Remediation of organic memory disorders: current status and future prospects

Elizabeth L. Glisky, PhD
Research Fellow
University of Toronto

Daniel L. Schacter, PhD
Assistant Professor
Unit for Memory Disorders
Department of Psychology
University of Toronto
Toronto, Ontario, Canada

MEMORY IMPAIRMENT is often one of the most debilitating deficits following closed-head injury.[1,2] It can affect all aspects of the rehabilitation process and can seriously disrupt an individual's ability to regain even the most basic functions of everyday living. Because of recent improvements in emergency medical care, increased numbers of people are surviving closed-head injury, and thus effective rehabilitative techniques—particularly those concerned with mnemonic function—are in increasing demand. In the past ten years, greater research activity has explored how various mnemonic techniques may be used to benefit different memory-impaired populations, including closed-head injury patients. Although the amount of research has been considerable, the results of the studies have not always been encouraging, and no clearcut formula for memory remediation has emerged. However, recent theoretical research concerning the nature of organic memory disorders has revealed that some learning abilities appear to be spared in even severely amnesic patients. These findings are beginning to provide a foundation for the

J Head Trauma Rehabil 1986; 1(3):54–63

development of new rehabilitation techniques.

In this article, the literature on memory remediation is summarized, and a number of conclusions are drawn about the effectiveness of various approaches. It is argued that (1) attempts to restore memory function with repetitive drills or exercise are unlikely to succeed, (2) mnemonic strategies have limited application and may be useful only for mildly and moderately impaired patients, and (3) external memory aids have the potential to serve as useful cuing devices, but patients must be trained to use them effectively. A new approach to memory remediation is then outlined. This approach focuses on the acquisition of domain-specific knowledge[3] and attempts to make use of patients' preserved learning abilities to teach them specific knowledge and skills. Research is described to illustrate several features of this approach. Finally, some ways in which the microcomputer may be able to overcome some of the problems encountered previously with external memory devices are suggested.

METHODS OF MEMORY REMEDIATION

Existing approaches to memory remediation can be divided into three main categories: (1) practice and exercise drills, (2) strategy learning, and (3) external aids. The bulk of the experimental work has been on the teaching and use of mnemonic strategies. The other two methods, however, are much in evidence in clinical and rehabilitation settings.

Practice and exercise drills

The notion that a damaged memory can be restored or improved in some general sense through practice or repetitive drills continues to persist among many workers in rehabilitation settings, despite the complete lack of empirical evidence that such general improvements ever occur. In a survey of British rehabilitation services, Harris and Sunderland[4] found widespread use of exercise regimens to strengthen memory, as if memory were some kind of "mental muscle." Similarly, in North America there are, among cognitive and memory therapists, many proponents of drill-oriented interventions. In recent years, with the appearance of the microcomputer in rehabilitation contexts, practice and exercise drills have become perhaps even more popular; they are easy to administer and use of a computer frees therapists for other duties. Typical memory-retraining packages require patients to try to remember letters, digits, words, shapes, or locations on a computer screen. The materials used often have no real-world relevance and learning them typically has no obvious practical value. The purpose of such drills would thus appear to be the general restoration or improvement of memory function.

Although there is evidence that memory-impaired patients can learn some specific pieces of information through repeated practice, there is no evidence that such practice improves memory for any other materials; that is, training does not appear to generalize to other situations, tasks, or stimuli.[5–8] Even with concentrated practice sessions over long periods of time, significant benefits of drilling on overall memory performance have not been found.[9] (See Schacter and Glisky[3] for a more detailed review.)

In view of the fact that careful experimental work has failed to produce any evidence that repetitive practice or drills yield general improvements in memory function, there is no reason to expect that computerized presentation of training materials will produce positive outcomes. The computer is merely a convenient and time-saving device that simplifies stimulus delivery and data collection. It has no inherent therapeutic powers (cf O'Connor and Cermak[10]). If the goal of a retraining program is to restore memory function through the use of repetitive practice or drills, all available evidence indicates that it will have little or no chance of success, whether the service is administered by computer or otherwise.

