Effectiveness of Cognitive Skill Remediation in Acute Stroke Patients

(visual scanning, visual-spatial, time judgment, retraining)

Lynn Tondat Carter

Bertram E. Howard

William A. O’Neil

The purpose of this study was to determine whether a cognitive skills remediation program could help acute stroke patients regain important thinking skills. Patients in a community hospital stroke program were pre-tested in three skill areas—visual scanning, visual-spatial orientation, and time judgment—and randomly assigned to a treatment (n = 16) or control (n = 17) group. The treatment group received cognitive skill retraining on a one-to-one basis for 30 minutes per day, 3 days per week, for 3 weeks. The retraining involved the use of paper and pencil tasks, simple cuing procedures, positive reinforcement, and immediate feedback. Although the control group did not receive this treatment, conventional therapies continued for both groups. Patients receiving treatment had overall and separate skill improvement scores that were significantly higher than those for control patients. The implications of this type of treatment program are discussed.

Cerebral vascular accident (CVA) or stroke, is the third leading cause of death in America today. Of the more than 400,000 new victims of stroke each year, approximately 180,000 die, leaving more than 220,000 survivors with varying degrees of disability (1). In addition to the more obvious motor and sensory impairments, cognitive skill deficits are also a common consequence of stroke. Examples of these deficits include decreased ability to scan visually, orient visually and spatially, remember, judge time, learn, concentrate, and do simple math computations (2-4). The degree of disability can range from a mild, annoying impairment to a

Lynn Tondat Carter, Ph.D., is Associate Professor, Department of Psychology, Southeastern Massachusetts University, N. Dartmouth, Massachusetts.

Bertram E. Howard, M.D., is a Cardiologist; and

William A. O’Neil, M.D., is a Neurologist; both at St. Luke’s Hospital, New Bedford, Massachusetts.
severe and devastating inability to perform even the simplest mental functions necessary for carrying out activities of daily living.

Historically, the emphasis of cognitive skill research in brain-damaged adults has been on the identification and assessment of deficits (4, 5). This is reflected by the increase in the presence and depth of questions about cognitive functioning on rehabilitation evaluation forms (6-8). While results of recent research are helping rehabilitation staff to become more aware of the importance and involvement of cognitive and perceptual skill deficits in the recovery process for brain-damaged adults (9-12), formal programs for the treatment of such deficits are still uncommon.

One well-known treatment approach, based on years of research, is used at the Institute of Rehabilitation Medicine, New York University. At the Institute, researchers developed and tested numerous behavioral treatment programs for the remediation of a variety of cognitive and perceptual skill deficits (2, 5, 13-17, 23, 24). The programs emphasize the relearning and practice of once-used cognitive sets and associated sensorimotor behaviors. Some important steps of the treatment process are: identifying the deficit area, giving informative feedback to make the client aware of the deficit and subsequent progress, and retraining tasks relevant both to the deficit skill area and to the related daily activities of the client (5, 4, 13, 14). These techniques and treatment programs, which can involve the use of scanning machines and other training apparatus, are made available to rehabilitation staff at yearly workshops sponsored by the Institute and through published monographs (e.g., 15-17).

Within the past several years, a program of cognitive skill remediation that can be applied to a number of rehabilitation settings was tested and developed (18, 19). The majority of the exercises in this program involves the use of paper and pencil tasks. This program incorporates the same principles tested and used effectively at the Institute of Rehabilitation Medicine: continuous reinforcement, immediate feedback, cuing, gradually increasing the difficulty level, and stressing the importance of the skills being taught to activities of daily living. In the 1980 study (18), rehabilitation patients (stroke and nonstroke elderly) who received such training were shown to improve significantly in overall cognitive skill performance in five skill areas compared to the patients who did not receive this training. This overall improvement was primarily due to better performance in visual scanning, visual-spatial orientation, and time judgment skills. The treated patients received training for an average of 35 minutes, 3 times per week, for 4 weeks. All patients continued to receive other traditional rehabilitation therapies.

