Current Trends in Cognitive Rehabilitation for Memory Disorders

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Abstract. Progress in the neuropsychology of memory disorders has provided a foundation for development of cognitive rehabilitation for amnesic patients. Accumulating evidence in the past two decades suggested that certain training techniques could be beneficial to many amnesic patients, such as teaching and acquisition of domain-specific knowledge, motor coding, reality orientation, and metacognition improvement. In this article we review and discuss the current trends in cognitive rehabilitation of memory disorders and provide a future direction in this emerging field. In addition, our experience in the successful rehabilitation of Korsakoff syndrome patients is also introduced. (Keio J Med 48 (2): 79–86, June 1999)

Key words: cognitive rehabilitation, memory disorder, domain-specific knowledge

Introduction

Progress in the neuropsychology of memory disorders has provided a foundation for development of cognitive rehabilitation for these patients. In fact, accumulating evidence in the past two decades suggested that certain training techniques could be beneficial to many amnesic patients. These include repetitive practices or exercises which train direct memory, mnemonic or internal strategies which are visual imagery or verbal strategies that train information retention and recall, and external memory aids or strategies which aim at compensating for the memory disorder. However, there remain several unsolved problems, such as the extent to which improvement on trained items generalizes to untrained items and difficulty in initiation and use of the newly learned strategies without prompting. More importantly, there are many severely amnesic patients who are totally refractory to cognitive rehabilitation.

The aim of this article is to review and discuss the current trends in cognitive rehabilitation of memory disorders and provide a future direction in this emerging field. At present, rehabilitation can be classified into teaching and acquisition of domain-specific knowledge, motor coding, reality orientation, and metacognition improvement; papers of each category will be reviewed and discussed in Part I. with emphasis on their theoretical and practical implications. In Part II, our successful rehabilitation of Korsakoff syndrome patients will be presented.

Part I: Recent Progress in the Cognitive Rehabilitation for Memory Disorders

Teaching and Acquisition of Domain-Specific Knowledge

"Domain-specific knowledge" is the term first advocated by Glisky and Schacter, who emphasized that for brain injury cases, rehabilitation aiming at the acquisition and maintenance of knowledge of specific domains that have practical significance to the patients’ daily life is more important than a rehabilitative technique that aims at total memory improvement.

Research has suggested that, although the core symptom of amnesia is the inability to learn new information, the patients can often acquire specific facts or knowledge that are related to their own environment.
For example, Cermak\textsuperscript{4} showed that patients with severe postencephalitic amnesia could learn a considerable amount of information related to daily life through training by visual imagery and verbal strategies. In addition, Jaffe and Katz\textsuperscript{2} used a verbal memory method using the first sound of a word as cue, and succeeded in training a patient with Korsakoff syndrome to learn the names of two ward staff members and the location of the locker. Wilson\textsuperscript{6} used various memory strategies which enabled a patient with severe amnesia to remember the names of hospital staff and the timetable. Studies using behavioral therapy have also shown that patients with memory disorder may be able to learn names of persons and to correct an excessive smoking habit.\textsuperscript{7,8}

These studies prompted us to attempt a 6-month group rehabilitation program of memory training for 5 patients with Korsakoff syndrome, using the photographs of 25 ward staff members. The results showed that the patients were capable of learning new names (formation of face-name association).\textsuperscript{9} The details of this study will be described in Part II of this paper.

The above studies indicate that amnesic patients can acquire domain-specific knowledge through appropriate procedures. The information learned there has practical importance to patients' daily life, solidly organized, consolidated and represented in the psychological makeup. These unique features may have led to successful learning by those brain-injured patients. Although the acquisition of the domain-specific knowledge has practical and theoretical significance, limitations are also acknowledged, including (1) the knowledge acquired was extremely simple and small in quantity, (2) the acquired knowledge cannot be put into practice, and (3) the knowledge is not generalized into daily life activities.

