

# Acquisition of Domain-Specific Knowledge in Patients with Organic Memory Disorders

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*Patients with organic memory disorders are typically unable to acquire and retain new information and are therefore often unable to lead independent lives. The present paper outlines an approach to memory remediation that attempts to teach memory impaired patients domain-specific knowledge relevant to their everyday functioning. Several studies describe the successful use of a training technique, the method of vanishing cues, in teaching patients information and skills associated with the operation of a micro-computer. Additional studies show that knowledge acquired in the laboratory can be applied in at least one important domain of everyday life—the workplace. Suggestions for the use of these techniques with other cognitively disabled populations and in other domains are considered.*

**M**emory disorders are among the most prevalent consequences of various kinds of cerebral trauma (for reviews, see Cermak, 1982; Hirst, 1982; Parkin, 1987; Schacter & Crovitz, 1977; Squire, 1987; Weiskrantz, 1985). Although memory impairments are typically associated with poor performance on standard laboratory tests of recall and recognition, they can also seriously affect an individual's ability to lead an independent life (Schacter, Glisky, & McGlynn, in press). With increasing numbers of people surviving closed head injury and other brain insults that produce memory problems, the need for effective rehabilitation techniques has increased and research activity has expanded correspondingly. Yet memory deficits have remained largely resistant to remedial efforts.

One reason for this is that most research concerning remediation of organic memory disorders has attempted either to restore memory function through the use of repetitive drills and exercises, or to teach patients how to use mnemonic strategies (i.e., visual imagery) that can be broadly applied in everyday life. Unfortunately, neither of these approaches has yet produced any clinically significant effects: The use of

repetitive drills and exercises, which is based on the misguided notion that memory is like a muscle that can be strengthened through practice (e.g., Harris & Sunderland, 1981), has failed to provide any evidence of memory improvement; and attempts to teach mnemonic strategies have foundered because brain damaged patients have proven unable to use such strategies spontaneously in their daily lives (for more detailed discussion, see Glisky & Schacter, 1986; O'Connor & Cermak, 1987; Schacter & Glisky, 1986; Wilson, 1987).

In view of the lack of evidence for general improvements of memory function in various patient groups, we decided to focus on a more limited goal that seemed somewhat more realistic and perhaps useful: to help patients acquire specific knowledge and skills that could enable them to function more productively in a particular area or domain of everyday life. Accordingly, our approach to memory remediation is concerned with the acquisition of *domain-specific knowledge*—knowledge pertaining to a specific task, function, or subject that is or could be relevant to a patient's ability to function independently in the real world (Schacter & Glisky, 1986). This approach is based in part on recent

theoretical and empirical developments concerning preserved memory abilities in amnesic patients, which have provided new insights into the nature of both normal and pathological memory processes.

The main purposes of the present paper are to review briefly the foundations of our approach to memory remediation, to describe a number of studies that have yielded positive outcomes both in the laboratory and in the real world, and to consider some promising new directions for future investigations.

## EMPIRICAL AND CONCEPTUAL FOUNDATIONS OF THE DOMAIN-SPECIFIC APPROACH

### Preserved Learning in Amnesic Patients

In recent years, it has become clear that memory impaired patients are capable of acquiring new facts about their everyday world. For example, patients have learned names of people in their environment (Dolan & Norton, 1977; Glasgow, Zeiss, Barrera, & Lewinsohn, 1977; Jaffe & Katz, 1975), appropriate hospital behaviors (Dolan & Norton, 1977; Seidel & Hodgkinson, 1979), details about their illness (McGlynn & Schacter, in press; Wilson, 1987), and information about daily living activities (Cermak, 1976). For the most part, however, knowledge acquired in these studies has been relatively simple, consisting of just a few discrete facts. More critically, in most instances, although they were able to learn the information, patients were unable to apply it in their daily lives. The newly acquired information seemed to remain isolated from the rest of their world knowledge (cf. O'Connor & Cermak, 1987).