One important issue yet to be addressed is the optimal time for the administration of cognitive skill remediation following the occurrence of stroke. The value of early rehabilitation using traditional therapies for stroke patients (i.e., early mobilization, repositioning of a patient, and initial physical therapy) is well known (20-22). Both the mortality and the morbidity rate decrease with early treatment. Stroke victims are more likely to return to independent functioning if placed on a rehabilitation stroke program directly after the stroke (20-22). Although physical, speech, and occupational therapies are now widely available for the acute stroke patient, cognitive retraining may not be routinely included as a part of these programs. Moreover, to our knowledge, there are no published studies that have tested the effectiveness of a formal program of cognitive skills retraining in acute stroke patients. The studies reporting on cognitive skill techniques for stroke patients have all been conducted with patients at least 6 to 8 weeks post-stroke or later (18, 25, 24).

The purpose of this study, therefore, was to determine the feasibility of administering cognitive skill training to acute patients within a week post-stroke, and to test the beneficial effects of such exposure. Three cognitive skills were selected for the study: visual scanning, visual-spatial orientation, and time judgment.

Method

Patients. Thirty-three acute stroke patients from St. Luke's Hospital, New Bedford, Massachusetts, were pre-tested for scanning, visual-spatial, and time judgment skills. (Pre-testing was done after obtaining the signed approval of the medical coordinator and consent of the patient.) The patients were randomly assigned to an experimental or control group following pre-testing. The following variables were compared between experimental and control groups to check for homogeneity: age, sex, pre-test score, and medical condition. The medical condition was assessed by the type and amount of damage, hemisphere damage, and the patient's functional abilities, and was determined by 1. medical coordinator's diagnosis; 2. neurological evaluation (Neurological Severity Score), and 3. Barthel Score. CAT scan reports and records of each patient's medical history were used to confirm the diagnosis and to rule
Table 1
Means and Standard Deviations for Subject Variables of Experimental and Control Patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>$\bar{X} = 70.5$ ($\pm 11.4$)</td>
<td>$\bar{X} = 73.4$ ($\pm 9.2$)</td>
<td>$&gt; .20$</td>
</tr>
<tr>
<td>Barthel Score (of 100)</td>
<td>$\bar{X} = 25.2$ ($\pm 8.6$)</td>
<td>$\bar{X} = 22.9$ ($\pm 11.7$)</td>
<td>$&gt; .20$</td>
</tr>
<tr>
<td>Neurological Severity Score (of 60)</td>
<td>$\bar{X} = 29.4$ ($\pm 3.9$)</td>
<td>$\bar{X} = 28.5$ ($\pm 6.4$)</td>
<td>$&gt; .20$</td>
</tr>
<tr>
<td>Side of Damage, No. cases</td>
<td>Right brain = 7 Left brain = 9</td>
<td>Right brain = 8 Left brain = 9</td>
<td>$&gt;.50$</td>
</tr>
<tr>
<td>Sex</td>
<td>M = 7 F = 9</td>
<td>M = 9 F = 8</td>
<td>$&gt;.50$</td>
</tr>
<tr>
<td>Pre-test Score (of 100)</td>
<td>54.2 ($\pm 24.3$)</td>
<td>48.9 ($\pm 24.1$)</td>
<td>$&gt;.10$</td>
</tr>
<tr>
<td>No. Days from Admittance to Stroke Program to Pre-test</td>
<td>4.81 ($\pm 1.6$)</td>
<td>4.6 ($\pm 2.6$)</td>
<td>$&gt;.20$</td>
</tr>
<tr>
<td>No. Days from Pre-test to Post-test</td>
<td>22.1 ($\pm 7.1$)</td>
<td>22.2 ($\pm 6.3$)</td>
<td>$&gt;.20$</td>
</tr>
</tbody>
</table>

Table 2
Mean Difference Improvement Scores* and Standard Deviations for Each Skill Area

<table>
<thead>
<tr>
<th>Task</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>P Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanning</td>
<td>Mean 35.9 S D 21.3</td>
<td>n 9</td>
<td>Mean 3.8 S D 13.2</td>
</tr>
<tr>
<td>Visual-Spatial</td>
<td>Mean 31.0 S D 22.8</td>
<td>n 14</td>
<td>Mean 3.3 S D 18.0</td>
</tr>
<tr>
<td>Time-Judgment</td>
<td>Mean 24.6 S D 18.3</td>
<td>n 12</td>
<td>Mean 7.8 S D 30.3</td>
</tr>
</tbody>
</table>

*Based on a 100-pt scale.

