Visuospatial Deficits after Right Hemisphere Stroke

(rehabilitation, self-care, perceptual disorders)

The influence of visuospatial deficits on functional status after right hemisphere stroke was investigated in 34 patients. Correlation coefficients between visuospatial deficits and other factors—age, sex, vocabulary, educational level, hemiparesis, hemianopia, left-sided extinction, length of stay on a rehabilitation unit, and time lapse between onset of stroke and admission to the rehabilitation unit—were also computed. Little correlation was found between the severity of the hemiparesis and the severity of the visuospatial deficits, yet both motor and visuospatial deficits proved to be important predictors of functional status at the time of discharge from the stroke rehabilitation unit. We conclude that visuospatial deficits are an important independent factor governing functional outcome and should be given as much attention as hemiparesis during discharge and rehabilitation planning for the right hemisphere stroke patient.

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Several attempts have been made to define the factors influencing stroke rehabilitation (1-7). The outcome of rehabilitation has been evaluated in terms of discharge functional level (degree of independence in activities of daily living), discharge disposition status (home versus extended care facility), and length of stay on the rehabilitation unit (1, 2, 4, 5).

There is general agreement that discharge functional level is adversely influenced by the severity of hemiparesis, perceptual deficits, cognitive dysfunction, and persistence of sphincter incontinence (1, 2, 4, 5). There is less consensus about the relationship of age, sex, and hemisensory deficits to outcome (1, 2, 4-7). Discharge disposition status appears to be more closely related to social and economic factors than to perceptual deficits (4, 8).

Opinions are varied about the importance of using perceptual deficits as a prognostic indicator of functional ability post stroke. Such factors as denial, neglect, spatial disorders, right-left disorientation, and dyspraxia have all been studied under the broad heading of perception; the frequent clustering of several of these factors has contributed to the divergence of opinion on the significance of perceptual disabilities in prognosis. Rosenthal, Pearson, et al. did not find a significant correlation between the severity of perceptual deficits and the degree of improvement during rehabilitation following right hemisphere stroke (7). Lorenze and Cancro found that the severity of visual perceptual deficits correlated with ability to perform activities of daily living (3). However, their sample was too small to obtain statistical significance. Feigenson, McDowell, et al. found that severe perceptual deficits upon admission were related to unfavorable outcome (1). Their study did not distinguish the individual influences of denial, neglect, apraxia, or visuospatial impairment. Similarly, from the Feigenson study, one is unable to ascertain which area of perception was most critical to their finding that "patients with perceptual dysfunction but not with cognitive dysfunction can make significant gains in activities of daily living." (2, p 660)

Most previous studies have tended to pool right and left hemisphere-damaged patients into a single sample (1, 2, 3, 5). Since right and left hemisphere-damaged patients differ in their pattern of neurological deficits, it is probable that the relative importance of prognostic factors will also vary between these two groups. Therefore, we have specifically studied the effects of visuospatial impairment in a group of patients with damage limited to the right hemisphere. The importance of visuospatial deficits as a factor predicting rehabilitation of the right hemisphere-damaged patient has been examined in detail. We have also explored the effect that age, sex, locus of lesion, hemianopia, left-sided extinction, educational levels, and time lapse from illness to admission have on visuospatial deficits following right hemisphere stroke.

Method

Patient Sample. Thirty-four patients (17 men and 17 women) with right hemisphere strokes participated in the study. All were admitted to the neurological unit of Massachusetts Rehabilitation Hospital between January and June of 1979. Consecutive patients who met all of the following criteria were selected: 1. age below 80 years, 2. no previous history of stroke, 3. right handed, 4. oriented to person, place, and time.

Radionuclide and computerized tomographic brain scans localized the lesions to the anterior (pre-Rolandic) cortex in 14 patients (7 men and 7 women). In 20 patients, damage was either confined to the posterior cortex (post-Rolandic) or extended to both the posterior and the anterior cortex. Ages of the patients ranged from 47 to 79 years with a mean of 66.9 years. Patients were admitted for rehabilitation a mean of 29.9 days after stroke onset and remained on the neurological unit for a mean of 49.9 days.

Sixteen control subjects (8 men and 8 women) consisting of patients hospitalized on other units of the hospital for nonneurological conditions were also tested. Control subjects were comparable to right hemisphere-damaged patients with respect to age and education (Table 1).