Other studies have demonstrated that severely amnesic patients can acquire various perceptual, motor, and cognitive skills in a normal or nearly normal fashion. For example, patients have learned to perform rotary pursuit tasks (Milner, Corkin, &

Teuber, 1968), read mirror-inverted text (Cohen & Squire, 1980; Moscovitch, 1984), and solve jigsaw puzzles (Brooks & Baddeley, 1976) at the same rate as normal subjects although they may have no explicit recollection of the learning experience.

Preserved learning by amnesic patients has also been demonstrated in repetition priming tasks (e.g., Cermak, Talbot, Chandler, & Wolbarst, 1985; Diamond & Rozin, 1984; Graf & Schacter, 1985; Jacoby & Witherpoon, 1982; Schacter & Graf, 1986; Warrington & Weiskrantz, 1968, 1974), in which performance with respect to a stimulus is facilitated as a result of a single prior exposure to the same stimulus. For example, Warrington and Weiskrantz (1974) reported that after studying a list of words such as *chair*, *flame*, and so forth, amnesic patients were as likely as normal subjects to complete word stems such as *cha\_\_\_\_\_* and *fla\_\_\_\_\_* with words from the studied list even though they could not explicitly remember that the words had been previously presented.

The foregoing findings have important implications for the remediation of memory disorders. The various demonstrations of preserved learning by amnesic patients suggest that it may be possible for patients to acquire knowledge in domains relevant to everyday life even though the knowledge may not be explicitly retrievable. Additionally, the results of the priming studies suggest that a possibly effective teaching method may be one that capitalizes on patients' positive responses to fragment cues. The goal of our research program was to explore these possibilities—to determine whether amnesic patients could acquire complex domain-specific knowledge that was applicable to everyday life and to assess the effectiveness of fragment cuing techniques in facilitating the acquisition of that knowledge. In addition, we hoped to establish whether such knowledge could be retained over long periods of time, and most importantly, whether the knowledge acquired in the laboratory could ultimately be used in real-world contexts.

## Method of Vanishing Cues

Initial studies focused on the domain of knowledge relevant to the understanding and operation of a microcomputer. We selected this domain both for its practical relevance and for its theoretical significance. The computer has the potential to serve as a powerful compensatory device if memory impaired patients can learn how to operate it (e.g., Harris, 1984; Jones & Adam, 1979; Skilbeck, 1984; Wilson & Moffat, 1984). Additionally, computer knowledge represents a well-specified domain of interrelated facts and information that is well suited to the experimental study of complex learning (cf. Norman, 1978).

Our first study (Glisky, Schacter, & Tulving, 1986b) investigated whether memory impaired patients could acquire some of the vocabulary associated with the use of a microcomputer. Relatively little is known about vocabulary learning by amnesic patients and the little evidence that exists is negative (Gabrielli, Cohen, & Corkin, 1983). For this reason, learning of vocabulary seemed like an ideal task in which to test the effectiveness of a new teaching technique. The teaching method that we developed was designed to tap patients' preserved memory abilities, specifically the ability to produce previously studied material in response to fragment cues. The basic idea of this technique, which we have called the *method of vanishing cues*, is to provide sufficient cue information on an initial learning trial to ensure elicitation of the correct response, and then to withdraw that information gradually across learning trials until the target is produced in the absence of cues.

The method of vanishing cues is similar to a procedure that Skinner (1958) found useful in developing programs for his teaching machines and to techniques that have been applied to teach normal and autistic children difficult discriminations (e.g., Schreibman & Charlop, 1981). Cue fading methods have also been used in cogni-

tive rehabilitation programs to facilitate problem-solving behavior (e.g., Ben-Yishay et al., 1985) and to teach new behaviors to mentally handicapped individuals (e.g., Schaefer & Martin, 1975). There is also at least one report of the successful use of a first-letter cuing and fading technique with an amnesic Korsakoff patient who learned the location of his locker and the names of two hospital staff members (Jaffe & Katz, 1975). Many of the reports, however, are anecdotal, and administration of the techniques has lacked systematic control.