Procedure. Following the pretesting and random assignment of patients to groups, cognitive skill remediation training was given to the treatment group. This training was administered on a one-to-one basis for 30 to 40 minutes three times per week and only for those skill areas that needed improvement, which were defined as areas with pre-test performances below 80 percent on any of the three skills (visual scanning, visual-spatial, and time judgment skills). Treatment continued for as long as the patient was on the Stroke Program, an average of 3 to 4 weeks. The training exercises and procedures were taken from the Thinking Skills Workbook (19), which was specifically designed to retrain visual scanning, visual-spatial, and time judgment abilities in adult patients. The training procedures included the use of positive reinforcement, immediate feedback, gradually increasing the difficulty level of tasks, and showing the relevance of the training tasks to daily skills. This training approach was used in a previous study for rehabilitation patients (18).
The nontreatment, or control group, did not receive this training. Other stroke program activities continued routinely for both groups. These included social worker interviews, physical therapy, speech therapy, occupational therapy, family visits, and constant interaction with the rehabilitation nursing staff.

The testing and training took place between 9:00 and 11:45 in the morning before or after the other stroke program therapies. The stroke program staff was not informed of group assignment for the patients in this project, or of the experimental nature of the project. Both treatment and nontreatment patients were post-tested for performance on scanning, visual-spatial, and time judgment skills before discharge from the stroke program. Although several trainers and testers were employed for the duration of the study, in all cases the same assistant gave both the pre-test and the post-test for any one patient. To help protect against experimental bias, these pre-test scores were not disclosed to the tester or to the patient until after the post-test was completed. At that time, complete feedback was given to all patients. For the major part of the study, an experimental blind testing procedure was used: that is, group assignment—experimental or control—was not known to the tester. However, because of the physical layout of the stroke unit, at times it was possible for the tester to see which patients were given training by the other assistant.

Results

Overall and separate skill area improvement scores, which represent a difference from the pre-test to the post-test score, were calculated for all patients. The overall improvement score for each patient represented a mean of the specific improvement scores for those skill areas that were pre-tested at a performance level below 80 percent. Therefore, scores for those patients in the experimental and control groups that had an 80 percent pre-test performance or better were not included in the calculations for those tasks (see procedure, no training was given for skill ≥ 80%). This was done to prevent possible ceiling performance effects. The overall mean improvement score was 32.2 (SD = 16.11) for the experimental patients (n = 16) and 4.9 (SD = 13.98) for the control patients (n = 17). A statistical analysis with a Mann Whitney-U test revealed that the experimental group's overall improvement was significantly higher than that of the control group (p < .005).
Table 2 displays the separate skill area improvement scores for both experimental and control groups. Mann Whitney-U tests were conducted between the groups for the visual scanning, visual-spatial, and time judgment tasks to determine statistical differences. As Table 2 shows, the mean improvement scores for each of these skills were significantly better for those patients who received cognitive skill remediation training. Note also that the n sizes vary for each task category. As mentioned above, those patients that scored ≥80 percent on the pre-test were not included in the calculations for those tasks. Since this actually produced subgroups of the original two groups, further tests were conducted to ensure that each of these subgroups was not different on the subject variables listed in Table 1. These statistical tests revealed no differences between the experimental and control patients in any of the skill area subgroups for any of the variables (ps > .05).

Figures 1-3 are examples of patients’ performances on visual scanning and visual-spatial tasks. The pre-test and score is shown at the top, and the post-test at the bottom, for each case. Substantial improvement can be seen in the post-test for patients who received training. In the first figure, the patient found all but one A on the post-test. When finished, the patient was then asked whether there were any more, the tester said there was just one more, and the patient quickly found it and crossed it out, the only one not numbered. Numbering the letters consecutively was a method this patient used as a helpful aid. Note the marked left-visual neglect on the pre-test for this patient.

Discussion and Summary
This cognitive skill remediation program administered to acute stroke patients resulted in significantly higher pre-test to post-test performance scores compared to those of patients who did not participate in the program. These higher scores were found for each of the three skills in the remediation training program: visual scanning, visual-spatial orientation, and time judgment.

