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Outcome of Different Treatment Mixes in a Multidimensional Neuropsychological Rehabilitation Program

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Abstract: *Within a clinical demonstration program, three groups of traumatically brain injured patients were treated with three different mixes of treatment. Mix 1 included cognitive remediation, small-group interpersonal communication training, therapeutic community activities, and personal counseling. Mix 2 was similar to Mix 1 but stressed small-group interpersonal exercises and eliminated cognitive remediation. Mix 3 emphasized cognitive remediation and eliminated small-group interpersonal exercises. The efficacy of these treatment mixes was evaluated with performance on neuropsychological tests, improved independence in functional activities, measures of intra- and interpersonal functioning, and vocational outcome.*

Keywords: Head injury, rehabilitation, treatment outcome.

It has long been recognized (Lishman, 1978) that cognitive and emotional–behavioral sequelae of traumatic brain injury (TBI) pose a greater obstacle to personal and vocational rehabilitation of persons than do residual physical limitations. Conventional approaches to

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rehabilitation, in which coexisting, multifaceted, and mutually exacerbating deficits are treated in isolation from one another (by physical, occupational, speech, and recreational therapists and by psychologists and vocational counselors) do not address the multidimensional nature of the problem.

The present study was conducted between 1978 and 1983. It was designed to test, in a clinical demonstration program organized and operated as a mini therapeutic community, the efficacy of three different mixes of systematic, multidimensional remedial interventions. Since the inception of this study, several other multidimensional clinical studies have been published with positive findings (Christensen, Pinner, Pederson, Teasdale, & Trexler, 1992; Cope, Cole, Hall, & Barkan, 1991a, 1991b; Johnston, 1991; Johnston & Lewis, 1991; Prigatano, 1986; Scherzer, 1986). However, these studies did not attempt to differentiate the relative effects of different multiple treatments.

Descriptions of the conceptual underpinnings of this study have been published previously (Ben-Yishay & Diller, 1983; Ben-Yishay, Rattok, Lakin, et al., 1985; Ben-Yishay & Prigatano, 1990). Programmatic elements were described (Ben-Yishay & Gold, 1990; Ben-Yishay & Lakin, 1989), and earlier findings and follow-up data in the vocational area were presented (Ben-Yishay, Silver, Piasetsky, & Rattok, 1987; Ezrachi, Ben-Yishay, Kay, Diller, & Rattok, 1991).

In this article, the results of the study are presented in their entirety. Specifically, in the study we sought to test the relative efficacy of different mixes of remedial interventions in terms of four types of outcome measures: (a) performance on a wide spectrum of neuropsychological tests; (b) measures of competence and independence in functional activities at home; (c) measures of intra- and interpersonal functioning; and (d) return to work.

Method

Subjects

The subjects for this study were 59 persons who experienced severe TBIs. Fifty-six (95%) were due to acceleration/deceleration concussion, and 3 (5%) were due to cerebral anoxia secondary to asphyxia, carbon monoxide poisoning, or cardiac arrest. At the time they commenced this study, all subjects had been discharged from in-patient rehabilitation and lived at home with relatives. Subjects had reached neurological stability (most suffered the injury more than one year prior to entering this program and had been discharged from physical therapy, occupational therapy, and speech therapy). In the majority of cases, traditional methods of rehabilitation (e.g., psychotherapy, vocational counseling, and modified or reduced academic study load) had failed to stabilize subjects in terms of their personal and social adjustment and their return to work. Failure was attributable to different combinations of typical cognitive and behavioral sequelae of TBI: manifestations of adynamic or disinhibition disorders (problems in initiation or paucity of ideation, impulsiveness, poor modulation of affective responses); impaired attention and concentration (distractibility, inability to persist at tasks); impaired ability to learn new information or to problem solve (due to interactions or mutual exacerbations of adynamia and disinhibition, attention disorders, memory deficits, reduced capacity for logical reasoning, or defective executive skills); lack of awareness resulting in inadequate response to remedial interventions and unrealistic expectations; and a damaged sense of self (poor morale, shaken ego-identity, inability to accept altered existential situation).

Criteria for participation in the study included (a) a diagnosis of TBI (penetrating or nonpenetrating, open or closed head) resulting in at least 1 hr of coma or a diagnosis of cerebral anoxia (secondary to carbon monoxide poisoning, asphyxia, or cardiac arrest) resulting in at least 12 hr of coma; (b) at least one year postinjury and attainment of neurological stability; (c) unsuccessful vocational or educational rehabilitation prior to entry into the program; (d) residence in the greater New York metropolitan area for the duration of the study; (e) age between 18 and 55; (f) command of functional English; (g) at least partial independence in basic activities of self-care, independence in ambulation, at least one functional hand, and continence; (h) a minimum (Verbal or Performance) IQ of 80 on the Wechsler Adult Intelligence Scale (WAIS); (i) a minimum demonstrated motivation for rehabilitation (compliance with assignments during the initial assessment period and voluntary expression of a desire to enter the program); and (j) intactness of a basic level of social appropriateness and manageability within a noncoercive (therapeutic and training) environment.

Excluded from this study were persons with (a) a history of past or present significant psychiatric complications, (b) a history of significant alcohol or drug abuse, (c) a history of sociopathy, and (d) major aphasic or dysarthric difficulties that precluded reliable two-way communication and participation in the therapeutic community.