We also observed that the patients' improvement was limited to the trained items, leaving other cognitive functions measured by general memory or frontal function tests unchanged. The learning of persons' names directly led to a more comfortable relationship with others, but no other practical benefits were produced.

A further possibility of domain-specific knowledge training was pursued by Glisky and Schacter,\textsuperscript{10} who attempted to make patients acquire complex knowledge, \textit{i.e.}, knowledge needed for operating and interacting with a computer. The method they developed was called vanishing cues, \textit{i.e.}, systematic reduction of letter fragments of to-be-learned words across trials. This method was based on the observation that technical learning (retention of procedural memory) and priming response such as fragment completion are conserved in amnesic patients.

The training starts by learning the vocabularies for computer operation. Subjects are required to give a word at the definition, and, when the word is not produced, the letter fragments that make up the target word are given as cues starting from the first letter and increased letter by letter until the correct answer is obtained (in the case of SAM; S, SA, SAM). In the next step, a cue is given to the patient which contains one letter less than the number of letters needed to obtain the correct answer in the last step (vanishing cues). These steps are repeated until eventually the patient is able to produce the target words in the absence of fragment cues. Using this method, Glisky and Schacter reported that patients with posttraumatic amnesia could learn computer operations such as data retrieval and input,\textsuperscript{2} and the learning effect lasted 7 to 9 months.\textsuperscript{11} Notably, one of the patients later worked as a data input operator in a computer company.\textsuperscript{12}

Domain-specific knowledge training can be applied to acquire various skills and is therefore considered an important method of memory rehabilitation. It was developed utilizing various existing behavioral psychological approaches such as forward chaining (to divide a behavior into a series of steps and teach each step in turn, starting from the first step), backward chaining (start from the last step and work towards the first step) and shaping and fading of cues.

Whether this method could be applied to other knowledge, such as that of occupational skills and housework, and generalization into daily life activities, is open to future research.

\textbf{Motor Coding or Using Movement as a Memory Aid}

In general, amnesic patients are impaired in declarative memory, but they perform well in procedural memory tasks such as mirror drawing and Hanoi tower tests. Even patients with severe amnesia can learn body movements.\textsuperscript{13-15} Several studies have demonstrated that these two memory systems would show double dissociation, in that amnesic patients were poor at declarative memory tasks but not at procedural tasks, while in Huntington's chorea the performance pattern is reversed.\textsuperscript{16,17}

In view of these findings, Powell\textsuperscript{18} has advocated using gesture as a cue in memory training. For example, when teaching the name of a person called "Bird", the patient is taught simultaneously the gesture that symbolizes the name (e.g. patient flaps two arms like the wings of a bird), and by repeating the gesture as cue the patient recalls the name. Memory training of persons' names using gesture to reinforce memory is conducted similar to that using visual imagery.\textsuperscript{19} A name is divided into 2 to 3 nouns, and a unique meaning is attached to the name and a gesture expressing the meaning is performed. For example, in teaching the name "Sue", the gesture of eating soup is used, and in teaching the name
"Ros", that of sniffing a rose is performed.

In a memory training program, teaching 8 words to posttraumatic amnesic patients was performed. Moffat reported that the number of words recalled increased significantly when they were presented in the context of actions to be performed using them (e.g. rocking motion for the word "baby"). Even in patients with a disorder of the temporal order due to frontal injury, McAndrews and Milner reported that memorization of object names was markedly improved when the objects were actually used.

The theoretical background of the motor coding method as cognitive rehabilitation for amnesic patients is that the procedural memory is conserved in these subjects. However, there are some problems, both theoretically and practically, concerning its application to memory rehabilitation. First, not all amnesic patients can acquire these cognitive skills. The capacity of procedural memory learning may be related to the anatomical location of the injury rather than the pathology, and accordingly effectiveness of the training varies widely among patients. Second, the procedural memory tasks claimed by various researchers actually consisted of a variety of tasks. They included various relatively simple motor learning, visual-spatial learning and problem solving exercises. This situation incurred confusion in interpretation of each study.