Our study compared the method of vanishing cues with a standard repetition procedure in which definitions and words were simply presented repeatedly without cues. Four memory impaired patients (three with closed head injuries and one postencephalitic) attempted to learn the definitions of 30 computer-related vocabulary items. In the vanishing cues condition, a definition was presented on Trial 1, for example, *to store a program*, and was followed by an ever-increasing fragment of the target word (i.e., *s\_\_\_\_\_*, *sa\_\_\_\_\_*, *sav\_\_\_\_\_*) until the subject was able to respond correctly with the word *save*. On subsequent trials, letters were gradually withdrawn from the fragment (i.e., *sav\_\_\_\_\_*, *sa\_\_\_\_\_*, *s\_\_\_\_\_*, *\_\_\_\_\_*) until eventually the definition was presented alone without any letter cues. If at any time patients were unable to produce the correct response, letters were added one at a time until the target was generated.

Results of this study demonstrated that (a) memory impaired patients were able to acquire 20 to 30 items of new vocabulary and produce them without letter cues, (b) learning was faster by the method of vanishing cues than by the standard repetition procedure, (c) the rate of learning for memory impaired patients was much slower than that for normal subjects, and (d) learning was durable with little forgetting over a 6-week retention interval. This evidence for learning and retention of vocabulary is particularly impressive in view of the fact that one of our patients was so severely

amnesic that he could not even remember ever having performed the task—yet he was able to learn and retain almost all of the vocabulary items.

Two positive features of the method of vanishing cues are noteworthy. First, the procedure permits a systematic tracking of performance over time in terms of the number of letter cues required for correct responding. In the present study, as training continued, subjects needed progressively fewer letters to identify targets. This steady reduction of letter cues implied that learning was taking place even though patients were unable in the early trials to produce the correct responses when no cues were present. Second, all patients enjoyed learning by this method. Because a correct response is generated on every trial, training is a positive experience that is much less frustrating for patients than simple repetition.

Having demonstrated that memory impaired patients could acquire the basic vocabulary associated with a microcomputer, we embarked on a series of studies to explore whether patients could use this knowledge to learn how to operate a microcomputer. In all of these experiments, the method of vanishing cues served as the principal training technique.

### **Computer Learning in Memory Impaired Patients**

Three interactive computer lessons were constructed to teach patients some of the basic operating procedures for an Apple IIe microcomputer. In the initial study (Glisky, Schacter, & Tulving, 1986a) four head injured patients with memory disorders of varying severity constituted the experimental group; a matched control group also participated. The three lessons were graded in complexity and required patients to learn and use correctly a total of nine different computer commands. For example, Lesson 1 focused on the PRINT command, which is used to display information

on the computer screen, and the HOME command, which is used to clear the screen. Patients were instructed regarding the meanings of these commands, and then performed various tasks that required use of them. In Lesson 2, patients had to learn many new commands such as LIST, SAVE, CATALOG, and others; they were also introduced to the idea of a “program” and were taught to write brief programs that increased in complexity as training progressed. Lesson 3 introduced additional commands and taught patients how to edit their programs by adding, deleting, or changing lines. In each of the three lessons, learning proceeded via the method of vanishing cues. If patients failed to type the appropriate command, they pressed the RETURN key on the computer and were presented with letter-fragment cues. As in the vocabulary study, patients’ progress was charted by tracking the number of letter cues required for successful performance.

All four head injured patients in our initial computer learning study successfully completed the three computer training programs. At the end of that time they could display messages on the screen, clear the screen, perform disk storage and retrieval functions, and write and edit simple programs. Even the most severely amnesic patient, who never remembered ever working on a computer despite more than 100 hours of training, nonetheless was able to learn all of the basic operations. Furthermore, the training techniques seem to be broadly applicable. In a subsequent experiment (Glisky & Schacter, in press) similar findings were obtained with memory impaired patients of other etiologies, including ruptured aneurysm and encephalitis. In addition, it was demonstrated that the computer knowledge acquired by patients in these studies was retained, with little evidence of decay, over long periods of time (7 to 9 months).