Each of the 59 subjects received one of three treatment mixes (described later). Treatment Mix 1 was given to 23 subjects, Treatment Mix 2 was given to 18 subjects, and Treatment Mix 3 was given to 18 subjects. Table 1 presents the median values on key demographic and injury-related variables for each of the three groups.

At baseline, the three groups were comparable (Kruskal-Wallis one-way analysis of variance [ANOVA]) with respect to age, education, time since injury, time in coma, and the Behavioral Competence Index (BCI), a measure of functional competence in the home environment (Ben-Yishay, Rattok, Ross, Lakin, Silver et al., 1982; Ben-Yishay, Ross, et al., 1980).

Design

The study was designed to compare three ways to mix and deliver treatments in an identical therapeutic milieu. Table 2 outlines the three variations.

Table 1
Median Values on Key Demographic and Injury-Related Variables for Patients in Treatment Mixes 1–3

Variable	Treatment Mix 1 (n = 23)	Treatment Mix 2 (n = 18)	Treatment Mix 3 (n = 18)
Age (years)	26.8	27.1	28.5
Gender (men/women)	15/8	16/2	11/7
Education (years)	14.3	13.5	14.6
Time since injury (months)	32.0	33.8	40.2
Time in coma (days)	34.3	38.9	36.9
BCI	6.2	6.7	7.2

Note. BCI = Behavioral Competence Index.

Table 2
Components of Treatment Mixes 1, 2, and 3

Component	Total treatment hours[a]		
	Mix 1	Mix 2	Mix 3
Attention training	80	80	80
Cognitive remediation	120		200
Small-group interpersonal exercises	100	200	
Community activities	60	60	60
Personal counseling	40	60	60
Total	400	400	400

[a]In a 20-week cycle.

Treatment Mix 1 was a balanced package that included training to alleviate attentional disorders, individualized cognitive remediation, small-group interpersonal communication exercises, therapeutic community activities, and personal counseling functions. In Treatment Mix 2, training in attention, community activities, and personal counseling were held constant, individualized cognitive remediation was eliminated, and emphasis was placed on small-group interpersonal exercises. In Treatment Mix 3, training in attention, community activities, and personal counseling were held constant, small-group interpersonal exercises were eliminated, and emphasis was placed on individualized cognitive remedial training.

Basic attention and concentration was assessed and trained through use of the orientation remedial module (ORM). The ORM is a specially developed assessment and remedial training hierarchy of microcomputerized tasks. Specifics concerning the rationale of task construction, method of administration, validity, and outcomes of remedial training have been presented elsewhere (Ben-Yishay, Diller, & Rattok, 1978; Ben-Yishay, Piasetsky, & Rattok, 1987; Ben-Yishay, Rattok, & Diller, 1979; Ben-Yishay, Rattok, et al., 1980; Piasetsky et al., 1983; Rattok et al., 1982).

Following training in attention, subjects in Treatment Mixes 1 and 3 were administered systematic, individualized remedial training on several cognitive modules. The cognitive training modules involved task and cueing hierarchies in the areas of eye–hand coordination with finger dexterity (Ben-Yishay & Diller, 1983; Ben-Yishay, Gordon, Diller, & Gerstman, 1978), constructional praxis (Ben-Yishay, Diller, Gordon, & Gerstman, 1978), visual information processing (Rattok et al., 1981), and logical reasoning (Ben-Yishay & Diller, 1983; Ben-Yishay, Lakin, et al., 1980a; Ben-Yishay, Piasetsky, & Diller, 1978; Ben-Yishay, Rattok, Ross, Lakin, Silver, et al., 1982).

Subjects in Treatment Mixes 1 and 2 were provided with daily, specialized, small-group exercises in interpersonal communications. The conceptual, methodological, and clinical rationale of these exercises have been presented elsewhere (Ben-Yishay & Diller, 1983; Ben-Yishay & Gold, 1990; Ben-Yishay et al., 1983; Ben-Yishay & Lakin, 1989; Ben-Yishay, Lakin, et al., 1980b; Ben-Yishay, Rattok, et al., 1979).

Community activities were held constant in all three treatment mixes. The rationale and specific programmatic elements subsumed under the rubric of community activities have been presented elsewhere (Ben-Yishay, Ben-Nachum, et al., 1978; Ben-Yishay & Gold,

1990; Ben-Yishay & Prigatano, 1989; Lakin et al., 1982; Ross et al., 1982).

Personal counseling functions included regular one-on-one sessions with a subject and a personal counselor; ad hoc conjoint sessions with a subject, his or her significant other, and the designated personal counselor; and special crisis intervention sessions with a subject, his or her significant other, and all members of the staff. Different aspects of the personal counseling component of the program have been published elsewhere (Ben-Yishay & Gold, 1990; Lakin et al., 1982; Ross et al., 1982, 1983).

The three treatment mixes were administered consecutively at the same facility by (essentially) the same staff. Staff-to-patient ratio (one psychologist per two patients), duration of treatment (20 consecutive weeks), intensity and frequency of treatment (5 hr/day, 4 days a week), and number of patients per group (a maximum of 10 subjects at any one time) were held constant for all treatment mixes. Subjects were tested on an extensive battery of criterion tests at baseline (prior to receiving treatment) and at the conclusion of the 20-week treatment cycle.