More fundamentally, the definition of procedural memory itself is far from established. This term has been reputed rather to represent the motor, sensory and cognitive skills that are capable of being learned or recalled by amnesic subjects. In addition, from the viewpoint of daily life training, most tasks cannot be classified as either declarative or procedural memory tasks, since daily life is so complex and any tasks closely related to it involve both systems.

Despite these questions, it does remain a fact that amnesic patients can learn certain motor or problem-solving tasks. Undoubtedly, memory rehabilitation utilizing this fact would be a benefit to amnesic subjects and hence a fruitful research area in the future.

Cognitive Rehabilitation for Dementia: Reality Orientation

Reality orientation is the teaching of specific information related to the orientation and environment in which the patient resides. It was developed initially for long-term hospitalized patients with senile dementia, with aims to stimulate the patient and to aid the nurses' care for the patient. Recently, however, concern has been shifted to improvement of cognitive behavioral disorders and to correcting confused behavior in the elderly. Thus the method originally developed for hospitalized dementia patients has been widely applied to other patients, such as brain trauma and day care patients.

According to Hanley, reality orientation is composed of: (1) presentation of new information including daily communication and specific learning items, (2) correction of confused behavior, (3) promotion, rehearsal and reinforcement of proper behavior, and (4) presentation of methods (aids) to improve memory disorder.

In practice, patients are asked questions such as "Who are you?", "Who is talking to you?" and "What is going on now?", and then their false responses are corrected by therapists. Information regarding time and place is also given to the patient. The therapists are required to present the information to the patient in a clear and simple manner. The patient is advised to rehearse and to talk with his or her own family and other patients. It is crucial that the therapist knows the details of the patient's family and their past history, because the therapist must immediately evaluate the patient's remarks.

Reality orientation can be either informal, which is a 24-hour training, or formal, which is organized in groups or in classes. However, informal reality orientation alone has been reported to produce no short-term or long-term effect. This may occur because of a lack of staff interaction such as asking specific questions and correction. On the other hand, improvement in orientation is observed in well-structured formal reality orientation, irrespective of whether it is conducted in groups or individually. Several reports have indicated improvement in verbal orientation through the formal reality orientation and special treatment compared to the no-treatment group. Other relevant training, such as ward orientation training using suitable signs (road marks), has been also reported effective.

To obtain better results, combination of reality orientation with other memory training strategies has been recommended. For example, Kurlychek successfully trained patients with early Alzheimer type dementia using reality orientation combined with instruction using an alarm clock and a timetable. In Japan, Honda and Kashima used reality orientation combined with attention process training in the rehabilitation for elderly dementia patients.

Generalization of this effect, however, is controversial. While behavioral changes after formal reality orientation have been reported by Holden and Sinebruch, generalization was not observed in the group training sessions conducted by Hart and Fleming, Goldstein et al., or in the individual training conducted by Woods.

In studies comparing formal reality orientation to other therapies such as social and occupational therapies, three reports have consistently demonstrated
greater improvement with reality orientation. In particular, Hart and Fleming reported remarkable effects using a modified reality orientation incorporating social reinforcement and certain recognition tasks. However, the results of two other studies did not favor reality orientation.

The above findings suggest that although the formal reality orientation is indeed an effective therapy, its limited generalization to other cognitive behavioral disorders and the lack of robust evidence of a better effect over other therapies are unsolved problems. In the future, well-structured reality orientation should be conducted by experts in neuropsychology who have considerable knowledge about the nature of the defect and residual capability of patients with dementia and other conditions.

**Metacognition Improvement**

Many amnesic patients cannot assess their memory impairment correctly, or are not aware of the insults at all. Amnesic patients’ failure to use memory strategies and lack of generalization of the rehabilitation effects are often attributed to the lack of metacognition. Recently, approaches to improve metacognition, or self-assessment of the memory disorder, have been attempted.

