The Relationship of Cognitive Skills Performance to Activities of Daily Living in Stroke Patients

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This article reports on two studies that examine the relationship between measurements of activities of daily living (ADL) and cognitive skills performance. Study 1 is a post hoc analysis of ADL improvement scores collected on acute stroke patients who were either given or not given cognitive skills remediation. An examination of individual ADL scores showed significantly higher personal hygiene, bathing, and toilet activity improvement scores for patients receiving cognitive skills remediation. In Study 2, cognitive skills and ADL pre- and posttest scores for stroke patients were measured by occupational therapists, who also implemented an ADL as well as a cognitive skills remediation program as part of the patient's therapy. Some significant positive correlations between initial cognitive skills measurements and ADL outcome were found. The best correlate of patients' ADL performance at discharge was performance on an auditory attention task. Verbal comprehension correlated with overall ADL improvement, and overall cognitive skills improvement correlated with overall ADL improvement. Implications of these two studies are discussed.

A behavioral treatment approach to retraining cognitive skills in adults who have had a stroke or a brain injury was pioneered by Diller and his colleagues at the Institute of Rehabilitation Medicine, New York University (Diller, 1976; Diller et al., 1974; Weinberg et al., 1977). Their program of cognitive skills remediation applies basic learning principles that include identifying specific deficits, using positive reinforcement, giving immediate feedback, grading difficulty of tasks, fading cues, and making cognitive skills tasks relevant to functional tasks. Several studies using this treatment approach have been published showing that remediation of specific cognitive tasks results in significant posttraining improvement for brain-damaged adults (e.g., Carter, Caruso, Languirand, & Berard, 1980; Carter, Howard, & O'Neil, 1983; Lewinsohn, Danaher, & Kikel, 1977). A variety of specific cognitive skills, such as visual scanning, visual-spatial ability, attention, and memory, have been retrained in these studies. Several good reviews of this research have been published elsewhere (Diller & Gordon, 1981; Gouvier, Webster, & Blanton, 1986; Piasetsky, Ben-Yishay, Weinberg, & Diller, 1982).

Although improvement in cognitive skills performance for specific tasks has been documented following cognitive skills retraining, the relationship between cognitive skills performance and functional ability is not as clear. Several studies have revealed significant correlations between visual-spatial and self-care abilities for stroke patients. In 1962 Lorenze and Cancro reported that visual-spatial ability, as measured by Wechsler Adult Intelligence Scale...
(WAIS) block design and object assembly subtests, was positively related to performance of dressing and grooming skills for right-cerebrovascular accident (CVA) patients. Kaplan and Hier (1982) found that initial visuospatial ability was positively related to ADL Kenny (Kenny Self-Care Evaluation) scores at discharge for right-CVA patients, although they did not report results for specific ADL skills. Diller et al. (1974) did implicate the importance of visual-spatial training (block design) on ADL outcome for patients with right- and left-brain damage; however, only feeding was systematically inspected. Warren (1981) reported that initial scores on design copy and body scheme tests were significantly correlated with final dressing scores for right- and left-CVA patients. Warren found that higher performance on admission on these tests was related to better dressing scores at discharge.

More recently, improvement in functional abilities following block design training was reported in an unpublished dissertation (Leer, 1984). Forty stroke patients with right-brain damage were randomly assigned to a treatment group that received 4 hours per week of block design training for 3 weeks, or to a control group that received no specialized cognitive skills training. Results indicated significantly higher improvement scores for treated patients in personal hygiene, dressing, homemaking, and a category called community ADL/vocational skills. The fifth category rated was feeding, for which no significant differences in improvement were found between the treated and the control group. Leer concluded that patients given this type of cognitive skills training showed not only improved visual-perceptual abilities, but also significantly better gains in ADL performance compared with patients on a regular rehabilitation program.

Although testing these hypotheses by using an experimental design is valuable, we note that it does not appear that Leer (1984) used a blind procedure in measuring either cognitive skills or ADL. Further, it is not known if testers were told not to review pretest scores before posttesting the patients on these measures. Although it is admittedly extremely difficult to conduct blind studies in clinical settings, absence of this methodological control leaves questions about the influence of knowledge of group assignment on the testing of these patients.

The conclusions that can be drawn from any one of the above studies on the relationship between cognitive skills and ADL performance are limited. However, when the results are taken together, they suggest that there probably exists an important functional relationship between cognitive skills performance and ADL outcome in recovering brain-damaged patients. The intent of our research is to further the understanding of this relationship.

**Study 1**

This was a post hoc inspection of data from a study previously published by the first author (Carter et al., 1983). Reported in 1983 were the significantly higher cognitive skills improvement scores for stroke patients receiving cognitive skills retraining compared with stroke patients not receiving cognitive skills retraining. Here we reexamined patients' Barthel discharge and improvement scores that were collected but not reported in the 1983 study. Specifically, we analyzed individual Barthel improvement scores obtained in 10 categories of self-care. This post hoc inspection revealed some significant differences in Barthel improvement scores between the treated group and the control group.

