What Is Episodic Memory?

Endel Tulving

Few problems in science are as difficult as those of working out the precise relation between two complex concepts that are deceptively similar. The relation between episodic and semantic memory belongs in this category. Intuition and rational thought reveal many similarities between these two kinds of memory and tempt us to think of the two as one. Yet, closer scrutiny reveals a number of fundamental differences. In this article, I discuss one such difference, namely, the nature of conscious awareness that characterizes retrieval of episodic and semantic information.

Not everyone accepts the general idea of multiple memory systems, and among those who do, not everyone accepts the same scheme of classification.[1] What follows represents my views on the issue.

The distinction between episodic and semantic memory has changed considerably since my 1972 essay in which I argued for the heuristic usefulness of a taxonomic distinction between episodic and semantic memory, conceived of as parallel, partially overlapping information processing systems. At that time, I could think of only five (hypothetical) differences between the two kinds of memory. Some 10 years later, in 1983, I suggested that, despite the scarcity of the data, it seemed reasonable to hypothesize that episodic and semantic memories represented different functional systems. At that time, it was possible to list some 28 diagnostic features of the distinction. After that, further progress was made in evaluating these ideas, and in revising and modifying the nature of the distinction. Thus, I elaborated on the concept of a memory system, suggesting that different systems deal with different kinds of information, operate according to different principles, and are represented in the brain by different neural structures and mechanisms. I further proposed that (a) episodic memory is a unique extension of semantic memory, rather than a separate, parallel system, (b) episodic and semantic memory differ with respect to the kind of conscious awareness that accompanies their operations, and (c) the distinction is related to the broader problem of classification of learning and memory.[2]

As a result of these developments, one now finds in the literature two different, albeit related, uses of the term episodic memory, one referring to a type of information and type of experiment, and another to a hypothetical neurocognitive system that fits into a more comprehensive theory of organization of memory. This article is about the theory of episodic memory.

Endel Tulving is Tanenbaum Chair in Cognitive Neuroscience at Rotman Research Institute of Baycrest Centre and University Professor Emeritus in Psychology at University of Toronto. Address correspondence to Endel Tulving, Rotman Research Institute, Baycrest Centre for Geriatric Care, 3560 Bathurst St., North York, Ontario M6A 2E1, Canada; e-mail: tulving@psych.toronto.edu.

EPISODIC AND SEMANTIC MEMORY SYSTEMS

In a nutshell, the theory holds that episodic and semantic memory are two of the five major human memory systems for which reasonably adequate evidence is now available. The other three systems are procedural, perceptual representation, and short-term memory.[3] Although each system serves particular functions that other systems cannot serve (the so-called criterion of functional incompatibility[4]), several systems usually interact in the performance of tasks in everyday life as well as in the memory laboratory.

Semantic memory registers and stores knowledge about the world in the broadest sense and makes it available for retrieval. If a person knows something that is in principle describable in the propositional form, that something belongs to the domain of semantic memory. Semantic memory enables individuals to represent and mentally operate on situations, objects, and relations in the world that are not present to the senses: The owner of a semantic memory system can think about things that are not here now.

Episodic memory enables a person to remember personally experienced events as such. That is, it makes it possible for a person to be consciously aware of an earlier experience in a certain situation at a certain time. Thus, the information of episodic memory could be said to concern the self's experiences in subjective space and time. In contrast, the information of semantic memory processes concerns objects and their relations in the world at large. The owner of an episodic memory system is not only capable of remembering the temporal organization of otherwise unrelated events, but is also capable of mental time travel: Such a person can transport at will into the personal past, as well as into the future, a feat not possible for other kinds of memory.

The relation between episodic and semantic memory is hierarchical: Episodic memory has evolved out of, but many of its operations have remained dependent on, semantic memory. A corollary is that semantic memory can operate (store

and retrieve information) independently of episodic memory, but not vice versa. Episodic memory is not necessary for encoding and storing of information into semantic memory, although it may modulate such encoding and storage. Semantic memory develops earlier in childhood than episodic memory: Children are capable of learning facts of the world before they remember their own past experiences. Finally, whereas medial temporal lobe and diencephalic structures, among others, play a critical role in semantic memory, frontal lobe structures seem to be involved in subserving episodic memory.[5]

CONSCIOUS AWARENESS IN REMEMBERING

One idea that was not clearly articulated in the *Elements of Episodic Memory* concerned the nature of conscious awareness that accompanies the act of retrieval of information from the two systems. At that time, there was little objective evidence relevant to that problem. Some progress on this front has now been made, and I summarize some of it here.