Although patients learned to perform all of the procedures within the context of the training programs, their learning was far from normal. They

required many more training trials (26 to 154) to achieve criterial levels of performance than did controls (10 to 28) and the knowledge that they acquired seemed to be qualitatively different. Patients’ new learning could be characterized as “hyperspecific”: it was bound to the stimulus characteristics of the training situation and was relatively inaccessible to cues other than those present during original learning. Patients had considerable difficulty responding to open-ended questions about what they had learned and could not specify appropriate computer commands when the wording of instructions was altered. Control subjects, on the other hand, had no particular problems with these tasks.

The results of these experiments provide some reasons for optimism concerning possibilities for the rehabilitation of memory disorders but they also suggest some caveats. First, on the positive side, patients with memory disorders of varying severity and etiology can acquire some complex knowledge and skills in the laboratory, including procedures necessary to perform basic operations on a microcomputer. It therefore seems reasonable to speculate that patients could be trained to use a microcomputer as an external aid outside of the laboratory to assist them in everyday living. Second, the vanishing cues technique could be used to teach patients complex knowledge in other domains (e.g., educational, vocational, domestic) that might enable them to handle problems of daily life independently. However, the inflexibility or hyperspecificity of learning achieved by patients implies that difficulties of transfer from the laboratory to the real world are likely. It is important therefore to test directly whether knowledge acquired in the laboratory can be used by patients in the real world and under what conditions. The next section describes a case study in which we attempted to teach a memory impaired patient knowledge and skills that had to be applied in an important domain of everyday life: the workplace.



## VOCATIONAL TRAINING: EMPIRICAL CASE STUDIES

### Computer-Related Work

Numerous studies of brain injured patients have cited memory impairment as a major obstacle to re-entry into the work force (Bond, 1975; Bruckner & Randle, 1972; Levin, Grossman, Rose, & Teasdale, 1979; Prigatano & Fordyce, 1986; Weddell, Oddy, & Jenkins, 1980). Because of their inability to remember the procedures required in even the simplest jobs, patients are often unable to obtain any kind of meaningful employment. We recently had the opportunity to investigate whether the vanishing cues procedure could be used to help a patient with serious memory problems acquire domain-specific knowledge necessary to perform a complex job (Glisky & Schacter, 1987).

The patient, H.D., was a 32-year-old woman who became severely amnesic as a result of herpes simplex encephalitis. Following her illness, H.D. was retained by her employer in a simple clerical position. When this job was subsequently eliminated from the company, however, the patient was considered to be untrainable for any of the remaining available jobs. On our recommendation, the employer agreed to allow us to attempt to train this patient for a part-time job within the corporation.

H.D. has a severe memory disorder; her memory quotient on the Wechsler Memory Scale is 65, which reflects substantial impairment. In addition she has a somewhat depressed IQ (84 on the Wechsler Adult Intelligence Scale-Revised) (Wechsler, 1981) and a slight dysnomia. However, she possesses excellent attentional abilities and is strongly motivated to learn new information and skills. H.D. had participated in our computer learning studies and had demonstrated that she was capable of learning complex material using the method of vanishing cues; she also had very good keyboard skills that she had acquired many years earlier as a typist. For

these reasons we recommended a computer data-entry job as being well suited to her capabilities.

The job required a data-entry clerk to extract information from company documents called "meter cards" and enter it into a computer display consisting of nine columns with coded headings. Meter cards were all similar in appearance and relevant information appeared on all cards in the same location. However, varying amounts of irrelevant information also appeared on the cards and had to be ignored, and the mapping between cards and computer display was not straightforward. For example, the last six numbers of the eight-digit SERIAL NO. on the meter card had to be entered into the DOC # column of the computer display, and the date was entered in the reverse order to which it appeared on the card. The task was thus relatively complex, but once learned it remained invariant across trials and cards.