At the conclusion of the 20-week remedial intervention period, those subjects who were judged by the staff as being viable candidates for work trials were assigned to the two specially trained vocational counselors who were attached to the program staff (Ben-Yishay et al., 1987). The vocational trials ranged from a minimum of 12 weeks to a maximum of 6 months and consisted of an initial assessment of a subject's residual work skills and his or her potential for learning to perform different types of work routines. After the initial assessment, subjects were assigned to real-work stations within the New York University Medical Center for on-the-job training and supervision; subjects also received off-the-job individual and group vocational counseling. Following that, actual job search and placement was initiated by the vocational counselors. Once a subject was successfully placed at a job in the community, or failed to attain employability status, he or she was followed up indefinitely, and his or her work status, as well as general adjustment, was periodically assessed. In a few cases, job placement was accomplished immediately after cessation of the intensive remedial phase, without the interim phase of work trials. In such cases, subjects were rated for level of employability and were followed with their cohorts.

Criterion Variables

Psychometric measures. The battery of psychometric criterion tests, which were administered both at baseline and after cessation of the remedial training period, included a broad spectrum of measures. These standard and specially developed tests yielded a total of 41 criterion variables. The measures included

1. tasks from the ORM (which includes a visual reaction time task, an attention-reaction conditioner, a rhythm synchrony conditioner, random and constant time estimation tasks, unilateral and bilateral visual discrimination tasks, and a zeroing accuracy conditioner);

2. measures of eye–hand coordination and finger dexterity (the Purdue Pegboard);

3. measures of visual processing skills (the figure recognition, letter cancellation [with double stimuli], spatial relations, and navigation tasks developed by the Rusk Institute of Rehabilitation Medicine [RIRM]);

4. measures of academic skills (the vocabulary, comprehension, and spelling portions of the Metropolitan Achievement Test and the reading portion of the Wide Range Achievement Test);

5. the WAIS Verbal and Performance subtests and related measures (e.g., recall errors on the Benton Visual Retention Test, the Sentence Repetition portion of the Neurosensory

Center Comprehensive Examination for Aphasia [NCCEA], and the Logical Memory subtest of the Wechsler Memory Scale [WMS]); and

6. measures of higher order verbal and conceptual skills (e.g., the category and shift portions of the RIRM similarities task, the category and shift portions of the RIRM object sorting task, and the self-generated portion of the RIRM telegram task).

Detailed descriptions of the test battery are presented elsewhere (Ben-Yishay, Diller, Rattok, Ross, & Schaier, 1979; Ben-Yishay, Piasetsky, & Rattok, 1987; Ben-Yishay, Rattok, Ross, Lakin, Ezrachi, et al., 1982).

Measures of competence and independence in daily life. Competence and independence in daily life was assessed with the BCI, an instrument developed by the Research and Training Center on Head Trauma and Stroke at New York University. The BCI consists of 19 items measuring levels of functioning in various activities of daily living. A subject's significant other received a structured, in-depth interview in which he or she was asked to provide detailed and specific answers (citing critical incidents) concerning the subject's competence and independence in these 19 areas. The program staff converted the significant other's responses into ratings ranging from 1 (*totally dependent*) to 10 (*totally independent*) for each of the 19 items. The rationale, procedure, and interrater reliabilities of this instrument have been presented elsewhere (Ben-Yishay, Ross, et al., 1980; Ben-Yishay, Rattok, Ross, Lakin, Silver, et al., 1982).

The following is a listing of the 19 areas assessed in the BCI: (a) self-care activities, (b) basic household chores, (c) activity/initiative level, (d) orientation within familiar environments, (e) orientation within unfamiliar environments, (f) orientation to time, space, and persons, (g) memory functions in everyday life activities, (h) basic adaptive skills outside the home (shopping, using public transportation, etc.), (i) appropriateness of basic interpersonal behavior within the significant other's environment, (j) appropriateness of basic interpersonal behavior outside the home, (k) comprehension, organization, and prioritizing of the routines of daily life, (l) comprehension, organization, and prioritizing of new (nonroutine) activities, (m) autoregulation of affect and moods, (n) fail-safe system of checks (on dangerous behaviors, e.g., aggression, suicidal attempts, etc.), (o) capacity for intimacy, (p) sexuality, (q) awareness of implications of the injury, (r) acceptance of existential situation, and (s) cooperation and collaboration.

Measures of intra- and interpersonal functioning. The adequacy of intra- and interpersonal functioning was measured with four specially developed procedures (Ben-Yishay, Rattok, Ross, Schaier, Scherzer, & Diller, 1979; Ben-Yishay, Rattok, Ross, Lakin, Silver, et al., 1982) for rating self-esteem, self-appraisal, interpersonal empathy, and social cooperation.

Vocational outcome. The level of employability attained by subjects after the 20-week treatment cycle was measured with a 10-point weighted scale. The rating system made it possible to differentiate among subjects in terms of the level of job complexity and income attained after rehabilitation, relative to preinjury levels. Details have been published elsewhere (Ben-Yishay, Silver, Piasetsky, & Rattok, 1987; Ezrachi et al., 1991).