**Method**

**Patients.** The acute stroke patients had been randomly assigned to either a control group (n = 17) or a treatment group (n = 16). No significant differences were found between the two groups in cognitive skills pretest performance, age, Neurological Severity Score, side of damage, or Barthel score at time of admission. The treatment group had received cognitive skills retraining for visual scanning, visual-spatial perception, and time judgment skills over a 3-week period. Trained research assistants administered the retraining exercises, which were taken from an earlier draft of *The Thinking Skills Workbook* (Carter, Caruso, & Languirand, 1984). The control group had not been given cognitive skills retraining, but had participated in the same other stroke program therapies (occupational, speech, and physical) as the treatment group. The stroke program staff were not told which group a patient had been assigned to.

**Barthel Rating.** The Barthel Index (Mahoney & Barthel, 1965), an evaluation of functional status, is made up of 10 self-care categories. Each category is rated in units of 5 from 0 (unable to meet criteria) up to a total of 5, 10, or 15 points (independent). The total possible points for each category are as follows: feeding (10 points), moving from wheelchair to bed (15 points), personal hygiene (5 points), toilet activities (10 points), bathing self (5 points), walking (15 points), ascending and descending stairs (10 points), dressing (10 points), controlling bowel movements (10 points), and controlling bladder (10 points). A total of 100 points would be given to patients with an independent rating in all categories. Admission and discharge...
Barthel ratings were taken by one of two charge nurses. These nurses were unaware of specific patient assignment to either treatment or control group; they were aware only that the patients were part of the study. The average time between admission and discharge rating was 4.7 weeks. Because complete discharge Barthel scores were not available for 3 patients in the control group and for 2 patients in the treatment group, data for only 28 out of the original 33 patients are presented here.

Results and Discussion

The average overall Barthel improvement scores were 22.86 ($SD = 19.09$) for control patients and 33.57 ($SD = 16.22$) for treated patients; these means were not significantly different ($p < .05$). However, when each scoring category was analyzed with ceiling scores removed for patients scoring perfectly both at admission and discharge, some specific self-care scoring areas did reveal differences. Average improvement scores for the control and treatment groups are listed by rating category in Table 1. Significant $p$ values for independent $t$ tests calculated on these means are also listed in Table 1.

As can be seen from this table, stroke patients who received cognitive skills retraining showed significant improvement in personal hygiene, bathing, and toilet activities ($p < .05$). Although treated patients showed higher improvement scores for stairs and dressing, these differences were not significant at the $p < .05$ level.

These results lend some support to findings by Leer (1984) who, as reviewed earlier, found significant increases in personal hygiene following retraining of visual-spatial ability. However, because three cognitive skills were trained in the present study, it was not possible from the results of this study to determine how a specific cognitive skill relates to a specific self-care skill. (An examination of this relationship was taken up in the study described below [Study 2].) Nonetheless, the results of Study 1 do indicate the likelihood of an important causal relationship between the improvement of three cognitive skills (visual scanning, visual-spatial perception, time judgment) and the improvement of three self-care skills (personal hygiene, bathing, and toilet activities).

Study 2

The purposes of this study were to examine the relationship between overall cognitive skills performance and ADL performance and to further the understanding of the relationships between specific ADL skills and specific cognitive skills. A correlational design was used because we felt it would be unethical to use an untreated control group in view of the many published studies showing the effectiveness of cognitive skills retraining. We hypothesized that stroke patients who were given both cognitive skills and ADL retraining would show significant improvement. We also predicted that overall cognitive skills improvement would correlate significantly with overall ADL improvement. Based on results from past research, visual-spatial performance was expected to predict skill levels for dressing, grooming, personal hygiene (Leer, 1984; Lorenze & Cancro, 1962), and feeding (Diller et al., 1974).

Method

Patients. Stroke patients from three hospitals in southeastern New England were included in the study. Because of severe time constraints resulting from the newly implemented Medicare prospective payment system (based on diagnosis-related groups),
the length of stay decreased dramatically for patients during the course of this study. Thus only 21 of the more than 80 patients considered for the study remained in the hospital long enough for the program. The average time on the program was 26.3 days. The mean age for these patients was 68.6 years ($SD = 14.93$; 5 patients were below 50 years, 11 were between 60 to 79 years, and 5 were above 80 years). Nine patients were female and 12 were male; 3 female patients and 1 male patient had left-brain damage, the remaining 17 patients all had right-brain damage. The average education was 11 years of formal schooling ($SD = 4.09$).