Performance of the job required learning of (a) the general terminology associated with the job, (b) the meaning of each of the nine coded headings in the computer display, (c) the document and operation codes, (d) the location and meaning of the information on the cards, (e) the mapping between cards and display, (f) the use of specific function keys on the computer keyboard, (g) the meaning of the correct response to error messages, and (h) the integration of all of these components into the correct sequence. In addition, the actual data-entry task had to be performed quickly; experienced clerks at the company required approximately 10 to 15 seconds to enter data from a single card into the computer.

The first three phases of job training were conducted in the laboratory, where we constructed a detailed simulation of the real-world job. In the first phase of training, H.D. attempted to learn, using the method of vanishing cues, the basic facts and concepts associated with the task. During this *knowledge acquisition* phase of training, 28 incomplete sentences were presented on the computer screen and

H.D. was required to type the correct completions on the keyboard. For example, *Information from one document is entered into a single row and is called a (blank)* was to be completed with the word *record*. Sentences defined terms and concepts, explained column headings, and outlined card/computer mappings. Hints were provided, when needed, in the form of initial letters of the target word and were gradually vanished over trials.

On the first training trial, H.D. needed 60 hints and took 55 minutes to complete all sentences correctly. By the end of the 25th trial, however, she was performing perfectly without hints in approximately 9 minutes. She then entered the *skill acquisition* phase of training during which she actually performed the data-entry task with real meter cards. The purpose of this phase of training was to improve speed and efficiency of data entry. Across 15 training sessions (2 to 3 per week) and 2,440 meter cards, H.D.'s time to enter data from a single card declined from 63 seconds to 13 seconds, well within the range of speeds achieved by experienced operators. The third segment of laboratory training was concerned with the teaching of *special procedures* such as error-handling routines. Once again, H.D. showed steady learning across six training sessions.

The final phase of the experiment took place in the real world, where we assessed whether and to what extent the knowledge and skills acquired in the laboratory could be used on the job. Following an initial adjustment to minor differences between the laboratory simulation and the actual task, H.D. rapidly achieved error-free performance at speeds equivalent to those attained in the laboratory. Furthermore, despite spending only 2 to 3 days per month on the task, her speed continued to improve on the job over 3 months until performance asymptoted at approximately 10 seconds per card. H.D., at the time of this writing, is still performing this job on a regular part-time basis at a high level of efficiency. Interestingly, although her ability to recount some aspects of the

job has improved with time and experience, she is still unable to report many details of the task despite her ability to perform it flawlessly.

### Extending the Domain of Vocational Training: A Microfilming Job

Because of our success in training H.D. for the part-time data-entry job and because of her skill and efficiency in performing the task, H.D.'s employers were interested in having us teach H.D. another part-time job so that she could eventually be employed on a full-time basis. The new job required that H.D. learn to operate a microfilming machine for the purpose of filming several thousand medical records that were occupying much-needed space in filing cabinets.

This job differed from the data-entry job in that laboratory simulation of the task was impossible because of equipment requirements. For this task, therefore, we used labeled pictures of the apparatus and attempted to teach all aspects of the procedures in propositional form—similar to the knowledge acquisition phase of the previous study. Forty-five incomplete sentences that explained information, concepts, and operations required by the task were presented on the computer screen one at a time. H.D. had to type the correct completions on the computer keyboard with initial letter cues of the target responses being provided as cues if needed. Some sample sentences are illustrated in Figure 1.

H.D. once again started slowly; she required 73 minutes to complete the first trial and needed 129 hints to produce the correct responses. However, as shown in Table 1, performance improved steadily and after 31 trials across 11 training sessions, H.D. achieved error-free performance in 21 minutes.