Results

Psychometric Outcomes

The pre- and posttreatment scores for the 41 criterion measures for subjects in each of the three treatment mixes are summarized in Table 3. Analysis was carried out with two-way, mixed-design ANOVAs, analyzing the effects of the respective treatment mixes and pre- and

text continues on page 405

Table 3
Summary of Pre- and Postprogram Cognitive Measures for Patients Receiving Treatment Mixes 1, 2, or 3

Measure	Mix 1		Mix 2		Mix 3	
	Pre	Post	Pre	Post	Pre	Post
Orientation remedial module						
Visual reaction time						
N	23		18		17	
M	233.30	159.52	214.44	153.50	275.29	252.12
SD	79.63	21.34	41.47	19.16	50.47	40.47
Attention reaction conditioner						
N	23		18		15	
M	6.31	7.69	6.46	7.49	6.34	7.05
SD	0.92	0.35	0.63	1.68	1.06	0.70
Zeroing accuracy conditioner						
N	22		18		16	
M	3.87	2.82	4.91	2.07	4.34	0.95
SD	1.05	1.66	1.73	0.98	2.48	0.47
Time estimation						
Random						
N	23		18		16	
M	1.29	0.55	0.69	0.39	1.00	0.86
SD	1.41	0.32	0.36	0.31	0.52	0.50
Time estimation						
Constant						
N	23		18		16	
M	1.49	0.80	0.77	0.36	0.98	1.17
SD	1.57	0.56	0.54	0.22	0.57	0.55
Rhythm synchrony conditioner						
N	13		17		18	
M	5.64	6.96	5.85	7.17	6.65	7.17
SD	1.64	0.97	1.17	0.56	1.21	1.46
Visual discrimination conditioner						
Unilateral						
N	23		18		13	
M	19.57	23.17	22.39	23.61	21.54	23.92
SD	4.79	1.11	2.17	1.20	3.26	0.28
Visual discrimination conditioner						
Bilateral						
N	23		18		13	
M	19.04	23.35	21.94	23.67	20.69	23.62
SD	4.79	0.88	2.13	0.97	4.53	1.12
Psychomotor dexterity						
Purdue Pegboard						
Right placement						
N	19		17		18	
M	11.24	13.53	13.15	13.62	12.14	13.19

(table continues)

Table 3 *(continued)*

Measure	Mix 1 Pre	Mix 1 Post	Mix 2 Pre	Mix 2 Post	Mix 3 Pre	Mix 3 Post
Psychomotor dexterity *(continued)*						
Right placement *(continued)*						
SD	3.05	3.56	2.90	3.27	3.17	3.36
Left placement						
N	22		18		17	
M	11.31	12.99	12.45	12.52	11.38	12.75
SD	3.91	4.22	2.74	2.85	3.35	3.69
Assembly						
N	23		18		18	
M	23.58	26.34	26.54	29.29	24.22	29.78
SD	7.38	9.36	7.36	8.89	10.11	11.46
Visual processing skills						
RIRM figure recognition task						
N	22		18		16	
M	78.36	79.36	78.39	79.11	78.06	78.62
SD	2.48	1.22	2.33	1.18	2.38	2.19
Cancellation task (double stimuli)						
N	23		18		17	
M	1.96	1.70	2.44	2.17	8.18	4.41
SD	2.60	1.58	1.79	2.18	8.15	6.36
RIRM spatial relations task						
N	22		18		16	
M	13.27	13.59	13.28	13.50	12.81	12.56
SD	1.20	0.67	1.27	0.79	1.47	1.21
RIRM navigation task						
N	23		17		15	
M	24.74	27.52	27.24	29.47	26.53	26.67
SD	6.17	6.58	3.09	1.18	3.7	4.35
Academic skills[a]						
MAT vocabulary test						
N	22		18		16	
M	9.57	9.41	9.37	9.29	9.38	9.64
SD	0.65	1.19	0.89	1.05	0.78	0.43
MAT spelling test						
N	22		18		15	
M	9.20	9.35	9.23	9.34	9.02	9.25
SD	1.19	1.33	0.82	1.16	1.07	0.90
MAT comprehension test						
N	22		18		16	
M	7.80	7.47	8.71	8.60	8.80	8.50
SD	2.22	2.62	1.98	1.88	1.33	1.59

Table 3 *(continued)*

Measure	Mix 1 Pre	Mix 1 Post	Mix 2 Pre	Mix 2 Post	Mix 3 Pre	Mix 3 Post
Academic skills[a] *(continued)*						
WRAT reading test						
N	22		18		16	
M	12.55	13.73	13.42	13.48	13.72	12.84
SD	3.45	3.03	4.23	3.74	4.16	4.05
Wechsler Adult Intelligence Scale and related measures						
Information						
N	23		18		18	
M	11.78	12.70	11.61	12.06	11.06	12.06
SD	2.83	2.93	2.40	2.41	2.96	3.44
Vocabulary						
N	23		18		18	
M	11.96	12.52	12.00	12.61	11.28	11.50
SD	3.18	2.81	2.91	3.13	3.41	3.84
Comprehension						
N	23		18		18	
M	12.17	14.00	12.56	12.56	12.83	12.83
SD	3.13	3.48	3.50	3.35	4.60	4.03
Arithmetic						
N	23		18		18	
M	11.22	11.61	11.33	11.11	10.61	11.72
SD	3.19	2.89	3.63	3.39	3.13	2.63
Similarities						
N	23		18		18	
M	11.83	12.87	12.39	12.94	12.00	11.56
SD	3.10	3.31	2.35	2.15	2.83	2.81
Digit Span						
Total						
N	23		18		18	
M	10.00	10.00	9.94	10.00	10.56	11.06
SD	2.37	2.73	3.28	3.24	3.91	4.24
Backward						
N	23		18		18	
M	4.43	4.43	4.78	4.89	5.06	5.22
SD	1.31	1.04	1.48	1.23	1.59	1.59
Picture Completion						
N	23		18		16	
M	10.57	11.57	11.33	11.83	10.88	12.25
SD	2.02	2.57	2.09	2.01	2.75	3.42
Digit Symbol						
N	23		18		18	
M	6.43	6.87	7.28	8.72	7.06	7.39
SD	2.69	2.65	3.12	2.95	2.82	2.89

