and parietal cortices, whereas know judgments tended to be right localized. Future research no doubt will clarify the picture. For our immediate purposes, the important finding is that differences in neuroanatomical activation were associated with autonoetic and noetic states of

awareness. Thus, at long last subjective phenomena of consciousness are becoming objective. The implications of this fact for the science of psychology are revolutionary.

Several researchers have suggested that frontal lobes play a critical role in autonoesis (Moscovitch & Melo, 1997; Tulving, 1993; Wheeler, Stuss, & Tulving, 1997). The results of Henson et al. (1999) provide initial direct support for these ideas. However, they also remind one that frontal lobes, like all other parts of the brain, do not do anything by themselves and that other brain regions are also involved.

Related Evidence

Other bits and pieces of empirical evidence that seem to fit into the developing pattern of data that forms the foundation for the story of autonoesis are worth mentioning. Clinical studies of patients with frontal lesions show that these patients have selective impairment in autobiographical remembering (DellaSala, Laiacona, Spinnler, & Trivelli, 1993; Kopelman, Stanhope, & Kingsley, 1999; Markowitsch et al., 1993; Markowitsch & Ewald, 1997; Rousseaux, Godfrey, Cabaret, Bernati, & Pruvo, 1997). Especially intriguing is the case of a young man, M. L., who suffered traumatic brain injury. He recovered most of his mental functions but was left with what appeared as a permanent impairment involving autonoesis (Levine et al., 1998; Levine, Freedman, Dawson, Black, & Stuss, 1999). The only observable brain damage was a lesion in the right-hemisphere uncinate fascicle, a fiber tract connecting prefrontal and temporal cortical regions. The patient's loss of autonoesis was accompanied by a seriously diminished affect and difficulties of self-regulation.

A related finding was reported by Markowitsch et al. (1999); they conducted a functional imaging study in which neural networks involved in the retrieval of "affect-laden" autobiographical material were compared with comparable fictitious material. The results show selective activations of the right amygdala and the right ventral prefrontal cortex near the uncinate fascicle associated with autobiographic material. In earlier research, Fink et al. (1996) described a positron emission tomography (PET) study where results revealed that a right-hemispheric network of cortical regions was involved in the ecphory (recovery) of affect-laden autobiographical information. To further complement the developing picture, Calabrese et al. (1996) reported a case of a postencephalitic patient, with brain damage mainly in the right temporofrontal region, which shows a severe and enduring loss of the ability to recollect premorbid personal experiences, and less severe loss of general knowledge. Finally, in a recent PET study, Craik et al. (1999) reported blood flow changes in a right-frontal region when participants made decisions about their own personality characteristics, thus hinting at the possibility that autonoesis associated with right-frontal regions may be analyzable into components related to "self" and "pastness."

In the realm of psychopharmacology, evidence has been reported that episodic memory retrieval but not semantic memory retrieval is impaired by various psychoactive drugs, such as benzodiazepines and ethanol, and that this impairment is limited to remembering and does not involve knowing (Bishop & Curran, 1995; Curran, Gardiner, Java, & Allen, 1993; Curran & Hildebrandt, 1999). Thus, the psychopharmacological approach, which allows the experimental creation of "reversible lesions" (Curran, 2000), shows promise as yet another window into the conscious mind.

Conclusion

There are two sciences of psychology, one of behavior and the other of the mind. The two share objectives, methods, and achievements, but in many ways they also differ. It is quite possible to study the lawfulness of behavior without even mentioning anything that has to do with the mind, and it is perfectly possible to study the mind at the same time using behavior merely as a measuring tool (Tulving, 1989a).

Here, I have told the story of how the idea of episodic memory spawned the idea of autonoesis (autonoetic consciousness), a human brain/mind capability that allows people to become consciously aware of their personal past and their personal future. Such awareness represents one of the truly unique human brain/mind capabilities. The story here is that empirical evidence is rapidly accumulating from a variety of sources and converging on the psychological and physiological reality of autonoesis. (A more thorough examination of these issues is available in Wheeler et al., 1997.)

The development of the story of autonoesis is interesting for several reasons. First, it symbolizes the emancipation of psychology as a science of the mind, or consciousness, as it was meant to be early in its history. Second, it illustrates how one can go beyond the traditional method to the study of consciousness that is based on the separation of conscious versus nonconscious phenomena and processes. Third, it points to what seems to be a radical shift in "doing" psychological science. The old "solo science" approach is being rapidly replaced by a new one based on multidisciplinary collaboration among experts of different backgrounds and with different skills but common objectives. Neuropsychological analyses of brain/mind relations provide outstanding examples of such a multidisciplinary approach. Functional brain imaging provides another. Finally, autonoesis may turn out to be a much more important player in the human drama than may be apparent now. One possibility, which I am exploring now, is that the evolutionary emergence of autonoesis, with backward and forward looking awareness of personal time ("palinscopic and proscopic chronesthesia") was a pivotal "driver" of the evolution of human culture and civilization. If so, autonoesis has played and is playing a highly crucial role in what humankind has been, is now, and will be in the future.

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THE NATURE OF REMEMBERING

ESSAYS IN HONOR OF ROBERT G. CROWDER

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