For example, Vroman et al. attempted to improve metacognition in various test items using computer feedback to confront the subjects with their errors. With respect to the inability to use memory strategies spontaneously, some reports have indicated improvement by teaching the patients an acronym for using memory strategy. For example, the acronym used by Lawson and Rice was WSTC (W: What are you asked to do?; S: Select a strategy for the task; T: Try out a strategy; C: Check out how the strategy is working). They applied this technique to patients with post-traumatic amnesia and showed an improvement in the results of various memory tasks and learning of names of places and objects. Unfortunately, this effect was not generalized to other tasks outside the training.

The ultimate goal of any cognitive rehabilitation is independence in functional living activities, thereby improving the patient’s work or study skills. Therefore, long-term maintenance and generalization of the use of memory strategies is the most important and indispensable research topic in memory rehabilitation, and further efforts in these areas are expected.

**Part II: Cognitive Rehabilitation for Patients with Korsakoff Syndrome**

**Teaching and Acquisition of Domain-Specific Knowledge**

**Introduction**

Previous studies in the past two decades have demonstrated that patients with memory disorders were capable of learning some information through cognitive rehabilitation. However, subjects of each study have disorders of various etiologies, hence interpretation of the efficacy of a given training technique is often difficult. Studies of such subjects, on the one hand, may have interesting implications for understanding the nature and variability of recovery. However, for practical purposes, this could be a drawback since the best rehabilitation program for a particular group of patients cannot be identified. It is reasonable to speculate that severity of amnesia is clearly not the sole determinant of learning capacity; the etiology may be equally important. That outcome studies from cognitive rehabilitation programs vary widely may be attributed to the heterogeneity of the amnesic subjects.

Here we present a rehabilitation program, the subjects of which are limited to alcohol-related Korsakoff syndrome. Given the large amount of literature concerning neuropathology and neuropsychology of these amnesic subjects, we predicted that the results of this cognitive rehabilitation would contribute greatly to the theoretical aspects of memory disorder, besides being of benefit to the participating subjects. However, deficits in motivation and problem-solving capability, often considered as signs of frontal lobe dysfunction of these patients, may be an obstacle to the training. Specifically, application of externally assisted approaches (e.g. diary and alarm clock) and memory strategies (e.g. visual images and the beginning sound of a word method) are expected to be more difficult than in amnesia of other causes such as postencephalitic sequelae.

The method we chose was the domain-specific knowledge learning technique advocated by Glisky and Schacter, which was shown effective for frontal lobe patients. Given the poor motivation of Korsakoff patients, we speculated that learning items should be directly associated with real-life functions, and tried to train them to memorize the names of ward staff (domain-specific knowledge) through repetitive practices.

**Subjects**

We studied 5 patients with Korsakoff syndrome secondary to alcoholism (mean age: 50.0 years, all males),
who were in the Special Alcoholism Treatment Ward of a psychiatric hospital (Table 1). All showed disorientation, anterograde and retrograde amnesia, and confused confabulation. None had productive confabulation. No definite lesions were observed in MRI and CT. Cases with physical complications such as cirrhosis and diabetes and with a low full IQ (FIQ) assessed by WAIS-R were excluded from the study. Those receiving drugs such as antipsychotics and anxiolytics that may affect the cognitive functions were also excluded. The average years of education was 12.0 years, and the average FIQ (WAIS-R) was 84.0. The subjects had been hospitalized for at least 6 months and had abstained from alcohol for an average of 27.4 months.

Methods

Training

The cognitive rehabilitation program was conducted in groups weekly for 6 months. The aim was to train the patients to memorize the names of ward staff as domain-specific knowledge, by repetitive practices using 25 color photographs (20 staff from the Special Alcoholism Treatment Ward, and 5 staff from another ward). The name of the person was written on the back of each photograph. At each training session, the photographs were shown randomly one by one to the patients who were asked to recall the names. When a name could not be recalled, the patient read the name on the back of the photograph to enhance memory.