Mnemonic strategies

The most commonly used and most thoroughly researched mnemonic strategy is the ancient technique of visual imagery.[11] Numerous studies with normal subjects have demonstrated the memorial advantages of constructing visual images of to-be-remembered material.[12,13] Not surprisingly, visual imagery has also been the most popular strategy attempted in the rehabilitation of memory-impaired patients.[3,10] The results of these investigations, however, have been somewhat mixed. Some patients seem able to benefit from imagery techniques under some conditions;[7,14–21] others, however, particularly those with severe memory deficits, do not.[16,22–26] Moreover, there is as yet no evidence that memory-impaired patients can learn a visual imagery mnemonic and subsequently use it spontaneously without instructions to do so. Nor is there any evidence that patients later use such strategies in their everyday lives. On the contrary, several studies have demonstrated that patients with memory deficits do not maintain or generalize imagery strategies even within the laboratory.[14,16,20,21]

There are at least two reasons why brain-injured patients are unlikely to use imagery mnemonics spontaneously. First, there are only a limited number of opportunities outside the laboratory to employ the technique. Many everyday memory problems do not present themselves in the form of paired associates, which are the materials most often used in laboratory training. Difficulties therefore arise in determining exactly which situations lend themselves to the use of imagery. Perhaps this is the reason why Harris[27] has found that visual imagery is seldom used even by normal adults. Second, imagery mnemonics are often difficult to learn; considerable memory ability may be involved in acquisition of the mnemonic itself, and subsequent application of the strategy requires much effortful and elaborate processing.[28] The cognitive demands and limited practical usefulness of visual imagery make it unlikely that teaching this technique will significantly improve the overall functioning of brain-injured patients.

Many of the same problems limit the general effectiveness of other mnemonic strategies. Verbal organization strategies, such as first-letter mnemonics[7,14] and semantic elaboration techniques, such as the chaining of to-be-remembered words into a story,[15,16,19,29] also tend to be resource-demanding, and although they have been used successfully to teach specific pieces of information to some memory-impaired patients, little evidence exists that patients use these strategies spontaneously. Even with simpler strategies, evidence of maintenance and generalization is weak. In a study[30] that investigated the effectiveness of a simple rehearsal technique known as spaced retrieval,[31] some evidence of strategy maintenance by two of four patients on a face-name association task was found. However, there was no evidence of continued use of the strategy outside the laboratory.

Available data thus suggest that general benefits associated with the teaching of mnemonic strategies are somewhat limited. Learned strategies are not readily applied in multiple contexts, and their acquisition does not lead to improvements in memory performance on other tasks or in general memory function. However, much of the research in this area has focused on patients with severe memory deficits. It is possible that more significant improvements may be obtained for patients with milder disorders. We know, for example, that mildly or moderately impaired patients can acquire new information, such as people's names, through use of mnemonic techniques; so such strategies are clearly useful for teaching information that is important to patients' everyday functioning. Even in cases of mild-memory disorders, however, it remains to be demonstrated empirically that patients can use mnemonic techniques beneficially in everyday life.

External aids

Several investigators have recently adopted another approach to memory remediation. Rather than attempting to restore memory function, they have attempted to discover ways to alleviate specific problems in patients' everyday lives that arise as a consequence of memory dysfunction. The approach most commonly taken to reduce the impact of memory disorders on daily living has been the use of external memory aids.[32–34] Several types of aids have been suggested: (1) storage devices such as diaries, notebooks, lists, calculators, and computers; (2) cuing devices such as alarm watches and bell timers; and (3) structured environments that reduce memory load such as labeled cupboards and drawers. Although many of these aids have been introduced to brain-injured patients in rehabilitation settings, there has as yet been little systematic investigation of their use and effectiveness.

Most of the external aids that have been suggested for use with head-injured patients fall at least partly into the category of cuing devices. Notebooks and lists, for example, are used not only to store information but also to provide prompts and cues for future actions, such as appointments to be kept and things to be done. However, little research is available that indicates the most effective ways of deploying notebooks or how to train patients to use them. More generally, little is known about what has been termed "prospective remembering"[35–37]—remembering to perform future actions for which there are no obvious external cues.[38] As opposed to retrospective memory (ie, recall of the past), about which a great deal is known, prospective memory, despite being an essential component of daily living activities, has received scant attention from experimental psychologists and neuropsychologists.[38–41] Consequently, relatively little is known about how people remember to do things.