(table continues)

Table 3 *(continued)*

Measure	Mix 1 Pre	Mix 1 Post	Mix 2 Pre	Mix 2 Post	Mix 3 Pre	Mix 3 Post
Wechsler Adult Intelligence Scale and related measures *(continued)*						
Object Assembly						
N	23		18		18	
M	9.65	10.83	10.22	9.33	8.06	9.61
SD	2.64	3.54	3.42	2.47	2.48	2.81
Block Design						
N	23		18		18	
M	11.39	13.96	10.61	11.06	10.44	13.67
SD	2.61	2.60	2.30	3.02	2.06	2.38
Picture Arrangement						
N	23		18		18	
M	9.35	10.22	10.39	10.83	8.94	9.17
SD	2.87	3.36	3.03	2.64	2.39	2.68
Verbal IQ						
N	23		18		18	
M	108.78	113.22	110.39	111.44	108.50	110.28
SD	13.19	12.03	14.34	14.71	16.95	17.90
Performance IQ						
N	23		18		18	
M	98.43	106.17	101.83	105.44	95.72	105.00
SD	12.67	14.35	14.94	13.14	13.79	16.47
Benton Visual Retention Test (recall errors)						
N	21		18		18	
M	6.52	4.62	6.17	4.89	7.83	5.94
SD	3.06	3.73	3.88	3.97	4.40	3.95
NCCEA sentence repetition						
N	23		17		16	
M	42.61	62.35	33.35	49.65	23.69	39.00
SD	31.35	27.26	35.25	36.68	19.91	30.63
WMS Logical Memory						
N	23		18		18	
M	6.91	8.70	6.17	8.61	7.39	9.28
SD	3.64	2.93	3.29	3.93	3.85	4.55
Higher order verbal and conceptual skills						
RIRM similarities task						
Category						
N	23		17		17	
M	59.09	66.00	62.76	64.88	57.06	68.41

Table 3 *(continued)*

Measure	Mix 1 Pre	Mix 1 Post	Mix 2 Pre	Mix 2 Post	Mix 3 Pre	Mix 3 Post
Higher order verbal and conceptual skills *(continued)*						
SD	8.93	10.54	5.13	7.54	14.62	6.02
Shift						
N	23		17		17	
M	51.52	59.65	58.94	64.82	50.88	64.12
SD	10.21	12.02	8.94	7.70	12.72	9.55
RIRM object sorting task						
Category						
N	23		18		8	
M	41.13	48.13	45.94	48.22	46.75	47.62
SD	9.64	9.30	12.02	12.40	11.66	14.85
Shift						
N	23		18		8	
M	10.48	17.35	20.83	21.78	10.00	17.12
SD	14.79	16.40	16.96	16.29	15.16	17.68
RIRM telegram task (self-generated)						
N	22		18		16	
M	17.14	23.32	18.89	22.44	17.62	21.62
SD	5.67	3.98	5.18	3.91	7.56	4.38

Note. RIRM = Rusk Institute of Rehabilitation Medicine; MAT = Metropolitan Achievement Test; WRAT = Wide Range Achievement Test; NCCEA = Neurosensory Center Comprehensive Examination for Aphasia; WMS = Wechsler Memory Scale.

[a] Grade equivalent.

posttreatment outcome. Analyses were performed separately on those criterion variables designated as potential indicators of near transfer versus those designated as potential indicators of far transfer of remedial training. Designated as near transfer criterion measures were several measures that were similar to some of the training tasks, whereas the secondary or far transfer criteria were all measures that were dissimilar to tasks involved in training.

Thus, the primary (near transfer) criterion measures included all the ORM measures, the Purdue Pegboard placement task, WAIS Block Design, the RIRM similarities task, and the RIRM telegram task. Results are presented in Table 4. Because of the number of analyses performed, only results associated with an alpha level of .01 or less are reported.

As shown in Table 4, carryover of training occurred on all near transfer criterion measures, as expected. Basic attention training was provided in all three treatment mixes. All ORM measures improved across the board. (The zeroing accuracy conditioner produced even greater average increases in Treatment Mixes 2 and 3 than in Treatment Mix 1. We are unable to provide a reasonable explanation for this unexpected difference.) Intergroup differences in outcome on the Purdue Pegboard placement, WAIS Block Design, the RIRM similarities task (best category), and the RIRM telegram task conformed with our expectations: Patients receiving Treatment Mixes 1 and 3 (in which they received cognitive training on tasks that were similar to these criterion measures) evidenced statistically significant improvement, whereas patients receiving Treatment Mix 2 did not.