Assessment

The training effect was assessed by a name recall test using color photographs at the beginning of every training session (1-week delayed reproduction) (Assessment 1). To see if transfer of acquired knowledge could be achieved, the staff members in the photographs met with the patients one week after the last training session and patients were asked to identify their names (Assessment 2). Maintenance of the knowledge was tested at one and two years after the training, by asking patients to recall the names of the staff from photographs (Assessments 3 and 4).

In each recall test, an immediate correct answer was regarded as "capable to recall". A correct answer given after correction of an initial incorrect answer, or a correct answer induced by cues, was not regarded as a correct answer.

To examine whether the training effect was generalized to other learning tasks, the Rey Auditory Verbal Learning Test and Rey-Osterrieth Complex Figure Test were conducted as a verbal and a nonverbal task, respectively, before and after the rehabilitation. Before the beginning of the rehabilitation program, the autobiographical memory test and personal semantic memory test were conducted as remote memory tests, and the Keio version of the Wisconsin Card Sorting Test was performed as a test to reflect frontal lobe functions (Assessment 5).

For statistical analysis, a paired t-test was used to compare scores of the name recall exercises. In the comparison of the name recall scores with other neuropsychological test results, the correlation coefficients were calculated and tested by Fisher's r to Z conversion method.

Results

All the patients completed the 6-month rehabilitation program. The number of names recalled increased with time but had almost reached a plateau by the 6th month, and we tentatively concluded that further improvement could not be achieved by continuing this method alone.

Assessment 1

The subjects had been in the hospital from 6 months to several years at the beginning of the rehabilitation program, and therefore had known on average 6.4 of 20 names of the staff members in the ward. After the 6-month program, the numbers of names recalled (average 11.6) had significantly increased for all the patients (Table 2).

Assessment 2

Table 2 also shows the number of names recalled when seeing the actual persons. The results were comparable to those of the photographs. These findings suggested that the face-name association was not just a memory of the particular photographs, but was in a form that could be utilized in real life.
Table 2 Number of Names Recalled

<table>
<thead>
<tr>
<th>Case</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Program</td>
<td>14</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>6.4 (4.8)</td>
</tr>
<tr>
<td>After 6-month Program</td>
<td>18</td>
<td>14</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td>11.6 (4.5)</td>
</tr>
<tr>
<td>(Photographs)*</td>
<td>19</td>
<td>13</td>
<td>11</td>
<td>11</td>
<td>5</td>
<td>11.8 (5.0)</td>
</tr>
<tr>
<td>After 6-month Program</td>
<td>18</td>
<td>16</td>
<td>11</td>
<td>10</td>
<td>5</td>
<td>12.0 (5.1)</td>
</tr>
<tr>
<td>(Actual person)**</td>
<td>17</td>
<td>14</td>
<td>/</td>
<td>8</td>
<td>7</td>
<td>11.5 (4.8)</td>
</tr>
<tr>
<td>1 year After Program***</td>
<td>18</td>
<td>16</td>
<td>11</td>
<td>10</td>
<td>5</td>
<td>12.0 (5.1)</td>
</tr>
<tr>
<td>2 years After Program****</td>
<td>17</td>
<td>14</td>
<td>/</td>
<td>8</td>
<td>7</td>
<td>11.5 (4.8)</td>
</tr>
</tbody>
</table>

*Assessment 1, **Assessment 2, ***Assessment 3, ****Assessment 4.

Assessments 3 and 4

As shown in Table 2, the average numbers of names recalled from the photographs one and two years after the rehabilitation program were 12.0 and 11.5, respectively. These recall scores were almost identical to those immediately after the training program.

Assessment 5

No significant improvement in the results of general learning tasks was observed after the rehabilitation program (Table 3). As for the correlations between the face-name association results (score increase and maximum score) and the results of various neuropsychological measures, no correlations were observed between the recall score and the result of remote memory test, learning task or frontal lobe function test. However, a significant correlation was detected between the recall score and FIQ assessed by WAIS-R ($r = 0.96$).

As regards the photographs of staff members of another ward, only one patient (Case A) remembered two names, but he did not recall the name when meeting the staff member face-to-face one week after the training, no did he remember the name when shown the same photograph one year after the rehabilitation program. The other four patients failed to learn the name of any staff member of another ward.