At the same time as H.D. was learning the facts and procedures associated with the performance of the microfilming job, she was also involved in another aspect of job preparation that attempted to teach her the names and occupations of her new co-

Picture A shows the machine that you will be operating. The machine is called a \_\_\_\_\_ (MICROFILMER)  
 Picture B is a close-up diagram of the \_\_\_\_\_. (COPYBOARD)  
 At the right front of the copyboard, there are three switches or \_\_\_\_\_. (BUTTONS)  
 The button labeled # 1 is called an \_\_\_\_\_. (INDICATOR LIGHT)  
 The indicator light is (color) \_\_\_\_\_. (RED)  
 When the film has reached the end of the roll, the red indicator light \_\_\_\_\_. (FLASHES)  
 Picture C is a close-up diagram of the \_\_\_\_\_. (CAMERA)  
 The part of the camera indicated by the number 1 is called the \_\_\_\_\_. (WINDING HANDLE)  
 When loading or unloading film from the camera, you turn the winding handle \_\_\_\_\_. (CLOCKWISE)  
 The number of turns you make is at least \_\_\_\_\_. (TEN)

Figure 1. Sample sentences from the microfilming training sessions with the correct completions shown in parentheses.

workers. Having observed in our previous study that H.D. was somewhat embarrassed by her inability to remember details about her work environment, we included this segment of training in an attempt to facilitate her social adjustment to her new surroundings. For the same reason, we included three sentences in the basic training program concerning the department and building in which the job was located.

To teach H.D. information about each of seven fellow employees, we presented her with a company photograph of the person, and three sentences on the computer screen. Sentences were as follows: *The first name of the person in photograph # 5 is \_\_\_\_\_*. When this sentence had been completed correctly with the name *Anne*, for example, the following sentence was displayed: *ANNE'S last name is \_\_\_\_\_*. After correct completion of this sentence, the final sentence read, *ANNE BLACK is the \_\_\_\_\_*, which was to be completed with the response *nurse*. The method of vanishing cues was again used to provide letter hints for the correct responses. The procedure was modified slightly from its usual format. To prevent random guessing of

proper names on the initial trial, complete names were provided on Trial 1 and vanished a letter at a time on subsequent trials. The minimum possible number of hints on the first trial was therefore 78, which included all letters in the names. Occupations were generated as in previous experiments with letters being added on the first trial until a correct response was produced and then withdrawn across trials.

Results of the name/face learning study are presented in Table 2. Steady learning over trials is again evident with hints decreasing from 94 on Trial 1 to zero by the end of 30 trials. Times decreased correspondingly. H.D. had some difficulty discriminating between three similar female faces, which she could not remember until she was given the first letter of the first

**Table 1**  
**Number of Hints and Time per Trial to Complete Correctly 45 Sentences Concerning the Microfilming Job**

Sessions (3 trials/session)	Hints	Time (min)
1	129-109	73.2-41.4
2	97- 64	39.8-29.2
3	52- 28	40.0-34.6
4	23- 13	36.7-30.5
5	12- 8	29.1-27.4
6	7- 4	29.0-26.6
7	4- 2	28.1-24.2
8	2- 1	28.4-24.6
9	2- 1	24.6-22.0
10	2- 1	21.8-20.3
11	0	21.0

**Table 2**  
**Number of Hints and Time Taken to Complete 21 Sentences Concerning the Names of Fellow Employees and Their Jobs**

Session (3 trials/session)	Hints	Time (min)
1	94-65	15.1-8.4
2	57-39	12.2-8.8
3	32-18	10.4-7.2
4	15-12	9.9-9.1
5	13- 5	8.1-7.2
6	8- 4	7.7-7.1
7	6- 4	9.0-7.5
8	4- 3	7.9-6.8
9	4- 3	7.8-6.8
10	2- 0	6.6-5.9
11	0	5.0

name. This pattern of responding can be seen in Table 2 by the flat levels of performance in Sessions 8 and 9. Until that point in training, photographs had always been presented in a different random order on each trial. During the 10th session, this procedure was changed in an attempt to overcome her problems. On each of the three trials of Session 10, photographs were displayed on the table in a hierarchical order according to job description. This organizational framework appeared to eliminate the confusion that she had been experiencing. In Session 11, photographs were again presented in a random order, and performance was perfect.