The working hypothesis is that episodic and semantic memory differ fundamentally with respect to the nature of conscious awareness that accompanies retrieval of information. The act of remembering a personally experienced event, that is, consciously recollecting it, is characterized by a distinctive, unique awareness of reexperiencing here and now something that happened before, at another time and in another place. The awareness and its feeling-tone are intimately familiar to every normal human being. One seldom mistakes remembering for any other kind of experience—perceiving, imagining, dreaming, daydreaming, or just thinking about things one knows about the world.

I refer to the kind of conscious awareness that characterizes remembering one's past as *autonoetic* awareness, contrasting it with *noetic* awareness, which characterizes retrieval of information from semantic memory, and *anoetic* awareness, which accompanies expression of procedural knowledge.[6]

The relation between autonoetic and noetic awareness, on the one hand, and episodic and semantic memory, on the other hand, can be illustrated with material derived from observations of a densely amnesic individual. K.C. is a 40-year-old man who at the age of 30 had a motorcycle accident that damaged his brain highly selectively. His intellectual functions other than memory are quite normal: He has a large vocabulary and a vast store of factual information, he can read and write, he can identify pictures of objects and photographs of people he knows, he can play bridge and chess, and he can do most other things that any normal person does. At any time, he also remembers things that have happened to him in the last few minutes or so. He can describe his minutes-old recollections, and he is aware that he is remembering the very recent past. But he cannot remember, in the sense of bringing back to autonoetic awareness, a single thing that he did or experienced more than a few minutes before the present moment. He claims to have no recollections of happenings even when given detailed descriptions of some of the rather traumatic events from his life before or after he became amnesic (such as his brother's accidental death, the derailment of a train carrying deadly chemicals near his house, or a traffic accident that caused his jaw to be wired shut for a week).[7]

K.C. is fully conscious, noetically aware of the world and of himself. But he has no autonoetic consciousness, and no autonoetic awareness of any past happening. He can recall facts from his own past, and in that sense can be said to know them. For instance, he knows that he owned a car, and he knows its make and color. But he cannot remember a single trip he took in his car, in anyone else's car, or by any other means. We can say that his episodic memory system is wholly dysfunctional, and that this fact is reflected in his inability to consciously reexperience any of his earlier experiences in subjective space and time.

Despite his total inability to remember any happenings from his past, and his inability to remember any ongoing events for a period longer than a few minutes, K.C. is capable of learning some new factual information. This learning is spotty and unreliable, but it does occur. For instance, when we drive by the structure known to the whole world, or at least to the whole baseball world, as Toronto's Sky Dome—a structure built after K.C. became amnesic—he is familiar with it in the sense that he knows what it is and what its name is. Of course, when I ask him whether he has ever been inside, he says that he does not know; when I ask him, "When did you drive by here last time," he does not know; when I ask him whether he's ever seen it before, he says, "I guess so," and when I ask him to explain why he guesses so, he says, "Otherwise I would not know its name."

K.C.'s knowledge of things that he has learned, and his retention of newly learned semantic facts, has been documented more formally and objectively in several extensive studies in which he has been taught new (experimentally manufactured) "facts." Thus, he can answer questions that few other people can, such as "Who is so tall that he cannot see his own shoelaces?" The answer, "giraffe," is an unknown "fact of the world" that he was taught in one of our experiments. K.C.'s learning is much slower and more laborious than that of normal subjects, but it

does occur. Moreover, once he has learned a new fact, he retains it over many months, indistinguishably from normal subjects. In contrast to the retention of learned facts, he remembers nothing. The assertion that a person cannot remember any happening from his past, if remembering is defined narrowly, as it is in this article, can be proved wrong by identifying a single instance of the person remembering a happening. So far, attempts to identify such an instance with K.C. have failed.

The conclusion drawn from these formal experiments accords with the Sky Dome anecdote. Although K.C. cannot recollect anything autonoetically, his semantic memory capabilities, and his noetic awareness, are reasonably intact, and therefore he can recover information about the world acquired on particular occasions through his at least partly intact semantic memory system.

If K.C.'s semantic memory is reasonably intact, why does he learn new facts so much more slowly than do normal subjects? One plausible answer is that his semantic system is also damaged, although not as severely as his episodic system. Another idea that fits into the theory of episodic and semantic memory is that K.C. does not learn particularly slowly, but that normal people, because of their fully intact episodic memory systems, learn much more quickly. One possible reason for such facilitation is that episodic memory minimizes the effects of proactive and retroactive interference.[8] Future research will show which of these hypotheses, or which other hypothesis, is closest to the truth.