Table 4
Significance of Analysis of Variance on Near Transfer Measures

Measure	Treatment Mix	Outcome	Treatment Mix × Outcome
Orientation remedial module			
Visual reaction time	.001	.001	.01
Attention reaction conditioner	*ns*	.001	*ns*
Zeroing accuracy conditioner	*ns*	.001	.001
Visual discrimination conditioner	*ns*	.001	*ns*
Time estimation	*ns*	.001	*ns*
Rhythm synchrony conditioner	*ns*	.001	*ns*
Purdue Pegboard (placement)[a]			
Right hand	*ns*	.001	.001[b]
Left hand	*ns*	.001	.001[b]
WAIS Block Design[a]	*ns*	.001	.001[b]
Higher level reasoning[a]			
RIRM similarities task (best category)	*ns*	.001	.01[b]
RIRM telegram task (self-generated)	*ns*	.001	.001[b]

Note. WAIS = Wechsler Adult Intelligence Scale; RIRM = Rusk Institute of Rehabilitation Medicine.

[a] Only patients receiving Treatment Mixes 1 and 3 received training on tasks similar to these measures.

[b] Improvement was shown only in patient groups receiving cognitive training (Treatment Mixes 1 and 3).

Results of the analyses on the secondary (far transfer) psychometric criterion measures are presented in Table 5. As may be seen, improvement in cognitive functioning as measured by the far transfer criterion measures was largely unrelated to treatment mix. Improvements occurred on the bimanual dexterity measure (Purdue Pegboard assembly task), on one of the visuoperceptual tasks, on three of four measures of memory functioning, and on four of six measures of higher level cognitive functioning.

Thus, as shown by results of the near and far transfer analyses, the data provide clear-cut evidence that intensive multimodal remedial intervention can produce improvements in cognitive functioning, irrespective of treatment mix. On the other hand, some improvements can be obtained only by means of specific treatments and not by others.

These analyses were performed for group data obtained with individual measures. At a group level, the magnitude of change, although statistically reliable, was not large enough to warrant a conclusion that the improvements represent an enhancement in underlying abilities. Rather, the gains achieved through participation in the program can be attributed, in the case of most subjects, to improvement in general alertness and ability to maintain focused attention, and to increased efficiency in applying residual abilities.

There were, however, individual subjects in each group who demonstrated major improvements in test performance. In those individuals, the magnitude of improvement was large enough to suggest that the treatments had not only enhanced the utilization of their residual abilities but also improved their mental capacity. Further analysis was undertaken to determine whether there were indeed clinically meaningful changes in mental capacity.

To test this consideration, we used the results of a factor analysis that was performed on

Table 5
Significance of Results of Analysis of Variance on Far Transfer Measures

Ability/measure	Treatment Mix	Outcome	Treatment Mix × Outcome
Visual scanning			
Cancellation (double stimuli)	.001	*ns*	*ns*
Intermanual dexterity			
Purdue Pegboard (assembly)	*ns*	.001	*ns*
Visuoperceptual and spatial			
RIRM figure recognition task	*ns*	*ns*	*ns*
RIRM navigation task	*ns*	.01	*ns*
RIRM spatial relations task	*ns*	*ns*	*ns*
Memory and mental control			
WAIS Digit Span (backward)	*ns*	*ns*	*ns*
NCCEA Sentence Repetition	*ns*	.001	*ns*
WMS Logical Memory	*ns*	.001	*ns*
Benton Visual Retention Test (recall error)	*ns*	.001	*ns*
Academic skills			
WRAT reading test	*ns*	*ns*	*ns*
MAT comprehension test	*ns*	*ns*	*ns*
MAT vocabulary test	*ns*	*ns*	*ns*
MAT spelling test	*ns*	*ns*	*ns*
Higher level intellectual abilities			
WAIS Verbal IQ	*ns*	.01	*ns*
WAIS Performance IQ	*ns*	.001	*ns*
RIRM similarities task (shift)	*ns*	.001	*ns*
RIRM object sorting task			
Category	*ns*	*ns*	*ns*
Shift	*ns*	*ns*	*ns*
RIRM telegram task (self-generated)	*ns*	.001	*ns*

Note. RIRM = Rusk Institute of Rehabilitation Medicine; WAIS = Wechsler Adult Intelligence Scale; NCCEA = Neurosensory Center Comprehensive Examination for Aphasia; WMS = Wechsler Memory Scale; WRAT = Wide Range Achievement Test; MAT = Metropolitan Achievement Test.

the criterion measures (Ezrachi et al., 1991). The 11 factors, along with the measures that loaded the highest on each, are as follows:

1. Alertness/Reaction Time: attention reaction conditioner, visual reaction time;
2. Focusing/Discrimination: visual discrimination conditioner;
3. Concentration: random time estimation and constant time estimation;
4. Dexterity: Purdue Pegboard (right placement, left placement, and assembly;
5. Visual Processing: RIRM figure recognition task and RIRM letter cancellation task (double stimuli);
6. Verbal Memory: WAIS Arithmetic, Digit Span, and Information subtests; NCCEA Sentence Repetition; and WMS Logical Memory subtest;
7. Academic Skills: MAT vocabulary, spelling, and comprehension tests and WRAT

Table 6
Number of Patients Achieving Significant Improvement in Each Cognitive Domain

Domain	Treatment Mix 1 ($n = 23$)	Treatment Mix 2 ($n = 18$)	Treatment Mix 3 ($n = 18$)
Visual Processing Skills	6	1	6
Academic Skills	0	0	0
Performance Aptitude	5	1	5
Verbal Aptitude	0	0	3
Verbal Memory	1	1	3
Verbal Categorical Reasoning	9	3	9
Nonverbal Categorical Reasoning	6	1	1