Current evidence shows that normal adults and children frequently prefer external retrieval cues to cognitive strategies for prospective remembering[27,37,42] and that even an arbitrary cue such as the proverbial string around the finger facilitates memory for a future action.[36,43] However, such nonspecific cues, which serve as reminders to search memory, clearly will not be effective for impaired patients who typically lack the ability to use active search or retrieval processes to remember recent events.[44–46]

Evidence from the developmental literature[47] may also be relevant. Young children have difficulty discriminating between good and poor cues for future actions, particularly if the cue and the action are separated in time. Beal[47] has suggested that children may be unable to adopt a future perspective and therefore do not appreciate the specificity that a cue must have to be informative in the future as compared with the present. As yet little is known about memory-impaired persons' abilities to prepare for future behavior (cf Tulving[48]), but it seems reasonable to assume that they also may have difficulty evaluating the future informativeness of a retrieval cue.

Harris[27] has proposed that for a cue to be beneficial to patients with memory deficits, it should be (1) given close to the time of the required action, (2) an active rather than a passive cue (eg, an alarm v a reminder in a book), and (3) specific. The problem, as Harris points out, is that most external-memory aids do not possess all of these features. A notebook, for instance, must be consulted regularly to be useful and when consulted should contain sufficient information to make the notations meaningful. Patients who come to our laboratory with notebooks rarely consult them, and when asked about information written in their books, they often cannot remember what it means. Their notes (or cues) do not contain sufficient detail or specificity to be useful, although patients may have thought that the cues provided sufficient information when they recorded them. (See Beal[47] for similar observations with young children.) Even mildly impaired patients who use notebooks regularly often have a confusing collection of messages that they fail to keep current.

These observations imply that the use of an external aid, even an apparently simple one such as a notebook, may require special training. It may be necessary to give patients explicit instructions concerning how to construct specific, effective external cues that are readily accessible. In the only work that we know that has attempted to address this problem (M.M. Sohlberg, personal communication, 1985), it was found that lengthy training was necessary before an amnesic patient could use a notebook proficiently. Research is needed to explore methods that could improve the efficiency of external aids. In view of the possible beneficial effects of external aids on patients' ability to function independently in the real world, continued efforts in this direction are warranted.

The external aid that may have the greatest potential for use by memory-impaired patients is the microcomputer. With its ability to store large amounts of information, a computer could function as an artificial memory capable of producing on-demand information, instructions, and reminders about all aspects of daily living.[32,49–53] For example, Kirsch et al[53] have reported some preliminary research in which a microcomputer was used successfully to instruct an amnesic patient on how to bake cookies—a task the patient could not accomplish correctly without the computer's assistance. The potential of the microcomputer in memory rehabilitation, however, remains largely untapped. One of the difficulties experienced by patients attempting to use a microcomputer has been their inability to remember the basic operating procedures, such as how to enter a message and how to clear the display screen.[33] These sorts of problems have so far limited the effectiveness of computers as aids for patients with memory deficits. However, the present authors' recent research, which is discussed in the next section, has provided reason for some optimism regarding the eventual use of microcomputers by memory-impaired patients.

ACQUISITION OF DOMAIN-SPECIFIC KNOWLEDGE

An alternative approach to memory remediation focuses on the acquisition of domain-specific knowledge: knowledge relevant to a particular task or function that is important to a patient's everyday life.[3] The approach differs from the previously outlined approaches in the following ways:

1. Whereas the goal of much of the work with repetitive drills and mnemonic strategies has been to restore memory function in some general sense, the goal here is to alleviate specific problems associated with memory impairment.
2. Although the procedures also involve repetitive practice, the information that is acquired across learning trials has practical value, unlike much of the meaningless material that is used with traditional drill therapies.
3. The purpose is similar to that of the external-aid proponents—to deal with specific problems that impact on daily living—but the methods are somewhat

different. Rather than simply providing external devices to serve as aids to everyday living, procedures are designed to teach requisite skills and knowledge that will allow patients to handle some of these problems on their own.

Several studies have demonstrated that patients with memory deficits can acquire discrete pieces of information important to their daily functioning, such as names of people in their environments[7,18,21,54,55] and behaviors appropriate to home or hospital.[7,54,56,57] Other research has revealed that some perceptual, motor, and cognitive skills can be acquired by memory-impaired patients, often without any recollection of the occasion of learning.[5,58,59] There is now, therefore, little doubt that even the most severely impaired patients have some preserved learning abilities. (See Nissen, this issue.) However, most of the information and skills that patients have been able to acquire have been simple and often unrelated to problems of everyday living. It was thus of interest to explore whether memory-impaired patients could acquire more complex forms of knowledge that might have important consequences for their daily lives.