Procedure. Occupational therapists evaluated patients with two different instruments: the revised Kenny Self-Care Evaluation (Iversen, Sibberg, Sever, & Schoening, 1973) and a cognitive skills evaluation (Carter et al., 1984). The Kenny scale rates level of functioning for the following six categories of self-care: bed activities, transfers, locomotion, dressing, personal hygiene, and feeding. For each category (all having rating subcategories, except feeding) an average score out of a total of 4 points is obtained ($0 = \text{dependent}, 1 = \text{with help}, 3 = \text{supervision}, 4 = \text{independent}$). Thus a maximum score of 24 would be given for independent functioning in all six categories. For this study, testing reliabilities from pre- to posttesting were $+ .66$ for the Kenny evaluation and $+ .75$ for the cognitive skills evaluation ($p < .01$).

The cognitive skills evaluation was taken from The Thinking Skills Workbook (Carter et al., 1984), which includes a pre- and posttest for eight different skills: time judgment (judging the length of 1 minute), verbal memory (remembering details of story), visual-spatial perception (matching to sample), digit span, visual scanning (letter cancellation), visual-spatial perception (matching to sample), digit span, verbal memory (remembering details of story), abstract reasoning (sequencing), and verbal comprehension (word analogies). Testing took between 25 to 35 minutes. Skills were scored according to guidelines given in the workbook (Carter et al., 1984) and in a normative study (Carter, Davis, Marzano, & Crapo, 1987).

ADL retraining was given daily by occupational and physical therapists and by nurses. Cognitive skills retraining was given at least three times per week by a different occupational therapist from the therapist who gave the ADL retraining. Cognitive skills training included paper-and-pencil exercises and activities recommended by the training guidelines in The Thinking Skills Workbook (Carter et al., 1984) as well as other occupational therapy techniques (e.g., training of body awareness, object manipulation activities, functionally based perceptual activities). The most frequently trained skills were visual scanning, visual-spatial ability, verbal memory, and auditory attention.

Posttests of ADL and cognitive skills were given after 3 to 4 weeks of therapy; evaluators did not review pretest scores until after the posttests had been given. The same occupational therapist administered both the pre- and postevaluations for the ADL scale. This was also true for the cognitive skills pre- and posttests. Where possible, different occupational therapists gave the ADL evaluation and the cognitive skills evaluation to each patient.

Results and Discussion

ADL and Cognitive Skills Improvement Scores. Improvement scores were obtained by subtracting pretest from posttest scores. These were calculated for each ADL and cognitive skills scoring category and combined to obtain an average overall ADL and cognitive skills improvement score. Improvement scores for patients whose pretest scores were greater than 80% (ceiling scores) for a specific category were not included in the calculations. Significant overall improvement was found for both ADL and cognitive skills performance ($p < .001$). When converted to a 100-point scale, ADL Kenny scores improved an average of 26.20 ($SD = 15.03$) over 3 to 4 weeks. Cognitive skills performance improved an average of 24.62 ($SD = 13.04$) over this same period of time. This improvement in cognitive skills compares favorably with earlier studies, which reported cognitive skills improvements of 20% to 30% for treated patients (Carter et al., 1980, 1983). This result documents significant cognitive skills improvement for patients who receive occupational therapy intervention that incorporates cognitive skills retraining.

Cognitive skills improvement averages for each skill area are listed in Table 2. Improvements ranged between 21% to 53% with the exception of abstract reasoning, which had the smallest gain. Therapists reported that this area was the most difficult to train.

Table 2

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<tr>
<th>Average Cognitive Skills Improvement Scores</th>
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<tbody>
<tr>
<td>Cognitive Skill</td>
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<tr>
<td>Time judgment</td>
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<tr>
<td>Visual scanning</td>
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<tr>
<td>Visual-spatial perception</td>
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<tr>
<td>Auditory attention</td>
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<tr>
<td>Digit span</td>
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<tr>
<td>Verbal memory</td>
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<tr>
<td>Abstract reasoning</td>
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<tr>
<td>Verbal comprehension</td>
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Note: Scores are out of a possible 100 with pretest ceiling score removed. Value of $n$ reflects removal of ceiling scores.
patients in. It was not possible to correlate specific skill ADL improvement (six skill areas) with specific cognitive skills improvement (eight skill areas) because of varied n sizes after removal of ceiling scores. However, a correlation between overall cognitive skills and ADL improvement was conducted to determine whether a patient who improved in cognitive skills performance also improved in ADL activities. As predicted, a significant positive relationship was found (r = +.37, p < .05).

Kenny improvement scores for each of the six rating categories can be found in Table 3. As can be seen from the table, substantial improvement occurred for all six rating categories.