Discussion

We have presented the principles and functioning of a 6-month course of domain-specific knowledge training for small groups of patients with alcohol-related Korsakoff syndrome. A primary concern for this project was that poor motivation characteristic of these amnesics might serve as a great obstacle. Contrary to prediction, however, all patients completed the 6-month program and significant effects were obtained. In the group training, when a subject gave a correct answer, all members clapped hands; and when the answer was incorrect, cues such as the first sound of the name were given to induce the correct answer. Efforts to make the training into an enjoyable, game-like session could, at least in part, have contributed to the successful completion of the program.

The number of names recalled from the photographs increased significantly, suggesting that patients with Korsakoff syndrome could learn to remember names of persons by repetitive practice. However, no improvement in the results of general learning tasks was observed, confirming earlier observation that the effect of rehabilitation was not generalized into other aspects of memory. These findings are in line with the notion of the "acquisition of domain-specific knowledge" approach of memory rehabilitation advocated by Glisky and Schacter. Our results demonstrated that training using photographs was suitable for practical purposes, because some transference of learned knowledge to real life was observed.

There has been no long-term study on the maintenance of domain-specific knowledge in patients with Korsakoff syndrome. Our results indicate that the recall scores one year after rehabilitation were almost identical to those immediately after the training, suggesting that the name-face association persisted for a long period of time. Considering the fact that 11 of the 25 staff members who were working in the ward at the time of training had been transferred to other wards by one year after training, our results were rather good. That speed of forgetting is slower in patients with Korsakoff syndrome than in those with temporal lobe amnesia gave a theoretical basis for the premise that the acquisition of domain-specific knowledge might be particularly effective in patients with Korsakoff syndrome.

A significant correlation was observed between the name recall score and FIQ assessed by WAIS-R, suggesting that domain-specific memory rehabilitation may be more effective in those patients with a low level of cognitive impairment limited to amnesia.

All patients except Case A failed to memorize the names of the staff members of another ward. Even in Case A, the face-name association was not retained.
over a long period of time. This finding showed that learning of the names of ward staff was based on implicit memory such as familiarity, and the higher the familiarity, the easier the face-name association was established.

Several studies reported the results of training face-name association as a domain-specific knowledge. Wilson et al. \(^5\) have proposed a hypothesis that amnesic patients are impaired in the ability to correct errors, which leads to difficulties in learning new tasks, and they encouraged errorless learning. The vanishing cues which we presented in Part I of this article consist of a systematic reduction of letter fragments of to-be-learned words across trials, and thus serves as an errorless learning method. Wilson et al. used the vanishing cue technique to teach staff names and reported a shorter duration required to achieve face-name association compared to simple repetitive practices. Thoene et al. \(^5\) compared face-name association learning using verbal elaboration and visual imagery memory strategies which evoke explicit memory, with that using the vanishing cue which utilizes implicit memory, and reported higher effectiveness using the former memory strategies. It should be noted that the faces they used for the training were unknown ones. As expected, face-name association has been reported to be more difficult with unknown faces than with known faces. In the domain-specific memory rehabilitation using known faces, implicit consolidation of memory in daily life could be expected. Studies consistently demonstrated that implicit learning is not impaired in amnesic patients, and therefore utilization of this preserved ability should be maximally encouraged. Development of training methods along this line is fruitful in cognitive rehabilitation, both theoretically and practically.

Lastly, we add a recent topic on methodology of cognitive rehabilitation for memory disorder. As described above, Wilson et al. \(^5\) stressed the impaired ability of amnesic patients to correct errors, and encouraged errorless learning. However, most of the standardized memory tests consist of effortful learning tasks, e.g. the retrieval task, in which error responses may occur. Effortful processes have been thought to be an important factor in successful rehabilitation of memory disorders. The issue of errorless and effortful processes involved in the learning task is a basic methodological problem and we have discussed it in detail recently. \(^5\)

**References**