The domain of knowledge chosen for investigation was that relating to the understanding and use of a microcomputer. As outlined previously, the computer has great potential to serve as a prosthetic device for patients with memory deficits; but if that potential is to be realized, patients must first be able to learn some simple operating procedures.

A research program therefore was initiated with the goal of teaching memory-impaired patients some basic computer concepts and some fundamental computer operations. A training technique was developed that was designed to tap patients' preserved-memory abilities, specifically the ability to produce previously studied material in response to fragment cues. Numerous studies have shown that even after only a single prior presentation of a word (eg, CHAIR) amnesic patients, like normal subjects, show an enhanced tendency to produce that word on a fragment completion test (eg, CHA__), even though they may have no explicit memory of the prior presentation.[46,60,61] The teaching technique, the method of vanishing cues,[62] attempts to exploit this preserved ability by presenting fragment cues of target responses and then gradually withdrawing letters from the fragment across learning trials.

In an initial study[62] it was found that four patients (three head injury, one encephalitic) with varying degrees of memory impairment could acquire and retain across a six-week retention interval a small vocabulary (20 to 30 words) of computer-related terms. A second study[63] explored whether patients could learn to use their acquired computer knowledge in the actual operation of an Apple IIe microcomputer.

A series of three computer lessons of increasing complexity was constructed. These lessions required the users to interact independently with the computer and to perform a variety of computer operations. Four head-injured patients, with a range of severity of memory deficits, comprised the initial experimental group. The training technique was a modified version of the method of vanishing cues in which first letters of target words were used as cues. All patients successfully completed the three lessons, at which time they were able to use a total of nine different computer commands: They could display messages on the screen, clear the display, perform a variety of disk-storage and retrieval operations, and write and edit simple programs. Even the most densely amnesic head-injured patient, who denies ever having worked on a computer before and remembers none of his more than 100 visits to the laboratory, nevertheless could manage all of these basic procedures. In addition, all patients reported that they enjoyed learning by the method of vanishing cues. The procedure eliminates many of the frustrations inherent in more standard teaching methods, and patients are always eager to participate.

These findings suggest that patients with severe memory disorders can acquire more complex forms of knowledge than was previously thought, and also lend some credence to the notion that patients may be able to use a microcomputer as an external-memory aid to facilitate their daily functioning. However, there are problems yet to be resolved. Teaching the fundamentals of computer operation to patients with memory disorders is not an easy task. Many repetitions are required before error-free performance is attained. Further, the knowledge acquired by patients seems to be qualitatively different from that acquired by normal subjects. Patients' learning seems "hyperspecific"—extremely bound to the stimulus characteristics of the training situation (see Glisky et al[63]). Before one can be confident that this training will have any practical benefits, it will have to be demonstrated that the computer knowledge acquired in the laboratory can be applied in real-world contexts.

However, the potential benefits are numerous. As discussed above, many of the difficulties experienced by memory-impaired patients in the use of external aids such as notebooks and lists arise from a failure to consult the aid on a regular basis, a failure to make messages specific enough to be meaningful, and a failure to develop appropriate organizational schemes during storage or retrieval of information. A microcomputer may help to overcome some of these problems. Although it is not certain, there seems little reason to doubt that patients could be trained to consult a microcomputer in their home on a regular basis, just as they learned to do in the laboratory. The computer, of course, can also call attention to itself through the use of audio signals, a feature that could be useful for cuing actions when timing is crucial.[53]

Further, the computer has the capability to teach the user how to use it, so that patients could be prompted for detail and specificity when typing cues or reminders for future reference. Such a feature could ensure that prospective retrieval cues are meaningful to patients at the time when they are consulted. Finally, the computer can impose an organizational framework during both storage and retrieval of information so that patients' access to wanted information can become more efficient. Although these ideas have yet to be tested systematically, it is expected that, with practice, patients could become quite proficient at using the computer in this way. The next step of the research program will explore some of the possibilities for home use of a microcomputer.