**Cognitive Skills Correlates of ADL Posttest Performance.** The correlations between ADL and cognitive skills performance revealed a number of significant relationships. Some may be interpreted to be useful predictors of a patient's later functional status. First, the overall pretest cognitive skills performance was significantly related to posttest ADL performance (r = +.59, p < .01). Table 4 shows the best specific cognitive skills correlates of each ADL skill. The best single cognitive skills pretest correlate of future overall ADL functioning was the auditory attention task. This auditory vigilance task correlated with five out of six of the ADL category functional skills (p > .025 to .001). The next best cognitive skills pretest predictor of ADL posttest functioning was visual-spatial perception, which correlated significantly with bed activities, dressing, and personal hygiene (p > .025 to .01). Finding a correlation between visual-spatial perception and both dressing and personal hygiene skills (which includes grooming) replicates an earlier study that showed a positive relationship for patients with right-brain damage (Lorenze & Cancro, 1962). None of the pretest measures of cognitive skills correlated with feeding, which was probably due to a lack of variability and thus sensitivity of scoring, that is, all patients at postlevel testing scored either 3 or 4 on the 4-point scale. Therefore, we could not replicate the Diller et al. (1974) finding of a relationship between visual-spatial perception and feeding performance.

To our knowledge, past studies relating cognitive skills and ADL have not specifically tested or trained auditory attention. Our finding that auditory attention relates significantly to performance for five out of six self-care skills at discharge would indicate a need to focus more on this cognitive skill. Not surprisingly, pretest levels of auditory attention correlated significantly with pretest levels for visual scanning (r = +.56), visual-spatial perception (r = +.58), and digit span (p = +.58; p < .01). In a normative study (Carter et al., 1987), this auditory vigilance task was found to be very sensitive. That is, a very small range defined performance for 95% of normal college students (mean age = 21 years) and for 95% of normal elder subjects (mean age = 68 years). The former group (n = 63) scored an average of .06 of an error (±.25), and the latter group (n = 39) scored an average of .10 of an error (±30). If future studies replicate our findings, then auditory attention may become an important indicator for therapists in planning cognitive skills and ADL retraining treatment for patients.

Gummow, Miller, and Dustman (1983) have encouraged more study of attentional deficits and cognitive remediation in brain-injured patients. We agree and would add that the development of effective training techniques for this skill should also be continued.

One final outcome of this study was the finding of a significant correlation between pretest verbal comprehension and overall ADL improvement. It is not clear why this task and not others correlated with

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<td>ADL Skill</td>
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<tr>
<td>Bed activities</td>
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<td>Transfers</td>
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<td>Locomotion</td>
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<td>Dressing</td>
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<td>Personal hygiene</td>
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<td>Feeding</td>
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*Note. Scores are out of a possible 100 with pretest ceiling scores removed. Value of n reflects removal of ceiling scores.*

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<th>Table 4</th>
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<tr>
<td><strong>Significant Correlations Between Cognitive Skills and ADL Skills</strong></td>
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<td>Cognitive Skill Pretest Area</td>
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<tr>
<td>Time judgment</td>
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<td>Auditory attention</td>
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<tr>
<td>Visual scanning</td>
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<td>Visual-spatial perception</td>
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*ps < .025; for all others, ps < .01.*

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overall ADL improvement. More research is needed to study the importance not only of auditory attention as it relates to ADL outcome, but also of the role that verbal comprehension might have in the improvement of ADL performance.

Summary and Clinical Implications

Study 1, a posthoc analysis, showed that stroke patients receiving cognitive skills remediation of visual scanning, visual-spatial perception, and/or time judgment skills showed significantly improved ADL functioning in personal hygiene, bathing, and toilet activities. Study 2 investigated the progress of 21 stroke patients given occupational therapy intervention that included testing and training in both activities of daily living and cognitive skills. Results indicated that ADL and cognitive skills performance increased significantly for these patients. Further, improvement in cognitive skills was found to be positively related to improvement in performance of activities of daily living.

Study 2 also revealed that overall pretest performance in cognitive skills was significantly correlated with later ADL functioning for recovering stroke patients. The single best cognitive skills correlate of later ADL performance was the auditory attention task, and pretest levels of verbal comprehension were positively related to overall ADL improvement. In view of these latter findings, auditory attention and verbal comprehension should probably be given more emphasis in the designing and testing of retraining programs.

We believe these findings are useful because now, more than ever, occupational therapists and other health care professionals must justify and account for their treatment choices and priorities in the care of brain-damaged patients. The findings support the hypothesis that how well a person recovers in ADL performance depends in part on how well he or she functions cognitively. The findings also strengthen the argument for making the testing and retraining of cognitive skills an essential part of the rehabilitation of brain-damaged patients. The type of cost-effective cognitive skills program used in the two studies can be continued with patients on an outpatient basis, at home or in the nursing home, with the involvement of a family member and the supervision of a health care professional. This can be an advantage in view of the ever decreasing length of stay for patients in acute care and rehabilitation settings.

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