Note. Significant improvement was defined as increase of at least one standard deviation over pretreatment scores.

reading test;

8. Performance Aptitude: WAIS Object Assembly, Picture Arrangement, Block Design, Picture Completion, and Digit Symbol subtests, and recall errors on the Benton Visual Retention Test;

9. Verbal Aptitude: WAIS Comprehension, Similarities, Vocabulary, and Information subtests;

10. Verbal Categorical Reasoning: RIRM similarities task (best category and shift scores) and RIRM telegram task (self-generated); and

11. Nonverbal Categorical Reasoning: RIRM object sorting task (shift score).

Both pre- and postprogram factor scores were obtained. For each domain of functioning examined, baseline (preprogram) factor loadings were applied to the postprogram scores. Postprogram factor scores were thus computed with the baseline means and standard deviations as a reference standard. This provided a basis for evaluating subjects' performance at posttesting relative to their own pretest distribution.

We adopted as our index of substantial (i.e., clinically meaningful) change a one standard deviation difference between pre- and postprogram factor scores. Furthermore, to ensure the stringency of the test, we examined only secondary (far transfer) criterion variables. The findings are summarized in Table 6.

As shown by the results, more subjects from Treatment Mixes 1 and 3 improved in several cognitive domains in a clinically meaningful way than did subjects from Treatment Mix 2. Results were statistically significant in two areas: Verbal Categorical Reasoning, $\chi^2(1, N = 46) = 4.50, p < .05$, and Visual Processing, $\chi^2(1, N = 46) = 4.43, p < .05$. It may thus be concluded that, at least for certain subjects, direct cognitive training (with or without group training) is more likely to produce superior outcomes in the cognitive area than are mere group interventions.

Functional Behavioral Measures

Four factors were derived from the 19 items of the BCI: Adaptation to Community Skills, Self-Care, Regulation of Affect, and Involvement With Others. Pre- and postprogram factor

Table 7
Number of Patients Achieving Significant Improvement in Functional Behavioral Domains

Domain	Treatment Mix 1 ($n = 23$)	Treatment Mix 2 ($n = 18$)	Treatment Mix 3 ($n = 18$)
Adaptation to Community	4	0	1
Self-Care	1	2	1
Regulation of Affect	11	6	2
Involvement With Others	10	7	9

Note. Significant improvement was defined as increase of at least one standard deviation above pretreatment scores.

scores were generated as described in the preceding section. The results are summarized in Table 7.

As can be seen, all three treatment mixes produced approximately the same number of people who significantly improved their involvement with others in naturalistic settings. However, patients receiving Treatment Mix 1, in which they received both cognitive and group interpersonal skills training, were more likely to exhibit significant change in their regulation of affect than were subjects from Treatment Mix 3, $\chi^2(1, N = 36) = 6.29, p < .01$. (Although the trend did not reach statistical significance, subjects receiving Treatment Mix 2, which emphasized interpersonal exercises in small groups, were also more likely to improve in regulation of affect compared with subjects receiving Treatment Mix 3.) It may thus be concluded that, from the standpoint of functional outcomes in daily life, the three treatment mixes are equally effective, but on the whole a balanced treatment mix is most likely to produce superior results.

Intra- and Interpersonal Measures

Pre- and postprogram scores on the four structured measures of intra- and interpersonal functioning are presented in Table 8, and results of a two-way, mixed-design ANOVA are shown in Table 9. As was the case with the cognitive measures, significant improvement was evidenced in all three groups without distinction as to treatment mix.

In general, the results indicate that subjects' participation in the program, irrespective of treatment mix, yielded improvements in self-image and the quality of interpersonal relatedness and interaction. These results support our clinical observations that interactions between staff and clients were equally effective whether they were carried out within the context of structured cognitive remedial exercises or small-group interpersonal training.

This is not surprising because a systematic effort was made in each type of remedial intervention to promote increased awareness, malleability, and self-acceptance. The results show that these clinical objectives are equally obtainable with any of the three approaches to mixing treatments.

Although the grouped-data analysis indicated no significant differences in the efficacy of any treatment mix in this outcome domain, we further examined the question of whether, for certain patients, one approach is more effective than another. To test this, we compared

Table 8
Summary of Patients' Pre- and Posttreatment Scores on Intra- and Interpersonal Measures

Measure	Treatment Mix 1		Treatment Mix 2		Treatment Mix 3	
	Pre	Post	Pre	Post	Pre	Post
Self-esteem						
N	23		18		17	
M	11.48	14.13	13.28	15.00	13.12	14.65
SD	3.65	1.60	1.32	0.84	1.62	1.11
Self-appraisal						
N	23		18		17	
M	6.35	7.52	6.78	7.94	6.47	7.00
SD	1.34	1.65	1.52	1.21	1.37	1.17
Interpersonal empathy						
N	23		18		17	
M	18.39	20.61	19.72	22.06	20.82	21.53
SD	2.98	3.51	2.61	2.31	3.56	2.70
Social cooperation						
N	22		18		14	
M	19.05	21.36	19.17	21.61	20.50	23.14
SD	4.80	4.75	3.97	4.27	4.57	3.84

pre- and postprogram *z*-score differences for individual subjects in each treatment mix. Once again, one standard deviation was set as an index of clinically meaningful improvement. Results are presented in Table 10. As can be seen, subjects receiving group interpersonal skills training (Treatment Mixes 1 or 2) more often exhibited significant change on the self-appraisal index than did patients who did not receive such training (Treatment Mix 3): Treatment Mix 1 versus Treatment Mix 2, $\chi^2(1, N = 46) = 6.17, p < .01$; Treatment Mix 2 versus Treatment Mix 3, $\chi^2(1, N = 36) = 10.60, p < .01$. A similar trend emerged for the self-esteem and interpersonal empathy measures, although these did not reach statistical significance.