More general and perhaps immediately applicable implications of these research findings stem from the effectiveness of the method of vanishing cues as a technique for teaching domain-specific knowledge. Although the acquisition of knowledge in a variety of domains has not yet been demonstrated, it has been found that even the learning of unrelated paired associates, a task on which memory-impaired patients show severe deficits, is facilitated by use of the vanishing cues procedure. Further, the technique has been used successfully with patients of various etiologies (eg, head injury, encephalitis, anterior communicating artery aneurysm, anoxia), with patients whose memory deficits range from mild to severe, and with patients who do and do not have accompanying cognitive deficits. It seems, therefore, that the technique can be applied broadly.

One important area in which application of these procedures could have a significant impact on patients' everyday lives is that of vocational training. Many people with memory deficits are unable to obtain employment because of their inability to remember the operations involved even in simple jobs. However, this research suggests that with the use of an effective technique such as the method of vanishing cues, memory-impaired patients can acquire some new knowledge and skills. Although there appear to be no studies concerning vocational training for patients with severe memory deficits, literature relating to the vocational rehabilitation of severely mentally retarded persons (for review see Wacker and Hoffmann[64]) provides some clues concerning potentially effective training procedures. The technique that has been used most successfully is a task analysis procedure whereby complex vocational tasks are broken down into their component subtasks and skills, and each component is taught separately and in its proper sequence. Training applies to a specific skill that is to be used in a specific context; generalization is of no concern. For this reason it is necessary to know the exact nature of a job for training to be beneficial; training in general work skills is unlikely to be of any value. This task analysis procedure, in combination with the method of vanishing cues, may be an appropriate technique for vocational training of memory-impaired patients and represents another important area for future research efforts.

• • •

Systematic investigation of memory remediation in brain-injured patients was initiated little more than a decade ago. It is therefore not surprising that existing research can provide few clear solutions to the problems faced by those who work with memory-disordered patients in clinical and everyday settings. Unfortunately, with the sudden popularity of catch phrases such as "cognitive rehabilitation" and the corresponding appearance of seductive computerized-training programs that claim to "retrain" memory, many present clinical applications go far beyond existing scientific knowledge. It is important for clinicians and practitioners to adopt an attitude of caution regarding memory-retraining packages that are available commercially and that they inquire critically about the scientific basis of any such program before committing patient and therapist time to it.

Despite the skepticism regarding some of the current trends in memory remediation, a number of the basic concepts and experimental tools are now available that should facilitate substantial advances in knowledge and application during the coming years.

REFERENCES

1. Levin HS, Benton AL, Grossman RG: *Neurobehavioral Consequences of Closed Head Injury.* New York, Oxford Univ. Press, 1982.
2. Schacter DL, Crovitz HF: Memory function after closed head injury: A review of the quantitative research. *Cortex* 1977;13:150–176.
3. Schacter DL, Glisky EL: Memory remediation: Restoration, alleviation, and the acquisition of domain-specific knowledge, in Uzzell B, Gross Y (eds): *Clinical Neuropsychology of Intervention.* Boston, Martinus Nijhoff, 1986.
4. Harris JE, Sunderland A: A brief survey of the management of memory disorders in rehabilitation units in Britain. *Int Rehabil Med* 1981;3:206–209.
5. Brooks DN, Baddeley AD: What can amnesic patients learn? *Neuropsychologia* 1976;14:111–122.
6. Godfrey HPD, Knight RG: Cognitive rehabilitation of memory functioning in amnesiac alcoholics. *J Consult Clin Psychol* 1985;53:555–557.
7. Wilson B: Success and failure in memory training following a cerebral vascular accident. *Cortex* 1982;18:581–594.
8. Woods RT: Specificity of learning in reality-orientation sessions: A single case study. *Behav Res Ther* 1983;21:173–175.