"REMEMBER" AND "KNOW" JUDGMENTS

If amnesics can learn new facts and subsequently know them, in the absence of any autonoetic recollection of the sources of the facts, is it possible that normal people, too, know facts without remembering where or how they acquired them? Of course, it happens all the time. Every person knows hundreds and thousands of facts, without remembering the circumstances of their acquisition. This *source amnesia* that characterizes the learning in hypnotized people and amnesics, as well as older people, is well known to all of us. The phenomenon is simply more extreme in some of these special cases than in normal adults.

Gardiner and his collaborators have reported a number of studies on remembering versus knowing newly learned information in normal people.[9] The interesting feature of these studies is that the information in question is something that is usually associated with episodic memory, namely, occurrence of familiar words in a to-be-remembered list tested by recognition. In a typical experiment, subjects see a list of unrelated words, presented one at a time, on a single study trial, and then take a two-step test. In the test, they are shown both studied and nonstudied words and are asked to make a judgment about each word's presence in or absence from the study list and to indicate the basis of each positive recognition judgment.

Subjects are instructed that there are two ways in which they can tell that a word was in the study list: They either "remember" the event of the word's presentation in the study list or simply "know" on some basis that the item had appeared in the list, without remembering its occurrence.

In one experiment, for example, subjects studied a list of words under the conditions of either full or divided attention and were then tested as described. Division of attention reduced the proportion of "remembered" words (.50 vs. .38) but did not affect the proportion of words "known" to have been in the list (.21 vs. .20). Other experiments have examined the effect of other variables, such as levels of processing, generating versus reading the word at study, retention interval, word frequency, and age of subjects. These too have produced dissociations between the "remember" and "know" components of recognition memory. Yet other studies—done on brain-damaged subjects, or using psychoactive drugs, or recording event-related potentials—have begun to identify some of the neural correlates of "remember" and "know" judgments.[10]

There are other approaches to the study of awareness of source of information,[11] and correspondingly different ways of interpreting these experiments and their results. I prefer the hypothesis that "remember" judgments, based on autonoetic awareness, reflect the operation of the episodic system, whereas "know" judgments, based on noetic awareness, reflect the operation of the semantic system. Thus, subjects have two sources of information concerning the membership of words in a study list—episodic and semantic memory. When they retrieve this information from semantic memory, they appear to suffer source amnesia: They do not remember the particular event of encountering the word. In amnesic patients, such as K.C., the source amnesia is more extensive, covering not just encounters with individual words, but personal encounters of all kinds.

CONCLUSION

Episodic memory is a neurocognitive memory system that enables people to remember past happenings. The *remembering* in this proposition is not a generic term designating all kinds of retrieval of stored information, but rather a specific concept that designates retrieval from episodic memory. For a rememberer to remember something

means that he or she is autonoetically aware of a past happening in which he or she has participated. For an experimenter or theorist to study episodic memory means to study autonoetic awareness of past experiences, separately from noetic retrieval of the semantic contents of the remembered episodes. This is a 1993 view of episodic memory. It is different from but related to the earlier ideas expressed in 1972 and 1983. It reflects the progress in our understanding of the human brain-mind, based on methods, approaches, paradigms, findings, and insights we did not yet have 10 or 20 years ago.

Acknowledgments—The author's research is supported by the Natural Sciences and Engineering Research Council of Canada, Grant A8632.

Notes

1. H.L. Roediger, III, M.S. Weldon, and B.H. Challis, Explaining dissociations between implicit and explicit measures of retention: A processing account, in *Varieties of Memory and Consciousness: Essays in Honour of Endel Tulving*, H.L. Roediger, III, and F.I.M. Craik, Eds. (Erlbaum, Hillsdale, NJ, 1989); M.S. Humphreys, J.D. Bain, and R. Pike, Different ways to cue a coherent memory system: A theory for episodic, semantic, and procedural tasks, *Psychological Review, 96,* 208–233 (1989).

2. E. Tulving, Episodic and semantic memory, in *Organization of Memory,* E. Tulving and W. Donaldson, Eds. (Academic Press, New York, 1972); E. Tulving, *Elements of Episodic Memory* (Clarendon Press, Oxford, 1983); E. Tulving, Multiple learning and memory systems, in *Psychology in the 1990's,* K.M.J. Lagerspetz and P. Niemi, Eds. (Elsevier Science Publishers, North Holland, 1984); E. Tulving, How many memory systems are there? *American Psychologist, 40,* 385–398 (1985).