Neurological Deficits. The right hemisphere-damaged patients were examined for the presence of tactile extinction, hemianopia, and degree of hemiparesis. Tactile extinction was considered present if the left-sided stimulus was ignored upon double-simultaneous stimulation of the hands with vision occluded (8). Hemianopia was assessed by confrontation testing of the visual fields. Hemiparesis was rated on a 4-point scale modified from Trombly and Scott (9): 1 = movement of limb through full range of motion against gravity and moderate resistance; 2 = movement of limb through full range of motion against gravity with no added resistance; 3 = movement of limb through full range of motion on a gravity-eliminated plane with no added resistance; 4 = trace or no movement. For purposes of statistical analysis, only the lower extremity was used in our calculations. Spasticity and passive range of motion were not considered.
Table 1
Characteristics and Test Scores of the Right Hemisphere Stroke Patients and the Control Subjects (Mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Controls n = 16</th>
<th>Right Hemisphere n = 34</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>66.0 ± 11.9</td>
<td>66.9 ± 9.4</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>11.6 ± 2.7</td>
<td>10.7 ± 2.8</td>
</tr>
<tr>
<td><strong>Vocabulary</strong></td>
<td>49.4 ± 16.1</td>
<td>48.7 ± 16.1</td>
</tr>
<tr>
<td><strong>Rey Figure</strong></td>
<td>32.3 ± 4.2</td>
<td>19.2 ± 11.2</td>
</tr>
<tr>
<td><strong>Embedded Figures Test</strong></td>
<td>17.9 ± 2.7 *</td>
<td>12.0 ± 9.8</td>
</tr>
<tr>
<td><strong>Block Design</strong></td>
<td>21.9 ± 8.2</td>
<td>11.8 ± 4.5</td>
</tr>
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</table>

*Means differ, two-tailed t - test, p < .01, df = 48.

Psychological Tests. Both the control subjects and right hemisphere-damaged patients were tested for vocabulary and visuospatial ability.

The 40-item vocabulary subtest of the Wechsler Adult Intelligence Scale (WAIS) was administered according to the instruction manual (10). Administration time was approximately 10 minutes with a maximum possible score of 80.

The first eight plates of the Figure-Ground Perception Test (11) were used as an embedded figures test to assess visuoperceptive ability. The test was discontinued after five errors. Administration time was approximately 10 minutes with a maximum possible score of 24.

Five minutes were allowed to copy the Rey Figure. The Rey Figure is a complex line diagram that patients with visuocognitive deficits find difficult to copy (Figure 1) (12). Subjects' productions were scored on a point scale of 0 to 36.

The WAIS block design subtest was used as a second measure of visuocognitive ability. The test was administered according to the instruction manual (10) with a maximum possible score of 48. Administration time was approximately 10 minutes.

Self-Care Scores. Level of independence in self-care was rated on a 28-point scale developed at the Sister Kenny Institute (13). The Kenny Institute self-care score assesses degree of functional dependence in seven areas: bed activities, transfers, locomotion, dressing, personal hygiene, bowel and bladder function, and feeding. In each of the seven areas, patients are rated from 4 points (totally independent) to 0 points (totally dependent). Maximum possible score is 28. Patients with scores more than 25 are generally quite independent, whereas patients with scores below 12 require almost complete care. Self-care scores were assessed on admission, every 2 weeks during hospitalization, and at discharge.

Disposition Status. Disposition status at time of discharge was rated on a 3-point scale: 3 = home independent; 2 = home with supportive services; or 1 = extended care facility.

Statistical Methods. Analysis of variance, analysis of covariance, and calculation of correlation coefficients were performed by standard methods (14-16).

Results and Discussion

The Visuospatial Deficit. The right hemisphere-damaged patients were impaired on all three visuospatial tests (Table 1). The performance of the right hemisphere-damaged patients fell 3 standard deviations below the controls on the Rey Figure, 2 standard deviations below the controls on the Embedded Figures Test, and 1 standard deviation below the controls on the Block Design Test.

All three visuospatial tests showed statistically significant intercorrelations (Table 2) despite the fact that two were visuocognitive tests (Block Design and Rey Figure) and one was a visuoperceptive test (Embedded Figures Test).

In agreement with earlier studies (17), visuospatial disorders were found to be more severe in patients with posterior as opposed to anterior right hemisphere damage. However, even patients with lesions limited to the anterior right hemisphere were impaired on the visuospatial tests when compared to controls (Table 3). Although patients without extinction or hemianopia did better on the visuospatial tests than patients with these deficits, they were still impaired on these tests when compared to controls.
Figure 1
Model for copying Rey Figure is above. Below are attempts of three patients with right hemisphere damage to copy the figure. Figure on far left shows a severe visuoconstructive deficit (Score = 6). Middle figure also shows a moderate visuoconstructive deficit (Score = 11). Figure on far right illustrates a mild deficit (Score = 22). Maximum possible score is 36 (reference 11).
Table 2
Correlation Coefficients for Right Hemisphere-Damaged Patients (decimal points deleted)

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<thead>
<tr>
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<th>Sex</th>
<th>Age</th>
<th>Education</th>
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<th>Extinction</th>
<th>Hemianopsia</th>
<th>Vocabulary</th>
<th>Rey Figure</th>
<th>Block Design</th>
<th>EFT</th>
<th>DSCS</th>
<th>LOS</th>
<th>Disposition</th>
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EFT = Embedded Figures Test
LOS = Length of Stay
CSCS = Change in Self-Care Status
DSCS = Discharge Self-Care Status
*p < .05, df = 32.