9. Prigatano GP, Fordyce DJ, Zeiner HK, et al: Neuropsychological rehabilitation after closed head injury in young adults. *J Neurol Neurosurg Psychiatry* 1984;47:505–513.
10. O'Connor M, Cermak LS: Rehabilitation of organic memory disorders, in Meier M, Diller L, Benton A (eds): *Neuropsychological Rehabilitation.* New York, Guilford Press, to be published.
11. Yates F: *The Art of Memory.* Chicago, University of Chicago Press, 1966.
12. Bower GH: Analysis of mnemonic device. *Am Sci* 1970;58:496–510.
13. Paivio A: Mental imagery in associative learning and memory. *Psychol Rev* 1969;76:241–263.
14. Cermak LS: Imagery as an aid to retrieval for Korsakoff patients. *Cortex* 1975;11:163–169.
15. Crovitz HF: Memory retraining in brain-damaged patients: The airplane list. *Cortex* 1979;15:131–134.
16. Crovitz HF, Harvey MT, Horn RW: Problems in the acquisition of imagery mnemonics: Three brain-damaged cases. *Cortex* 1979;15:225–234.
17. Gasparrini B, Satz P: A treatment for memory problems in left hemisphere CVA patients. *J Clin Neuropsychol* 1979;1:137–150.
18. Glasgow RE, Zeiss RA, Barrera M, Lewinsohn PM: Case studies on remediating memory deficits in brain-damaged individuals. *J Clin Psychol* 1977;33:1049–1054.
19. Kovner R, Mattis S, Goldmeier E: A technique for promoting robust free recall in chronic organic amnesia. *J Clin Neuropsychol* 1983;5:65–71.
20. Lewinsohn PM, Danaher BG, Kikel S: Visual imagery as a mnemonic aid for brain-damaged persons. *J Consult Clin Psychol* 1977;45:717–723.
21. Wilson B: Teaching a patient to remember people's names after removal of a left temporal tumor. *Behav Psychother* 1981;9:338–344.
22. Baddeley AD, Warrington EK: Memory coding and amnesia. *Neuropsychologia* 1973;11:159–165.
23. Cutting J: Patterns of performance in amnesic subjects. *J Neurol Neurosurg Psychiatry* 1978;41:278–282.
24. Jones M: Imagery as a mnemonic aid after left temporal lobectomy: Contrast between material specific and generalized memory disorders. *Neuropsychologia* 1974;12:21–30.
25. Jones-Gotman MK, Milner B: Right temporal lobe contribution to image mediated verbal learning. *Neuropsychologia* 1978;16:61–71.
26. Patten BM: The ancient art of memory. *Arch Neurol* 1972;26:25–31.
27. Harris JE: External memory aids, in Gruneberg MM, Morris P, Sykes R (eds): *Practical aspects of memory.* London, Academic Press, 1978.
28. Cermak LS: Imagery and mnemonic training, in Poon LW, Fozard JL, Cermak LS, et al (eds): *New Directions in Memory and Aging.* Hillsdale, NJ, Erlbaum, 1980.
29. Gianutsos R, Gianutsos J: Rehabilitating the verbal recall of brain-damaged patients by mnemonic training: An experimental demonstration using single-case methodology. *J Clin Neuropsychol* 1979;1:117–135.
30. Schacter DL, Rich SA, Stampp MS: Remediation of memory disorders: Experimental evaluation of the spaced-retrieval technique. *J Clin Exp Neuropsychol* 1985;7:79–96.
31. Landauer RK, Bjork RA: Optimum rehearsal patterns and name learning, in Gruneberg MM, Morris PE, Sykes RN (eds): *Practical Aspects of Memory.* New York, Academic Press, 1978.
32. Harris J: Methods of improving memory, in Wilson BA, Moffat N (eds): *Clinical Management of Memory Problems.* Rockville, MD, Aspen, 1984.
33. Wilson B, Moffat N: Rehabilitation of memory for everyday life, in Harris JE, Morris P (eds): *Everyday Memory: Actions and Absentmindedness.* London, Academic Press, 1984.
34. Gouvier W: Using the digital alarm chronograph in memory retraining. *Behav Engineer* 1982;7:134.
35. Meacham JA, Columbo JA: External retrieval cues facilitate prospective remembering in children. *J Educ Res* 1980;73:299–301.
36. Meacham JA, Leiman B: Remembering to perform future actions, in Neisser U (ed): *Remembering in Natural Contexts.* San Francisco, Freeman & Co, 1982.
37. Meacham JA, Singer J: Incentive effects in prospective remembering. *J Psychol* 1977;97:191–197.
38. Harris JE: Remembering to do things: A forgotten topic, in Harris JE, Morris PE (eds): *Everyday Memory, Actions and Absentmindedness.* London, Academic Press, 1984.
39. Baddeley AD, Wilkins A: Taking memory out of the laboratory, in Harris JE, Morris PE (eds): *Everyday Memory, Actions and Absentmindedness.* London, Academic Press, 1984.