It remained to be demonstrated whether such laboratory training would benefit on-the-job performance given that the actual job had never been performed except in the laboratory. Because the laboratory and real-world tasks were so different, we were not able to obtain direct measures of transfer. However, we provided two days of on-the-job practice on the microfilming task and then monitored H.D.'s performance continuously for 6 days and twice a week for 2 weeks thereafter. Our observations indicated that the patient was initially confused by the actual job situation and did not recognize various aspects of the task as being related to those learned in the laboratory. For example, she appeared not to be familiar with the microfilming equipment although it was identical to the apparatus in the photographs with which she had been trained. In addition, many features of the job were new to H.D.: the location of her work space, the procedures involved in removing and replacing files from the cabinets, some record-keeping chores, and so on.

However, she appeared to learn the task relatively quickly. Across the first 6 days, H.D.'s filming speed increased from approximately 12.3 seconds to 7.3 seconds per document. By this time, performance appeared to be relatively automatic and the patient was filming approximately 2,500 records per day, a number that the company considered to be more than

satisfactory. She also learned to monitor for the end-of-film signal and to load and unload film from the camera without help. Although we could not be certain that on-the-job performance was enhanced by prior laboratory training (no control conditions were possible), the fact that she learned the task so readily is strongly suggestive of that conclusion.

### Summary of Training Studies

The two foregoing studies demonstrate that it is possible to teach a patient with a severe memory disorder different kinds of complex domain-specific knowledge that can be applied in an important segment of everyday life. Although we have demonstrated success with two different vocational tasks, we have as yet trained only a single patient. Generalizability of our findings to other patient groups, therefore, is uncertain until further investigations are conducted. On the basis of our research to date, however, we have reached some tentative conclusions concerning the types of jobs that are most likely to be appropriate for memory impaired patients and some of the potential pitfalls that might be encountered in vocational contexts.

First, suitable jobs are likely to be those that require a set of relatively invariant procedures. Patients appear able to learn complex tasks but are unable to cope with novel situations. Any variations on basic procedures thus disrupt performance unless the means of handling such variations are taught specifically. Second, it appears that complex tasks can be most easily learned if they are broken down into component steps with each component being taught explicitly and directly. This approach is well documented as an effective instructional technique with learning disabled individuals (e.g., Smith & Robinson, 1986) and similar task analysis approaches have been used in vocational training of severely retarded persons (e.g., Mithaug, 1979; Wacker & Hoffman, 1984; Wehman & Hill, 1981). Third, laboratory training should mimic the

actual job situation as closely as possible in order to minimize transfer problems. Although much has yet to be discovered about the factors affecting transfer of training, we know that memory impaired patients experience serious difficulties when called upon to apply information learned in one setting to similar problems that occur in a different setting.

### CONCLUDING COMMENTS

The research reported in this paper represents an initial attempt to explore some of the conditions under which patients with memory disorders can acquire complex knowledge and skills in domains relevant to everyday life. Only a few domains have been investigated as yet and those only with a few patients. Nevertheless, the results are encouraging. In the domains that we have studied, we have not yet observed any limit on the amount or complexity of knowledge that can be acquired by amnesic patients. It is conceivable that although the learning process is slow, a great deal of knowledge can be acquired and retained by memory impaired patients that could significantly improve their ability to function independently in the real world.

Many directions for further research can be envisioned. Other domains of knowledge need to be explored—vocational, educational, social, and so on, and opportunities for non-sheltered employment might be considered for individuals with other kinds of handicaps (cf. Brown et al., 1986). The method of vanishing cues has proven to be an extremely effective technique for teaching new information to patients with memory deficits. Other intellectually or cognitively disabled populations, including children with cerebral trauma, may benefit similarly.

Problems involved in transfer will continue to occupy investigators concerned with training handicapped individuals to function in the real world. Until more is known about the factors affecting generalization to new contexts, the methods of training that seem most likely to be successful are



those that focus on teaching each skill, fact, or procedure directly and explicitly in a context as similar as possible to that in which the information will ultimately be used. A major challenge for research will be to discover methods by which such learning can be made more flexible and thereby more useful in the endless variety of situations presented in everyday life.

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