Tables 4 and 5). This suggests that neither hemianopia nor left-sided extinction can fully explain difficulties of the right hemisphere-damaged patients on visuospatial tests.

Consistent with findings of Weinstein and Teuber (18) we found that educational levels attained before the stroke did not affect the magnitude of the visuospatial deficit (Table 2). Verbal ability as measured by the vocabulary subtest of the WAIS was also found to be unrelated to visuospatial deficits (Table 2). These results suggest that higher verbal intelligence may not be successful in compensating for nonverbal visuospatial deficits. Nor did the duration of time between onset of stroke and admission to unit affect the patients' performance on visuospatial tests; this finding suggests that spontaneous recovery from visuospatial deficits may be an extremely slow process (19).

Age Effects on Visuospatial Ability. When the right hemisphere-damaged patients and the control subjects are dichotomized by age with a cutpoint of 67 years, the younger subjects do perform better than the older subjects in both the right hemisphere-damaged and control groups on visuospatial tasks (Table 6).

An analysis of variance based on the cell means in Table 6 revealed significant AGE effects for block design ($F = 11.2; df = 1.46; p < .01$), Embedded Figures Tests ($F = 10.0; df = 1.46; p < .01$), and Rey Figure ($F = 9.8; df = 1.46; p < .01$). Thus, the subjects less than 68 years old performed better on all three visuospatial tests than the older subjects.
This result is compatible with earlier observations that visuospatial ability declines with age (20).

Analysis of variance on the cell means of Table 6 also reveals a significant effect for DIAGNOSIS with the right hemisphere-damaged subjects faring less well on all three visuospatial tests than the controls (see also Table 1). However, there was no evidence for an AGE X DIAGNOSIS interaction effect on block design ($F = .6; d = 1.46; p = .44$), Rey Figure ($F = 2.6; df = 1.46; p = .11$), or Embedded Figures Test ($F = 1.0; df = 1.46; p = .31$). The absence of a significant AGE X DIAGNOSIS interaction (Table 6) suggests that the greater visuospatial deficits found in the older right hemisphere-damaged patients are due to the effect of age on visuospatial ability itself rather than any special susceptibility toward visuospatial deficits following right hemisphere damage in the older patient.

**Sex Differences in Visuospatial Deficits.** Both men and women showed a substantial decline in visuospatial ability after right hemisphere stroke when compared to controls (Table 7). Although the decline in visuospatial ability was slightly less marked among the women, this difference was not statistically significant on any of the visuospatial tests even when an analysis of covariance corrected for the older age of the female sample.

There is some evidence (21) that men have a greater dependence upon the right hemisphere for visuospatial tasks than do women. This hypothesis leads to the prediction that men will show a greater decline in visuospatial ability after right hemisphere damage than will women. Although our results show that women do marginally better than men on visuospatial tasks after right hemisphere stroke, the differ-

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### Table 3

Visuospatial Test Scores According to locus of Right Hemisphere Lesion
(mean ± SD)

<table>
<thead>
<tr>
<th>Posterior Lesions or Combined Anterior and Posterior Lesions</th>
<th>Anterior Lesions Only</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded Figures Test</td>
<td>10.0 ± 4.3</td>
<td>14.3 ± 3.3</td>
</tr>
<tr>
<td>Block Design</td>
<td>8.2 ± 9.4</td>
<td>17.4 ± 7.4</td>
</tr>
<tr>
<td>Rey Figure</td>
<td>14.5 ± 11.3</td>
<td>24.9 ± 9.1</td>
</tr>
</tbody>
</table>

*Means differ, *t*-test, $p < .005.$

### Table 4

Effect of Hemianopia on Visuospatial Test Scores

<table>
<thead>
<tr>
<th></th>
<th>RHD with Hemianopia</th>
<th>RHD without Hemianopia</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded Figures Test</td>
<td>7.9 ± 3.0</td>
<td>13.0 ± 4.8</td>
<td>17.9 ± 2.7</td>
</tr>
<tr>
<td>Block Design</td>
<td>3.5 ± 6.7</td>
<td>16.6 ± 7.9</td>
<td>21.9 ± 8.2</td>
</tr>
<tr>
<td>Rey Figure</td>
<td>9.6 ± 9.2</td>
<td>23.8 ± 9.6</td>
<td>32.3 ± 4.2</td>
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</tbody>
</table>