3. E. Tulving, Concepts of human memory, in *Memory: Organization and Locus of Change,* L.R. Squire, N.M. Weinberger, G. Lynch, and J.L. McGaugh, Eds. (Oxford University Press, New York, 1991).

4. D.F. Sherry and D.L. Schacter, The evolution of multiple memory systems, *Psychological Review, 94,* 439–454 (1987).

5. E. Tulving, Memory: Performance, knowledge, and experience, *European Journal of Cognitive Psychology, 1,* 3–26 (1989); A.P. Shimamura, J.J. Janowsky, and L.R. Squire, Memory for the temporal order of events in patients with frontal lobe lesions and amnesic patients, *Neuropsychologia, 28,* 803–813 (1990).

6. E. Tulving, Varieties of consciousness and levels of awareness in memory, in *Attention: Selection, Awareness and Control: A Tribute to Donald Broadbent,* A. Baddeley and L. Weiskrantz, Eds. (Oxford University Press, London, in press).

7. E. Tulving, C.A.G. Hayman, and C.A. Macdonald, Long-lasting perceptual priming and semantic learning in amnesia: A case experiment, *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 595–617 (1991); C.A.G. Hayman, C.A. Macdonald, and E. Tulving, *The role of repetition and associative interference in new semantic learning in amnesia,* manuscript submitted for publication (1993).

8. A.P. Shimamura and L.R. Squire, A neuropsychological study of fact memory and source amnesia, *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 464–473 (1987); F.I.M. Craik, L.W. Morris, R.G. Morris, and E.R. Loewen, Relations between source amnesia and frontal lobe functioning in older adults, *Psychology and Aging, 5,* 148–151 (1990).

9. J.M. Gardiner and R.I. Java, Recognizing and remembering, in *Theories of Memory,* A. Collins, M. Conway, S. Gathercole, and P. Morris, Eds. (Erlbaum, Hillsdale, NJ, in press).

10. H.V. Curran, J.M. Gardiner, R.I. Java, and D. Allen, Effects of lorazepam upon recollective experience in recognition memory, *Psychopharmacology, 110,* 374–378 (1993); M.E. Smith, Neurophysiological manifestations of recollective experience during recognition memory judgments, *Journal of Cognitive Neuroscience, 5,* 1–13 (1993); T.A. Blaxton, *The role of temporal lobes in remembering visuospatial materials: Remembering and knowing,* manuscript submitted for publication (1993).

11. G. Mandler, P. Graf, and D. Kraft, Activation and elaboration effects in recognition and word priming, *The Quarterly Journal of Experimental Psychology, 38A,* 645–662 (1986); L.L. Jacoby, A process dissociation framework: Separating automatic from intentional uses of memory, *Journal of Memory and Language, 30,* 513–541 (1991); M.K. Johnson and W. Hirst, MEM: Memory subsystems as processes, in *Theories of Memory,* A. Collins, M. Conway, S. Gathercole, and P. Morris, Eds. (Erlbaum, Hillsdale, NJ, in press).

Predicting the Strength of a Conditioned Reinforcer: Effects of Delay and Uncertainty

James E. Mazur

A conditioned reinforcer is a stimulus that has acquired the ability to strengthen behavior because it has been associated with a primary reinforcer. For example, if a light is repeatedly followed by food, the light will become a conditioned reinforcer, and it can then be used to strengthen any operant response upon which it is made contingent. For decades, psychologists have studied factors that affect the strength of a conditioned reinforcer. Among the relevant factors are the number of times the conditioned reinforcer has been paired with a primary reinforcer, the size and quality of the primary reinforcer, and the delay between the conditioned reinforcer and the delivery of the primary reinforcer.[1]

In recent years, conditioned reinforcers have been studied using choice procedures in which subjects must choose between two or more alternatives. The literature on this topic has become so extensive that not even a brief survey of the main findings is possible here. Chapters by Fantino[2] and Williams[3] provide useful overviews. This review focuses on two variables that play crucial roles in determining the strength of a conditioned reinforcer—delay and probability. Recent studies by myself and others have helped to define the roles of these variables more precisely than has been possible previously. To explain these developments, I must first describe my research on how subjects choose

James E. Mazur is an Associate Professor at Southern Connecticut State University, where he does research on operant conditioning and choice. Address correspondence to James E. Mazur, Psychology Department, Southern Connecticut State University, New Haven, CT 06515.