Each of these skills is relevant to the performance of other tasks that are normally performed on a daily basis. Visual scanning is needed for reading and looking at objects in the entire visual field. Retraining of visual scanning skills has been shown to improve reading and other related tasks in right brain-damaged patients (14). Deficits in visual scanning were found to be related to
an increase in accident-prone behavior of both right and left brain-damaged rehabilitation patients (24). According to Diller and Weinberg, this relationship is understandable since scanning is necessary for many activities in a rehabilitation setting, such as accurately perceiving and locating objects in space, operating a wheelchair, and for transferring to and from a wheelchair (24).

Visual-spatial orientation is a skill needed for identifying and perceiving objects with different forms and in various positions (object constancy). In a recent study by Kaplan and Hier (11), visual-spatial orientation was found to be an important predictor of functional ability, as measured by self-care scores and disposition status, in patients with right brain damage.

They suggest that occupational therapists should reconsider the importance of visuospatial skills in successfully rehabilitating patients with right brain damage. In our study, as can be noted in the results, not only were visual-spatial deficits the most frequent skill deficit, but they were found in patients with both right and left brain damage.

Time judgment, or estimating a 1-minute time interval, is a skill that requires attention, orientation, and an immediate awareness of events. An awareness of the length of the training session was incorporated into the training for this task. This presumably helped to orient the patient to better attend to the actual training process.

Traditionally, when cognitive skill remediation programs have been employed, they are started later in the rehabilitation process, that is, not in the acute phase or week following brain damage. The argument given has been that before this phase the stroke or head trauma patient is not emotionally or mentally prepared to engage in this type of active rehabilitation (16). Yet, this study demonstrated that it is feasible to successfully implement a cognitive skills remediation program for stroke patients during the acute phase of rehabilitation. Such a program may ideally be integrated into a patient's ongoing occupational therapy treatment program during the acute phase. This of course does not preclude a more extensive program later in the rehabilitation process.

Moreover, since the trend of recent research indicates that mental or cognitive abilities play an impor-
tant role in the effective rehabilitation of brain-damaged patients (11, 12, 22), early intervention and treatment of such deficits would be desirable in order to maximize the rehabilitative efforts. Future research is needed to ascertain the exact nature of this relationship between the return of functional abilities and the degree of cognitive skill impairment, as well as the effect of cognitive skill remediation on the recovery of activities of daily living.

Another consideration is the impact that thinking skill deficits would have on the patient's emotional and general mental attitude. Such deficits can lead to frustration and, if left unattended, even to depression. In our study, many of the patients seemed relieved that their thinking skills were also being helped after the stroke. In general, during this acute phase, these patients worked steadily and eagerly on the retraining tasks. They were shown the relevance of these tasks to their daily living routine, and the trainers constantly incorporated items in the patients' hospital room (family pictures, greeting cards, reading material) into the training for each skill area.

In conclusion, this study demonstrated that a cognitive skills remediation program was effective in improving thinking skills for acute stroke patients. Since the assessment and treatment of cognitive skill deficits are becoming increasingly viewed as important to occupational therapy (11), future research focusing on the integration of these remediation procedures with existing occupational therapy programs would be beneficial.

Acknowledgments
This research was supported by a grant awarded to the first author by Southeastern New England Long Term Care Gerontology Center, Brown University, through the Administration on Aging, Older Americans Act Title IV E, 90 AT-2164. The authors thank the Administration, Nursing, and Rehabilitation Staff at St. Luke’s Hospital for their encouragement and support of this project; Lori Levesque, Pamela Grumney, and Jo Ellen Guerreiro for their assistance as testers and trainers; and finally, David S. Greer, M.D., Andrea Lukoff, OTR, and Johanna Duponte, OTR, for their helpful suggestions on earlier drafts of this manuscript.

REFERENCES
15. Rehabilitation Monograph No. 50: Studies in Cognition and Rehabilitation in Hemiplegia, Institute of Rehabilitation Medicine, New York University Medical Center, 1974
16. Rehabilitation Monograph No. 61: Working Approaches to Remediation of Cognitive Deficits in Brain Damaged Persons, Institute of Rehabilitation Medicine, New York University Medical Center, 1980
17. Rehabilitation Monograph No. 61: Supplement: Methods for the Evaluation and Treatment of the Visual Perceptual Difficulties of Right Brain Damaged Individuals, Institute of Rehabilitation Medicine, New York University Medical Center, 1980