Vocational Outcomes

Employability ratings, based on performance in occupational trials at 3 months posttreatment and employment status at 9 months posttreatment, were compared for the three treatment mixes using median tests. The results are presented in Table 11.

Because of the nature of the data, nonparametric analyses were performed, revealing that vocational outcomes were statistically indistinguishable across groups at both assessment points. As shown in Table 11, a substantial percentage of clients in all treatment mixes were returned to productive employment following participation in the program. Treatment mix was unrelated to level of employability or to the number of clients attaining employment. Hence, from the standpoint of vocational outcome, all three treatment mixes proved equally effective.

Table 9
Significance of Results of Analysis of Variance of Intra- and Interpersonal Functioning Measures

Measure	Treatment Mix	Outcome	Treatment Mix × Outcome
Self-esteem	*ns*	.001	*ns*
Self-appraisal	*ns*	.001	*ns*
Interpersonal empathy	*ns*	.001	*ns*
Social cooperation	*ns*	.001	*ns*

Summary

The effects of three treatment mixes were measured in terms of outcomes in four domains: neuropsychological test performance, aspects of functional daily life, selected intra- and interpersonal functions, and vocational outcome. Results showed that (a) all three treatment mixes produced near and far transfer of remedial training in certain circumscribed areas of cognition but that systematic cognitive remedial training yielded additional, specific carryover cognitive effects; (b) with respect to functional competence in daily life, all three treatment mixes were effective but that the balanced treatment mix was superior to the other two in some respects; (c) in terms of intra- and interpersonal functions, the three treatment mixes were equally effective but that the treatment mixes in which group interventions were emphasized were superior to Treatment Mix 3 in some respects; and (d) the three treatment mixes were equally effective in terms of posttreatment return to work as well as level of vocational attainment.

Discussion

Improvement on the primary (near transfer) criterion measures indicates that, if nothing else, practice effects followed intensive remedial interventions. Results on the secondary (far transfer) criterion measures, however, indicate that some improvement in cognitive functioning other than that due to practice also occurred. Moreover, results of the factor analysis

Table 10
Number of Patients Achieving Significant Improvement in Each Intra- and Interpersonal Domain

Domain	Treatment Mix 1 (n = 23)	Treatment Mix 2 (n = 18)	Treatment Mix 3 (n = 18)
Self-esteem	10	7	3
Self-appraisal	9	10	1
Interpersonal empathy	5	4	0
Social cooperation	7	7	5

Note. Significant improvement was defined as an increase of at least one standard deviation above pretreatment scores.

Table 11
Vocational Outcomes

Outcome	Treatment Mix 1		Treatment Mix 2		Treatment Mix 3	
	No.	%	No.	%	No.	%
Employability ratings at 3 months posttreatment						
Open environment	16	70	14	78	15	83
Sheltered environment	4	17	2	11	1	6
Unemployable	3	13	2	11	2	11
Employment status at 9 months posttreatment						
Open environment	12	52	14	78	11	61
Sheltered environment	4	17	2	11	3	17
Unemployed	7	31	2	11	4	22

suggest that, for some subjects, the magnitude of the gains was large enough to warrant the interpretation that clinically meaningful improvements occurred in certain domains of cognitive functioning as a result of remedial interventions.

Taken together, the findings from this study appear to disprove the arguments of those critics of cognitive remediation (Butler & Namerow, 1991; Volpe & McDowell, 1990) who question both its validity and efficacy on the grounds that it can produce no more than practice effects rather than a genuine improvement in cognitive functioning.

The factor analysis addresses another issue as well. It has been argued that (single) psychometric tests may not be good indicators of change after neuropsychological rehabilitation because people with brain injuries may pass, or fail, the same test for different reasons (Rattok & Ross, 1991), so that a single test may not reflect the same underlying ability across different subjects. It can be argued, however, that factor scores are more stable reflections of a common underlying ability. Hence, if this is correct, factor scores should be used to assess change following cognitive remediation.

The evidence from this study points to the superiority of the balanced mix of treatments over the other two variations. This has significant practical implications for treatment and service delivery.

Because outcome was assessed with psychometric, functional, interpersonal, and vocational measures, this study goes a long way toward capturing the efficacy of treatments for the different domains of functioning that are relevant in the context of neuropsychological rehabilitation. Although this study does not directly address the issue of treatment generalization (a central problem in the rehabilitation of persons with a head injury), the results clearly indicate that gains occurred in skill areas that were related to the treatments but that the gains also tended to remain circumscribed to certain aspects of cognitive functioning. Methodologically speaking, the present study demonstrates that it is possible to conduct effective clinical tests of multimodal approaches. More such studies will help establish the credibility of neuropsychological rehabilitation.

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