40. Harris JE, Wilkins AJ: Remembering to do things: A theoretical framework and an illustrative experiment. *Hum Learn* 1982;1:123–136.
41. Pajurkova EM, Wilkins AJ: Prospective remembering in patients with unilateral temporal or frontal lobectomies. Read before the Sixth European Conference of the International Neuropsychological Society, Lisbon, Portugal, June, 1983.
42. Kreutzer MA, Leonard C, Flavell JH: Prospective remembering in children, in Neisser U (ed): *Remembering in Natural Contexts.* San Francisco, Freeman & Co, 1982.
43. Meacham JA: A note on remembering to execute planned actions. *J Appl Dev Psychol* 1982;3:121–133.
44. Baddeley AD: Amnesia: A minimal model and an interpretation, in Cermak LS (ed): *Human Memory and Amnesia.* Hillsdale, NJ, Erlbaum, 1982.
45. Jacoby L: Incidental vs. intentional retrieval: Remembering and awareness as separate issues, in Squire LR, Butters N (eds): *Neuropsychology of Memory.* New York, Guilford Press, 1984.
46. Schacter DL: Priming of old and new knowledge in amnesic patients and normal subjects. *Ann NY Acad Sci* 1985;444:41–53.
47. Beal CA: Development of knowledge about the use of cues to aid prospective retrieval. *Child Dev* 1985;56:631–642.
48. Tulving E: Memory and consciousness. *Can Psychol* 1985;26:1–12.
49. Jones GH, Adam JH: Towards a prosthetic memory. *Bull Br Psychol Soc* 1979;32:165–167.
50. Skilbeck C: Computer assistance in the management of memory and cognitive impairment, in Wilson BA, Moffat N (eds): *Clinical Management of Memory Problems.* Rockville, MD, Aspen Publishers, 1984.
51. Furst CJ: Utility of a computer prosthesis for impaired intention memory. Read before the American Psychological Association, Toronto, Canada, August, 1984.
52. Vanderheiden GC: The practical use of microcomputers in rehabilitation. *Bull Prosthet Res* 1982;19:1–5.
53. Kirsch NL, Levine SP, Fallon-Krueger M, et al: The microcomputer as an orthotic device for patients with cognitive limitations. Read before the American Congress of Rehabilitation, Boston, Mass, 1984.
54. Dolan MP, Norton JC: A programmed training technique that uses reinforcement to facilitate acquisition and retention in brain-damaged patients. *J Clin Psychol* 1977;33:496–501.
55. Jaffe PG, Katz AN: Attenuating anterograde amnesia in Korsakoff's psychosis. *J Abnorm Psychol* 1975;34:559–562.
56. Cermak LS: The encoding capacity of a patient with amnesia due to encephalitis. *Neuropsychologia* 1976;14:311–326.
57. Seidel H, Hodgkinson PE: Behavior modification and long-term learning in Korsakoff's psychosis. *Nurs Times* 1979;75:1855–1857.
58. Cohen NJ, Squire LR: Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of "knowing how" and "knowing that." *Science* 1980;210:207–209.
59. Moscovitch M: Multiple dissociations of function in amnesia, in Cermak LS (ed): *Human Memory and Amnesia.* Hillsdale, NJ, Erlbaum, 1982, pp 337–370.
60. Graf P, Squire LR, Mandler G: The information that amnesic patients do not forget. *J Exp Psychol: Learn Mem Cog* 1984;10:164–178.
61. Warrington EK, Weiskrantz L: The effect of prior learning on subsequent retention in amnesic patients. *Neuropsychologia* 1974;12:419–428.
62. Glisky EL, Schacter DL, Tulving E: Learning and retention of computer-related vocabulary in memory-impaired patients: Method of vanishing cues. *J Clin Exp Neuropsychol,* to be published.
63. Glisky EL, Schacter DL, Tulving E: Computer learning by memory-impaired patients: Acquisition and retention of complex knowledge. *Neuropsychologia,* to be published.
64. Wacker DP, Hoffmann RC: Vocational rehabilitation of severely handicapped persons, in Charles CJ (ed): *Current Topics in Rehabilitation Psychology.* Orlando, Fla, Grune & Stratton, 1984.