*Means differ, *t*-test, $p < .001.
RHD = right hemisphere-damaged

### Table 5

Effect of Extinction on Visuospatial Test Scores

<table>
<thead>
<tr>
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<th>RHD with Extinction</th>
<th>RHD without Extinction</th>
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<tbody>
<tr>
<td>Embedded Figures Test</td>
<td>9.8 ± 4.2</td>
<td>13.9 ± 4.3</td>
<td>17.9 ± 2.7</td>
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<tr>
<td>Block Design</td>
<td>5.6 ± 8.8</td>
<td>17.7 ± 6.6</td>
<td>21.9 ± 8.3</td>
</tr>
<tr>
<td>Rey Figure</td>
<td>11.9 ± 10.7</td>
<td>24.9 ± 8.6</td>
<td>32.3 ± 4.2</td>
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</tbody>
</table>

*Means differ, *t*-test, $p < .001.
RHD = right hemisphere-damaged

### Table 6

Effect of Age on Visuospatial Ability: Cell Means According to AGE and DIAGNOSIS for Three Visuospatial Tests

<table>
<thead>
<tr>
<th></th>
<th>RHD Young Group N = 15</th>
<th>RHD Old Group N = 19</th>
<th>CONTROL Young Group N = 8</th>
<th>CONTROL Old Group N = 8</th>
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<tbody>
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<td>14.6</td>
<td>9.8</td>
<td>19.1</td>
<td>16.6</td>
</tr>
<tr>
<td>Block Design</td>
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<tr>
<td>Rey Figure</td>
<td>25.7</td>
<td>13.1</td>
<td>34.3</td>
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</table>

RHD = Right hemisphere-damaged
Young = Less than 68 years
Old = Greater than or equal to 68 years
of current rehabilitation strategies.

### Discharge Disposition Status

Twenty-two patients were discharged home with supportive services, six patients were discharged to extended care facilities, and six patients were discharged home fully independent. Discharge disposition status correlated with hemianopia ($r = +.51$), extinction ($r = +.60$), and Embedded Figures Test scores ($r = -.67$). Surprisingly, degree of hemiparesis did not significantly influence discharge disposition status, whereas visual and visuospatial deficits did correlate with discharge disposition status. This again suggests that current rehabilitation strategies may be more effective at compensating for the motor deficits than the visual and visuospatial deficits that accompany right hemisphere stroke.

### Length of Stay

Length of stay was found to correlate weakly ($r = +.31$) with degree of hemiparesis, perhaps a result of current health insurance regulations governing rehabilitation hospitals that tend to promote early discharge of patients with a lesser degree of hemiparesis. Unfortunately, many such patients have severe visual or visuospatial deficits and thus remain highly limited in their level of functional independence. Even though patients with visuospatial and visual deficits are ready for discharge by one prevalent criterion—ambulation—they are often unable to function independently because of their other deficits.

### Conclusions

Visuospatial deficits have a significant influence on several indices of rehabilitation and right hemisphere stroke: discharge disposition status, discharge self-care score, and change in self-care score during hospitalization. It is through a better understand-
standing of visuospatial deficits that rehabilitation aimed at compensat-
ing for these deficits can be made more effective.

Increasing age, hemianopia, and extinction contribute to, but are not solely responsible for, these visuo-
spatial deficits. Sex has only a mark-
ginal effect on performance favor-
ing women. Hemiparesis, verbal ability, educational level, and dura-
tion from onset of illness to time of admission did not correlate with
visuospatial deficits. Factors that were not examined include motivate-
tion, family support, and emotional adjustment to illness.

Hemiparesis is an obvious deficit repeatedly studied as a factor affect-
ing functional outcome (1-7). This study suggests that, after right hemi-
sphere stroke, visuospatial deficits are equally important in predicting
functional outcome and may be more important in determining dis-
charge disposition status.

Therapists who routinely check for hemiparesis may fail to consider
visuospatial deficits as an explana-
tion for a patient’s failure in in-
dependent living. In a study of 153
stroke patients any notation about
the presence of visuospatial deficit
was absent in 93 percent of the med-
cal records (24). Another study that
identified the areas of dysfunction most frequently included on formal
occupational therapy CVA forms found that whereas 97 percent of all
returned forms included a space for
a motor assessment, only 47 percent
included an area for the assessment of visual perception (25). This study
may suggest a lack of emphasis by
occupational therapists on the area
of visual perception (when com-
pared to motor performance).

Our results suggest the critical
importance of further developing and improving treatment programs
aimed at compensating for visuo-
spatial deficits. Helping patients to
understand why they are experienc-
ing difficulties in activities of daily
living will help to alleviate undue frustration. Research is needed to
test the effectiveness of various tech-
niques and strategies in this area.
Therapists must reconsider the piv-
tal role visuospatial abilities play
in the successful rehabilitation of
the right hemisphere-stroke patient.

Acknowledgment
Acknowledgment is due to Pamela
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tial stages of the research.

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berg SD, Feigenon WD: Factors in-
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